FLORVERDE

SUSTAINABLE FLOWERS

Guide for the safe IPM practices implementation in ornamental crops

Planning | Execution | Verification | Adjustment

Guidelines for the management of pest control substances and agents in Colombian floriculture

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Guide for the safe IPM practices implementation in ornamental crops

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First Edition, January 2021

Quote as:

Quintero C, J and Valcárcel C.F., 2022.

With the support of:

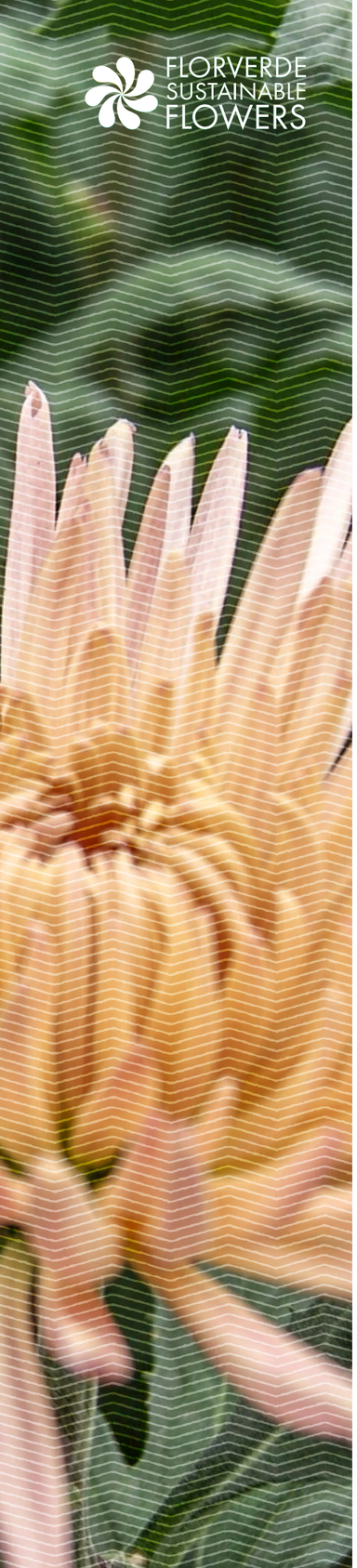
asocolflores
Asociación Colombiana de Exportadores de Flores

Disclaimer

This document is for information purposes only. It has been made for internal use of flower and ornamental plant-producing companies to update concepts about the safe use of pesticides and other pest control substances and agents and as a tool for professionals and technicians responsible for pest control in Colombian flower-growing companies.

Asocolflores and the certification scheme of Florverde Sustainable Flowers will not be liable for improper use of this information.

All concepts herein do not waive the companies' responsibility to comply with applicable legislation.



Introduction

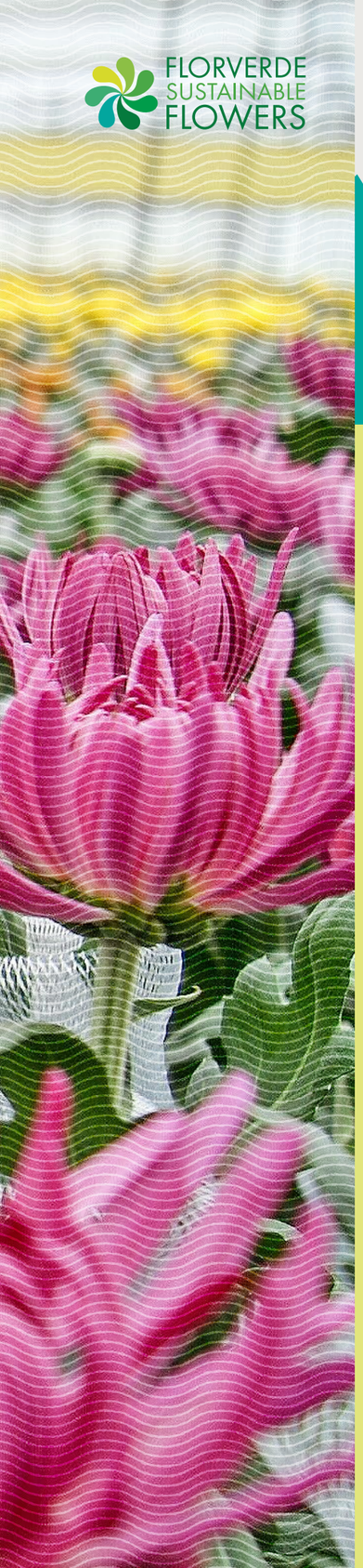
Agricultural production is associated with the presence of organisms whose increase in population may turn into plagues, fluctuating according to climate change conditions, the development condition of the crops, and the management practices at flower farms. This encourages growers to integrate different pest control strategies to maintain or increase the productivity and quality of their crops.

Among the objectives of Asocolflores Sustainability Route and the certification of Florverde Sustainable Flowers is to promote that flower and ornamental plant companies implement programs for Integrated Pest Management (IPM) and the safe use of pesticides and other chemical substances for pest control to minimize human health and environmental risks, according to standards applicable and in effect. That generated the need to revise and update the Guide for Safe Use and Management of Pesticides (Quintero, J. 2009) and to adjust and harmonize it with the status of IPM best practices in the flower-growing sector.

This guide updates concepts for the safe use of pesticides, as developed in the previous edition, and includes standards for the safe management of other pest control chemical substances currently in use, and it is complemented with documentation of the central IPM practices. Its contents become a more comprehensive working tool at the reach of professionals and technicians who manage the companies. We hope this document serves those responsible for IPM programs to design, document, and implement the prevention, containment, and phytosanitary management plans demanded by the competent national authorities.

The Guide's structure focuses on the processes and includes the continuous improvement cycle since it unites the planning, execution, verification, and adjustment elements related among themselves, which can come together within a logical sequence to reach a result: the ornamental product phytosanitary quality. This allows seeing the IPM process holistically, facilitating its management according to the culture, the resources available, and the organization's structure of the flower-growing companies.

It is important to clarify that the scope of this Guide in terms of the current use of new chemical substances and pest control practices in the sector, some of which still do not have clear regulations, is solely for information purposes. It is not intended to be seen as a technical document, nor a standard which strives to recommend or demand its implementation by the different companies. The decision to adopt, interpret, and use this Guide is the growers' exclusive responsibility.



Contents

Processes-Based Management Approach

As already mentioned and shown in the following figure, this Guide uses the processes-based management approach and includes the continuous improvement cycle to facilitate IPM management and its interaction with other company processes. Results are more efficient when activities and resources are managed as a holistic process.

A process is a set of mutually related activities or activities that interact and transform the input elements into results (ISO 9001:2005). The next page's figure illustrates the process route.

When IPM is approached as a project, the responsible manager will be able to:

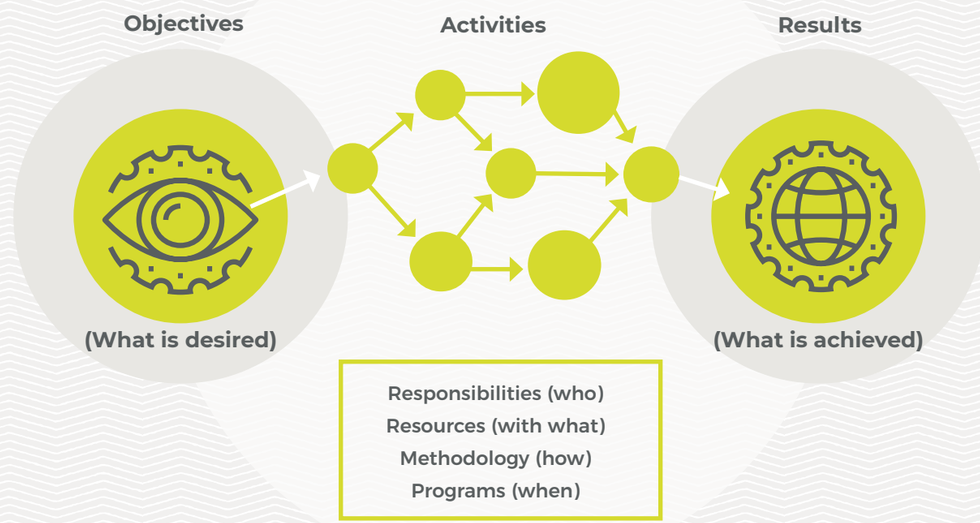
- Guarantee and manage the necessary operating resources.
- Manage each of its elements as parts of a system.
- Guide actions towards the achievement of goals.
- Continuously improve the proces.

For the IPM process to work and be considered as a fundamental piece within the production of ornamental plants, it is indispensable to have the leadership, commitment, and support of the top management, as well as the technicians, establishing clear policies and objectives that guarantee the necessary resources for its execution. These shall promote thoroughness and teamwork, the constant monitoring of goals and objectives achievement, accountability facilitation, and continuous improvement.

Objectives

Our objectives were to document current IPM best practices in Colombia's flower-growing sector, to update the criteria and guidelines for pest control substances safe management, and to deliver a tool that facilitates the administration process according to the applicable standards in effect.

Below is a description of each of the Guide elements, as well as guidelines for their implementation. Additionally, the applicable standards will be mentioned within the national legislation and Florverde's Standards for flower and ornamental plants sustainable production. This will allow everyone to know the process, make consultations, ensure their compliance, and wait for new updates.



I. Planning

The IPM process must be planned considering the company's context and characteristics, as well as the needs and expectations of internal and external stakeholders.

Planning means establishing objectives and goals, as well as the allocation of the necessary resources to achieve the best IPM process results in accordance with the company's requirements and the competent national authorities' demands. Planning shall include, at least, the following elements:

Policy

The IPM process must be aligned with the productivity, quality, and socio-environmental commitment of the company.

Applicable Standards

» Florverde's Standard for sustainable production of flowers and ornamental plants.

Objective

Make sure the person responsible for IPM is committed to complying with the company's productivity, quality, and socio-environmental policies, as well as phytosanitary regulations for flowers and ornamental plants exports.

Implementation Guidelines

» Start with managerial guidelines to disseminate policies and follow-up their implementation within the IPM process.
» Establish Company policies from the moment of designing the position profile and during the induction process of the IPM Manager.
» The company's policy will be permanently socialized by the IPM Manager with his work team, ensuring its compliance.

IPM Objectives and Goals

IPM must have clear objectives and goals that focus on increasing productivity, quality, the socio-environmental responsibility, and compliance of phytosanitary guidelines for exporting flowers and ornamental plants.

Applicable Standards

» Florverde's Standard for sustainable production of flowers and ornamental plants.

Objectives

» Align the IPM Manager with the Company's objectives and goals.
» Promote the best use of available resources to achieve the proposed objectives.
» Facilitate the monitoring of the implementation of IPM practices and define the adjustments required to reach the expected results.

Implementation Guidelines

» Objectives and goals shall be agreed on by the management, the production technician, and the IPM Manager.
» Propose annual, clear, enforceable, and measurable objectives and goals that allow monthly evaluations.
» The IPM Manager will discuss the objectives and goals with the rest of his/her work team.
» IPM indicators (described under section III – Verification) will be used to define the objectives and goals of the process.

IPM Participation Team

The IPM Manager, pest-monitoring personnel, and those executing pest control strategies will integrate the participation team.

Applicable Standard

» Florverde's Standard for sustainable production of flowers and ornamental plants.

Objective

Ensure proper operation of the IPM process in the company to achieve the planned tasks and objectives.

Implementation Guidelines

» Establish a weekly meeting between the IPM Manager and his/her work team of one (1) hour maximum with defined topics and schedules to monitor the routinary activities and define the adjustments required.
» Definition of the agenda by the IPM Manager, who will act as a facilitator to encourage the participation of all team members.
» Analyze the process assurance indicators and their evaluation regarding the IPM objectives and goals included under Section III. Verification.
» Write commitments in meeting minutes that will be followed up in the next meeting(s).
» Permanent coordinate work between the IPM Manager and the technical and area managers or those in charge of the productive processes for the proper and seamless execution of IPM actions.

IPM Action Plan

Describes actions required to comply with the IPM objectives and goals during a specific period.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for sustainable production of flowers and ornamental plants.

Objectives

» Determine concrete actions and allocate necessary resources, assign those who will be responsible, and establish execution dates to comply with each of the objectives and goals previously established.
» Monitor the execution of programmed actions and reprogram those deemed convenient.

Implementation Guidelines

» The IPM Manager shall be trained on basic management system concepts and preparation of action plans.
» Actions defined will aim to achieve objectives and goals established and comply with the *Phytosanitary Management Plan* demanded by competent national authorities.
» It is necessary to define a model or format to document action plans with a detailed description of concrete activities, the persons responsible for them, and the execution timeframes.
» It is recommended to define an action plan for each established objective and goal.
» The IPM Manager and his/her work team will monthly follow-ups of the action plans and goals execution.
» The management, the production technician, and the IPM Manager will monitor the action plans at least once every six (6) months to evaluate the progress made and make the corresponding adjustments, if necessary.
» The IPM Manager will permanently work in coordination with the technical manager for the implementation of the action plans.

II. Execution

The execution refers to the implementation of the plan. If it is not done, the non-compliance facts shall be immediately identified for their timely correction, making the necessary adjustments to be able to implement the plan. Following is a description of all actions through which it is expected IPM to reach its objectives.

IPM is the "careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and/or the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms" (FAO, 2006).

The IPM process includes cultural, physical, bio-rational, and chemical monitoring and control strategies, many of which have been developed and implemented during decades in the flower-growing sector, striving to maintain crops' health.

Below is a description of each of the IPM strategies, showing standards related to each one of them, and providing guidelines for their implementation.

1. Monitoring Pests in Crop and Post-Harvest

The monitoring of pests and environmental conditions, which favor them, is the main element for planning and a fundamental factor for taking IPM control decisions.

The monitoring methods must consider the nature of pests, their life cycle, and living habits, as well as their interaction with weather conditions. There are direct search methods for pests and their damages on crops or harvested products, as well as other indirect ones that use elements to attract the pests, facilitating their capture and count, as shown in the following figure.

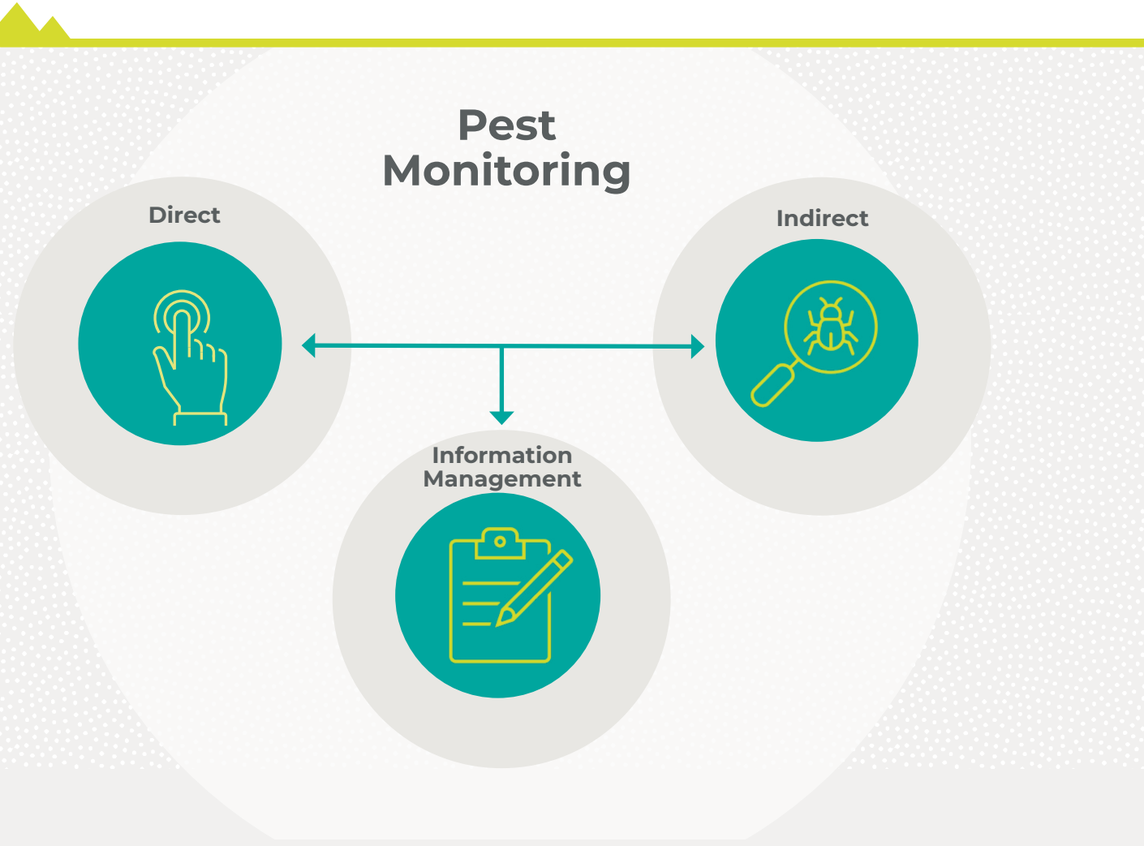
Below are the principal pest monitoring methods in ornamental plant crops.

1.1 Direct Monitoring

This is the direct, regular, and systematic inspection of the crop, the plant material after harvest, and the material given by third parties to detect and identify pests' presence.

Applicable Standard

» Resolution No. 4332 of 1995 of ICA: *Measures to Protect the salubrity of Export Pom Poms and Chrysanthemums.*



- Booklet *Quarantine Pests and Diseases in Cut Flowers*, year 2005, ICA-Asocolflores Agreement.
- Resolution No. 3440 of 1997 of ICA: *Which declares a phytosanitary contingency in the entire national territory due to the presence* of Thrips palmi *Karny*.
- Resolution No 20008 of 2016 of ICA: *Contingency Plan for Chrysanthemum White Rust (Puccinia horiana Henn) in Colombia.*
- Resolution No. 63625 of 2020 of ICA: *Requirements to register as producer, exporter and importer of flowers or cut branches of ornamental plants for exportation.*
- ICA work plans for the exportation of cut flowers and foliage to Australia (2018), Panama (2008), Argentina (2007), Paraguay (2007) and Chile (2002).
  https://www.ica.gov.co/importacion-y-exportacion/planes-trabajo-exportacion-vegetales
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Early detection of the presence of pests in crops and post-harvest to plan and execute effective pest control, so all cultivated, harvested, commercialized, or exported plant material is free of phytosanitary problems and is not intercepted by phytosanitary authorities in the ports of the destination countries.

Implementation Guidelines

Working Scheme Definition

- Define routines, times, and frequency of crop and post-harvest monitoring.
- Include all pests attacking the cultivated species.
- Comply with timeframes and frequencies of pest monitoring activities regulated by phytosanitary authorities.
- Include timeframes and routines derived from work plans agreed between ICA and the phytosanitary authorities of the importing countries.
- Have documented protocols for the execution of monitoring practices, specifying the techniques, number of samples to establish incidence percentages, pest severity, and report format (written or digital).
- Establish, program, and follow a method to ensure the quality of monitoring practices, as described in Section III. Verification.

Form a Team of Monitors

- Form work teams whose members have optimal health conditions for executing the job, reading, writing, and communication skills, good eyesight, and excellent command of basic mathematics, among other abilities.
- Assign responsibility areas to each monitor and establish dedication hours by area, day, and week.
- Allocate enough hours to comply with the daily and weekly work in all crop areas.
- Monitoring personnel must be exclusively devoted to this job, having an established schedule for its execution.
- Give working equipment to each monitor (magnifying glass, elements for written or digital reports, photographs of pests or diseases, bags, labels, ribbons, etc.).
- Establish a training program for monitors, which is documented, and minimum develops the following topics:
  - Knowledge of crops to be monitored: Basic phenology (or life cycle) and main agronomic practices for the management of every ornamental specie in the farm.
  - Life cycle, habits, and taxonomic identification of each pest attacking the crops.
  - Direct and indirect pest monitoring methods. Revision techniques.
  - Registration, processing, and reporting forms of monitoring findings.
  - Monitoring data flow.
  - Basic communication skills.
  - The IPM Manager shall participate in training programs for administrative, crop and post-harvest personnel for the

recognition and management of pests, according to the requirements of phytosanitary authorities (ICA Resolution 63625 of 2020).

Monitoring of plant material received from third parties

- This implies all material (seeds, bulbs, corms, rhizomes, cuttings, stakes, plants, cut flowers, foliage, etc.) received from third parties, for use in production or harvested product areas for post-harves processes.
- All plant material entering the farm must be accompanied by a phytosannitary certificate issued or endorsed by competent authorities (ICA) or the material vendor, in compliance with ICA's requirements.
- Implementation of protocols for revision and reporting mechanisms.
- Communicate non-conformities to vendors and demand solutions to comply with phytosanitary requirements.
- Maintain historic files which allow vendors to trace every event.

1.2 Indirect Monitoring

Indirect monitoring refers to methods to complement visual monitoring. This may be done by using adhesive traps, indicator plants, black light, or visible light traps, pheromones, baits, spore capture instruments, or humidity cameras.

Applicable Standards

- ICA Resolution 3440 of 1997. *Declaration of phytosanitary emergency in the entire national territory due to presence of* Thrips palmi *Karny.*
- ICA Resolution 63625 of 2020: *Requirements to obtain the register as producer, exporter, and/or importer of flowers or cut bouquets of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Improve the timely detection of pests and diseases affecting crops to plan and execute effective pest control.

Implementation Guidelines

- Comply with thrips indirect monitoring method and frequencies demanded by ICA in peripheral traps in all registered premises.
- Define the pests and diseases that may be monitored using indirect means as a complement to direct monitoring.
- Implement monitoring methods according to pest habits. The following are generally used in the flower-growing sector:
  - Adhesive yellow, blue, or white traps to capture leaf miners, thrips, aphids, and white fly, among others.
  - Attractive baits to capture slugs.
  - Black light traps for lepidoptera.
  - Traps with pheromones for lepidoptera.
  - Incubation of *Botrytis* in moist chambers.
  - Capture of *Botrytis* spores using passive or active mechanisms.
  - Monitoring climate-related variables.
- For each indirect monitoring method, define the reading frequency and findings registration method.
- Establish, program, and follow a method to ensure the monitoring quality as described in section III. Verification.

1.3 Monitoring Information Management

This refers to the flow and processing of the information resulting from pest monitoring. Its proper collection and sorting are definitive for taking the right control decisions.

Applicable Standards

- Resolution 63625 of 2020 of ICA: *Requirements to register as producer, exporter and importer of flowers or cut branches of ornamental plants for exportation.*
- Resolution 20008 of 2016 of ICA: *Contingency Plan for Chrysanthemum White Rust (Puccinia horiana Henn) in Colombia.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Process monitoring information to facilitate decision-making and evaluate the efficacy of the implemented control strategies.

Guidelines for its Implementation

- Internal and external reports will be obtained from the monitoring. Internal reports are generated for the specific use of the company, while external reports are required by phytosanitary authorities.

Internal Reports

- Define if data registration will be written in hard copy or digital.
- Define the type of reports that will enable the consolidation of data for each monitored area.
- Quantify the incidence, severity, and intensity of attacks by pest and by monitored area.
- Co-relate pest trends with information on climate-related variables.
- Define control indicators for the fluctuation of each pest throughout time and, if possible, establish tolerance thresholds according to monitoring historical data.
- Use monitoring results for making control decisions.

External Reports (demanded by law)

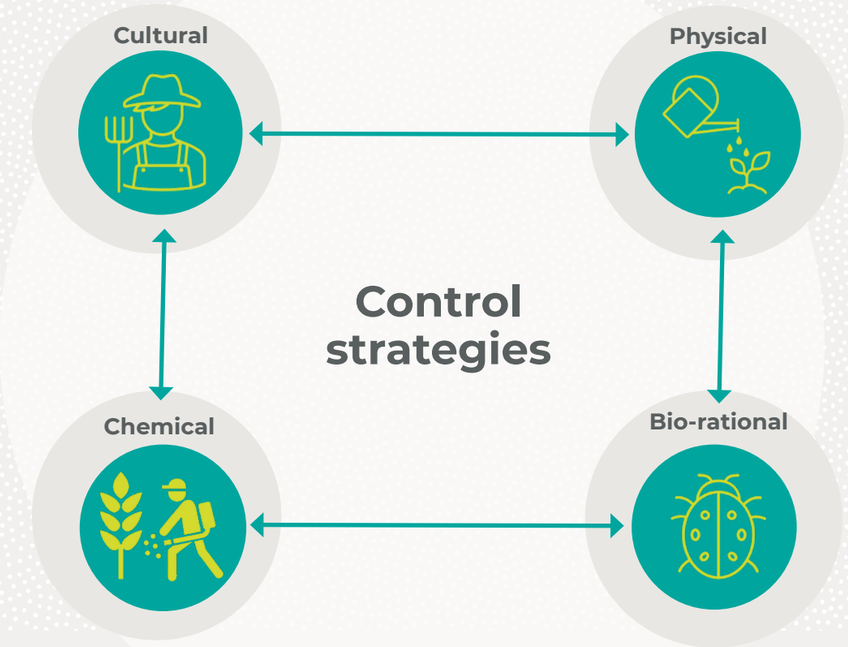
- Deliver data in physical or digital means (SISFITO), according to the terms established by ICA.
- Receive legal control visits, having monitoring data available in writing or digitally.

2. Control Strategies

2.1 Cultural Control

Cultural control is made by using diverse agronomic practices to avoid the presence of pests in cultivated areas. Initiating a crop using healthy plant material, sowing plants on pest-free soils, using optimal irrigation waters, utilizing irrigation and fertilization in adequate volumes, maintaining crop labor up-to-date, and rotating crops when feasible are practices that improve productivity and discourage the propagation of pests.

All cultural practices used by the farms with an evident relationship with pest incidence must be standardized and documented. Their implementation shall be verified within routinary work by



monitoring personnel. Below is a description of the main pest control practices used in the sector.

Soil and Substrates Preparation

Make sure that the soil and substrates used for sowing are free of pests and pathogens that may deteriorate the material to be planted.

Applicable Standards

- Resolution 63625 of 2020 of ICA: *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flores and Ornamental Plants.

Objective

Application of aseptic principles to ensure soils are free of pests and pathogens before and during plant material sowing.

Implementation Guidelines

Before Soil Preparation

- Make sure the soil is free of any kind of plant residues after the previous crop is eradicated.
- Process and manage plant residues so they do not become sources of pests and diseases in the cultivated areas.
- Analyze soils to evaluate the initial presence of pests or pathogens, focusing on those which may damage the crop species to be established.
- Analyze sowing substrates to ensure they are clean and free of pests or pathogens.
- Make sure the structures (ladders and wooden supports, containers, or plastic trays, etc.) are free of pests or pathogens.
- Before starting the preparation and adaptation of the site, it is necessary to know the results of the soil, substrates, and infrastructure analysis to make control decisions over the relevant problems.
- The IPM Manager and the Crops Technical Director shall define the corrective measures for the identified problems, considering cultural, physical, biological, or chemical actions.
- If applying pesticides or other substances to the soil is required before sowing the plants (pesticides, disinfectants, herbicides, etc.), the risk inherent to their use will be considered, resulting in their safe use for the people who apply them, as well as for those who are near or will be in contact with the treated soil, respecting the minimum buffer zones, proper signage, re-entry periods recommended in the labels, and the use of the corresponding PPE.
- It is important to respect the pre-sowing intervals recommended for the applied products to ensure their total inactivity and safety for the material to be planted.

During Soil Preparation and Plant Sowing

- During soil or substrate preparation, until the plant sowing, it is necessary to implement the necessary aseptic measures to avoid recontamination of clean areas.

  One of such measures is the use of bowls or recipients with chemical disinfectants or containers with lime (calcium hydroxide) to disinfect personnel footwear entering the sowing area. The life cycle of the disinfectant used must be checked, replacing the products when required..
- The tools, utensils, and equipment used to prepare the soil and substrates must be previously washed with clean water and disinfectant outside the sowing area to avoid the transmission of pests or diseases to clean areas.
- Once the sowing process ends, the area shall remain clean and free of plant residues and all other materials used.

Plant Material Phytosanitary Quality

Plant material to be reproduced or planted in the flower-growing farm shall come from producers with ICA registration to ensure the product's phytosanitary quality.

Applicable Standards

- Resolution 20008 of 2016 of ICA: *Contingency Plan for Chrysanthemum White Rust (Puccinia horiana Henn) in Colombia.*

- Resolution 1475 of 2012 of the Andean Community of Nations (ACN), *Establishing the phytosanitary risk categories for importing plant material.*
- Florverde's Standard for Sustainable production of flowers and ornamental plants.

Objective

Ensure the use of plant material (seeds, rhizomes, buds, corms, bulbs, stakes, cuttings, plants) is legally obtained and pest-free.

Implementation Guidelines

- Acquire plant material from vendors who have been legally registered by ICA to execute this activity. The flower-growing company shall request, verify, and maintain available a copy of the valid ICA registration for each of its plant material suppliers.
- All plant material entering the farm that comes from a third party shall bring along a phytosanitary certificate signed by an agricultural engineer with a valid Plant Health Certificate (SV for its acronym in Spanish) issued by ICA.
- When the plant material is received, the IPM Manager will order its inspection to ensure it is free of pests or diseases. In case of finding any problem, the IPM Manager and the Technical Director of the crop will decide whether the material is received or returned, depending on the problem.
- Plants whose entrance is authorized must be taken to an acclimation and adaptation area for at least one (1) week. After that time, plants shall be revised again by personnel doing pest control to ensure they are healthy.
- If problems are detected during the acclimation period, the IPM Manager will decide on control measures, such as the elimination of the affected plants, a chemical treatment, etc.

Arvense Control and Vegetative Materials Management

The timely elimination of arvense weeds and vegetative material is a measure that helps avoid the establishment and propagation of pests.

At flower farms, arvense management is mostly done manually. Currently, there are no herbicides with registered use in ornamental plants; their application increases crops toxicity risks.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Resolution No 20008 of 2016 of ICA: *Contingency Plan for Chrysanthemum White Rust (Puccinia horiana Henn) in Colombia.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Establish measures for the timely elimination of weeds and vegetative materials to avoid pest growth and propagation towards cultivating ornamental plants areas.

Implementation Guidelines

Weeds' Management

- Timely and permanent weed control shall be maintained inside and outside the cultivated areas, avoiding plants flowering that enable pests establishment and propagation.
- Pest monitoring personnel shall report areas with arvenses that require intervention by production personnel.
- Crop managers or supervisors will plan and execute permanent weed control inside and outside cultivated areas.
- Before pruning the grass with a string trimmer around the greenhouses, the lateral drapes next to the working areas shall be closed to avoid pests entering the crops.
- The plant material resulting after cutting the weeds will be packed and transported in closed recipients or containers until it reaches the processing destination.

Sprout Management

- Sprouts: Parts of the plants that remain on the floor after collecting their flowers, which, if not eliminated, can continue alive, generating tender stems and even flowers, which are attractive for pests.
- As soon as the flower harvesting ends, sprouts must be pulled and removed from the area to be prepared for the next crop.
- Once pulled out, it must be moved in bags or canvasses to avoid the potential spreading of pests throughout the transportation roads to the processing plant.
- Material processing shall be immediately done in the assigned area to avoid the dissemination of the problem towards the clean areas.
- Soils not being used shall be free of weeds or sprouts; if possible, they must be covered with greenhouse plastic. Greenhouses with lateral drapes, if they exist, should be totally closed, so both the establishment and movement of pests between the areas are impeded.
- In areas without crops, it is recommended to maintain the monitoring and control (cultural, physical, and chemical) of the reported pests, avoiding keeping the focus of problems in cultivated areas.

Pruning and Removal of Parts or Plants Affected by Pests

The elimination of parts or total plants affected by pests is a useful measure to interrupt the pests' life cycle and reduce their impact on crops.

Applicable Standards

- Resolution No. 20008 of 2016 of ICA: *Contingency Plan for Chrysanthemum White Rust (Puccinia horiana Henn) in Colombia.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

To eliminate plant material affected by pests and diseases to minimize the risk of dispersion of infectious agents into clean areas.

Implementation Guidelines

- Identify areas and plants with critical pest attacks, according to direct monitoring with the possibility of intervention through the eradication of affected material.
- Define eradication procedures according to the optimal crop agronomic management.
- Personnel doing plant material eradication shall be trained and have adequate tools and working clothes to avoid damaging the plants or contaminating the clean areas.
- The timely elimination of diseased plants, open flowers, non-productive flowers, or plants, buds, stumps, and dried stems attacked by pests or pathogens is favorable to avoid the establishment and spreading of pests on the crops.
- Plant material which has been erradicated or eliminated must be packaged and evacuaated immediately fron the crop areas, in closed containers, to avoid pest dissemination throughout transportation routes.
- Erradicated material shall be properly processed, ensuring clean crop areas are not contaminated.

Management of Crop and Post Harvest Plant Residues

Management of residues from the harvest and other activities will be done in a timely and adequate manner in order to avoid creating a new source of contamination and substrate for the development of pests and pathogens.

Applicable Standards

- ICA Resolution 63625 of 2020: *Requirements to obtain the register as producer, exporter, and/or importer of flowers or cut bouquets of ornamental species to be exported.*

» Florverde Standard for sustainable production of flowers and ornamental plants.

Objective

To establish minimum parameters for proper managemenbt. of plant residues generated during the crop's productive process and post-harvest

Implementation Guidelines

» Have available an area isolated from the crop, for the management of plant residues.
» Plant residues shall be evacuated on a daily basis from their source, being taken to the corresponding waste processing area.
» Leaves that fall to the floor from the flower beds and lixiviate in hydroponic crops will be removed with the defined frequency to avoid them to turn into pathogen's substrate.
» Before and after removing dry leaves, it is recommended to spray chemical disinfectants or fungicides to mitigate the spread of fungi.
» Sweeping plant residues will be done carefully, without raising dust, to avoid pathogens dispersion over the plants.
» Plant waste must be packed in covered recipients or containers to avoid spreading the problem throughout the transportation routes.
» Plant material shall be processed in accordance with procedures established by the company. In the case of compost, the process will be done under strict management conditions to avoid pest spreading into crop areas.

Cultural Labor

These are the agronomic practices that contribute to a better plant physiological performance and influence the phytosanitary condition of the crop.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

To maintain agronomic and cultural labor updated to facilitate the prevention and control of pests attacking.

Implementation Guidelines

» Having the cultural labor updated helps to maintain plants' strength, reduce their susceptibility to pest attacks, and allows for better controlling plants through an optimal pesticide spraying coverage.
» The person responsible for IPM will have knowledge of cultural labor corresponding to the phenological condition of each crop to ensure that once they are up to date, the origin of a phytosanitary problem must be found somewhere else.
» During the phytosanitary committee meetings, the IPM Manager shall show which are, in his/her opinion, the areas that require more cultural labor to have better pest control.
» Area or Crop Managers shall keep the missing cultural labor up to date to help pest control.

Adequate Irrigation and Fertilization Management

The proper management of irrigation and fertilization will guarantee favorable conditions for the plants and will minimize the risk of having phytosanitary problems.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter,*

and importer of flowers or cut branches of ornamental plants to be exported.
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective
To guarantee a lower risk of transmission and establishment of pests in cultivated areas and plants through the proper use of irrigation and fertilization.

Implementation Guidelines
» It is necessary to know the physical-chemical and microbiological qualities of irrigation water to assess and discard the presence of harmful factors for the plants.
» The company shall establish and frequently analyze irrigation water to evaluate the presence of relevant phytopathogens according to the cultivated plant species.
» According to the results, the IPM Manager and Technical Director of the crop shall define the treatment to be followed.
» Irrigation volumes shall be defined by the Fertilization and Irrigation Team to avoid excess water and conditions for the generation or spread of pathogens in the crop.
» The Crop Monitoring Team shall report areas with excess water or failures in the irrigation systems.
» The IPM Manager shall report the flooded areas, and the Crop Managers or those in charge will immediately take the corrective actions.
» The Fertilization and Irrigation personnel shall monitor and inform the IPM Manager about the groundwater levels in each of the cultivated areas to implement mitigation measures to counteract the effects this factor may have on the crop.
» The IPM Manager, through the fertilization and irrigation area indicators, shall be updated on the crop's nutritional condition to identify and intervene on potential phytosanitary risks.

Crop Eradication
These are measures that a flower and ornamental plants producer must take when the decision is made to suspend or abandon the flower-growing activities to minimize the risk of pest transmission to neighboring crops.

Applicable Standards
» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective
To implement measures to minimize the risk of pest transmission to neighboring crops.

Implementation Guidelines
» The decision to suspend or abandon floriculture activity will be duly informed to the ICA, who shall indicate the measures The producer of ornamental plants will inform the neighboring flower producers of potential migration of pests due to the plantations' suspension or abandonment.
» The farm will maintain permanent pest control in the suspended crops until their reactivation.
» The farm will make sure the plantations to be abandoned maintain permanent pest control until their eradication. The plants will be eliminated, and the resulting plant material will be treated in a manner that does not cause any phytosanitary problems to neighboring flower-growers.

2.2 Physical Control
Is the use of physical resources to control pests. The use of insect-trapping thrips, nets or anti-pest barriers, light traps, vacuum pumps and mechanical blowers, ventilation, temperature, and humidity management inside the greenhouses, and washing with water are practices

that do not have a chemical effect but exercise physical control over pests.

Each of the physical practices which have incidence and are used in farms shall be standardized and documented, and their implementation shall be verified within the daily work of the monitoring personnel. Following are the most used practices:

Water Vapor

Consists of the application of heat to the soil and substrates using water vapor to destroy pathogens and seeds of undesirable herbs.

Disinfection with water vapor is a useful practice to reduce nematode populations and some development stages of insects that live or spend part of their life cycle in the soil. It also lowers the incidence of harmful pathogens in crops.

It is important to consider that water vapor treatments on soils and substrates do not achieve thorough sterilization because some thermo-resistant microorganisms may remain after the process.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for sustainable Production of Flowers and Ornamental Plants.

Objective

Use water vapor to reduce soil insects and pathogens populations and start the productive cycle with a low incidence of phytosanitary problems.

Implementation Guidelines

- Identify the areas to be treated with water vapor based on direct monitoring data.
- Before and after the treatment, it is necessary to analyze the soils and substrates, focusing on the search of pests or pathogens of interest, which initially justify the application and later allow assessing their efficacy.
- A saturated vapor boiler shall be available with an approximate power of 5 BHP/M³ of soil.
- Key aspects for achieving a good result are:
  - Excellent soil preparation at a depth ranging between 50 and 30 cms.
  - Soil humidity at field capacity.
  - Leak-proof vapor distribution network..
  - High caliber canvas or plastic to cover the soil surface.
  - Secure the cover with chains to avoid losing the water vapor.
  - Have a needle or long stem thermometer to monitor the temperature at different sites and depths during the soil disinfection process.
  - Consider temperature ranges according to control target, according to the following chart: (https://www.usgr.com/soil-sterilization/soil-temperature-sterilizing-table/)

Temperature (˚C)	Control Target
>80	*Fusarium*, resistant weeds
70-80	Weeds, phytopathogen fungi, bacteria (*Phythopthora*)
60-70	Some soil insects, phytopathogen fungi (*Rhizoctonia, Sclerotinia, Botrytis*), nematodes

- Generally, when disinfecting the soil with vapor, the temperature is set at 100° C. That eliminates all pathogens, except for some bacteria which develop spores (Alpi, A. and Tognoni, F., 1999).
- The temperature defined shall be maintained during two (2) hours, counted from the time in which the range is reached at the most remote site.

» During the soil or substrate treatment and until the plants are sowed, it is necessary to take aseptic measures to avoid recontamination of the clean areas.
» As soon as the disinfection process ends, the treated soils shall be gradually irrigated, until reaching the accustomed irrigation levels, without damaging the soil's structure.
» Before sowing, it is recommended to start a recolonization program on the treated soils to reestablish the trophic chain and minimize the revival of pathogens. This shall be done using pathogen-free materials and biological products from recognized sources and proven efficacy.

Use of Vacuums and Blowers

This refers to the use of machines that enable capturing flying insects (i.e., leaf miners) or sedentary arthropods (i.e., mites) and lower their incidence in crops.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Reduce the incidence of arthropod pests in crops by using vacuums or blowers.

Implementation Guidelines

» The IPM Manager will use the pest monitoring results to define the areas to be intervened and the vacuum or blower treatment frequency.
» Define the equipment to be used, according to pests to be controlled, and consider their ease of use in the crop: source of energy (electricity or fuels).
» The IPM area will define the usage parameters and will have documented procedures for the application of the tool in the field.
» The necessary labor to perform the work shall be available.
» Personnel in charge will be trained to ensure the proper labor execution and its safe management.

Adhesive Trap Strips

This is a physical control mechanism for flying insects. Plastic traps of different colors are used to attract insects and are complemented with an adhesive material to facilitate their capture.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Reduce the incidence of pests in infested areas by using adhesive trap strips.

Implementation Guidelines

» Based on the pest monitoring reports, the IPM Manager will define the areas to be intervened with this tool.
» Select the color, quantity, distribution, and location of traps in the field, according to the plague to be captured, considering literature reports or supported experiences.
» Define the adhesive to be used, according to its durability, as well as the traps' life cycles, according to the visual saturation reached while in use.
» Establish the adequate final disposal of the generated plastic waste.

Physical Barriers

The natural or artificial physical barriers are elements that hinder the migration of insects that, helped by wind drifts and attracted by food availability, come from the peripheral area to the ornamental plants' production area. The company shall have its own criteria for its design, construction, and functionality.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Control insect infestation from the peripheral areas to ornamental plants' crops using physical barriers.

Implementation Guidelines

- The neighboring crops and their phenolic condition are a potential source of pest migration, which must be considered to prevent their entering the ornamental plants' production areas.
- Based on the pest monitoring data using external traps and weather conditions (rainfall, wind direction, and speed, among others), the IMP Manager will define the points with the highest migration and entrance of insects, such as thrips, miners, and lepidoptera, etc. to establish a plan for the installation of physical barriers which facilitate their control.
- The dimensions and materials for the construction of the artificial physical barriers will be elected according to the farm's criteria.
- The natural or live barriers will be established on the farm's periphery or boundaries specifically, in places identified as points of migrating pests' entrance through the sowing of native species (Lee, R., et al., 1999).
- All barriers shall be installed 5-meters away from the greenhouses for them not to interfere with their ventilation.

Greenhouse Ventilation

Ventilation of greenhouses strives to replace the hot air concentrated inside with a cold air mass coming from the outside. Once the hot air is evacuated, the temperature decreases, as well as the concentration of gases and the air's humidity, preventing the development and establishment of phytopathogenic organisms.

The hot air, being lighter than the cold air, rises and exits through the roof vents of the greenhouse, while fresh air mainly enters through the lateral drapes and doors. This creates an air flow which allows for its renovation.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Use greenhouse ventilation as a strategy to avoid having favorable environmental conditions for the development of pathogens.

Implementation Guidelines

Passive Ventilation (natural)

- Ventilation management will depend on the type of lateral drapes installed in the greenhouse. Drapes that open downwards allow for better control of air volume and direction, holding back air currents that facilitate the dispersion of pathogens over the plants.
- Based on the information given on crop monitoring and climatic variables, Production and IPM personnel will define the areas to be ventilated and the ventilation frequency, as well as the opening and closing times for the vents, lateral drapes, and roof windows.

» Before opening the lateral drapes of the greenhouse and defining their opening degree, it is necessary to evaluate the conditions of exterior air since the wind speed can facilitate the spread and establishment of pathogens, such as the powdery mildew of roses (*Sphaeroteca pannosa = Podosphaera pannosa*). In that case, the recommendation is to open drapes until reaching, at the most, the height of the crop's canopy.

Mechanical Ventilation (forced)

» Mechanical ventilation is the renewal of air using fixed or rotating electromechanical ventilators placed on the lateral walls, vents, and supports in roof angles or internal columns throughout the greenhouses.
» Mechanical ventilation will be synchronized with the passive one because they complement each other and together have a better result.
» The Production Technician, with the support of the Engineering Department and based on the farm's greenhouses characteristics, will define the areas that need ventilation, the types, quantities, and cost of ventilators to be installed, the electrical installations, and their operating power, as well as the distribution and height in which the equipment shall be installed throughout the greenhouses.
» Based on the crop monitoring and climatic variables information, those responsible for Production and IPM shall define the areas to be ventilated, the use frequency, and the ventilation schedules.
» Air flow produced by the fans will be applied over the crop's canopy, avoiding turbulences which could enable the spread of phytopathogens to the plants.
» Ventilation will be restricted or suspended when according to the opinion of those responsible for IPM and Production, there are phytopathogen fungi present and considered as critical.
» A program for ventilation equipment maintenance shall be established, according to the operation instructions, to ensure their normal operation.

Conditions of the Protection Covers

The good condition of the plastic covers is a favor that helps avoid the entrance and establishment of pests and helps improve the crops' productivity.

Applicable Standards

» Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Maintain plastic covers in good conditions to avoid the entrance and establishment of pests in the cultivated areas.

Implementation Guidelines

» The company will have a permanent and timely inspection, cleaning, repair, or replacement program for the protection covers. These activities will be programmed according to the life cycle of the covers, as guaranteed by the manufacturer.
» The covers and other plastic structures will be maintained in good condition, without holes or perforations which allow the free entrance of water, causing leaks and waterlogging in the crops.
» IPM Monitors, every month or sooner, if demanded by the circumstances, will report the relevant damages in the plastic covers of their assigned areas. It is necessary to inspect the site after any atypical events, such as rain, hail, or strong winds that may have caused unexpected damages.
» In the phytosanitary committees, the person responsible for IPM will inform the plastics' monitoring results to the technician and maintenance person responsible for the crop with the purpose of programming, executing, and monitoring the damage repairs.

Light Traps

Black light is used to attract, monitor, and control some night insects and positive phototropism.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Use light traps to attract, capture, monitor, and control pests and reduce their entry into cultivated areas.

Implementation Guidelines

- Light traps will always be associated with materials such as glues, soapy water, and others, which facilitate the capture of attracted insects.
- Based on the monitoring results obtained, the IPM Manager will define the location of traps inside and out the crop areas or outside the post-harvest area. If located inside cultivated areas, it is necessary to consider and mitigate the effects that light may exercise over growing plants.
- Read the number of captured individuals per week and in taxonomic order (i.e., lepidoptera, coleoptera) and ideally be able to separate them by gender (*Copitarsia, Spodoptera, Ancognatha*, etc.) and register the data.
- Every week, it is also necessary to check traps' operation to guarantee insect capturing.

Use of UV Light

UV lamps, as reported, are used indoor and outdoor to control of fungi, bacteria, and virus in agricultural crops (Cornell University, 2019). Others are used to disinfect waters. Their use in the flower industry is still not an extended practice.

Applicable Standards

- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.
- WHO (2007), *Protecting Workers from Ultraviolet Radiation.*

Objective

Reduce the inoculum of fungi and phytopathogenic bacteria in the cultivated areas' environment using UV light.

Implementation Guidelines

- Verify the technique's efficacy in controlling the biologic target(s).
- Study health risks and establish protection measures.

Foliage Wash

Refers to the use of clean water irrigated over the plants in volumes higher than a spray to exercise mechanical control and lower the severity of the attacking pests.

Applicable Standards

- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

To lower the incidence and severity of plagues affecting crops through the application of water over the foliage of plants.

Implementation Guidelines

- This practice is normally used when there are severe attacks of certain pests over the plants, such as mites, which attack roses and carnations, and white-fly and powdery mildew that affect roses.
- Washing shall be done when climate conditions are appropriate; this means, in sunny mornings, so by the end of the day, the plants are free of water, and the areas are not flooded.
- It is necessary to ensure that the application method does not cause any mechanical damage to the plants.

- Based on the monitoring, the person in charge of IPM will define the pests and areas to be intervened, as well as the volumes, methods, and frequency of the application, according to the severity of the biological target to be controlled.
- Foliage washing shall not occur on the same day pesticides or other chemical substances are applied.
- The IPM Manager should consider there may be other phytosanitary problems related to washing the plants (i.e., *Botrytis*, *Agrobacterium*, among others) associated with the increase in the environment's humidity, which must also be addressed.

Shaking Bunches in Crops and Post-Harvest

This is a mechanical practice used to exclude pests from arthropods (thrips, mites, etc.) that may be present in the harvested products.

Applicable Standards

- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to register as producer, exporter, and importer of flowers or cut branches of ornamental plants to be exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Reduce the presence of pests in harvested products by shaking the bunches or stems before entering the classification room.

Implementation Guidelines

- Based on crop monitoring data or post-harvest reports on the presence of pests in the harvested product, the IPM Manager will define the material to be shaken.
- Meet the requirements demanded by the ICA to work with the flowers' destination countries (at least 10% of the bunches and, in critical situations, up to 100% of the shipped bunches).
- The shaking method defined may be done in the crop or in a separate area before the flower enters the classification room.
- This procedure shall not deteriorate the bunches or harvested product.
- When shaking the bunches is done in the crop, the necessary conditions and implements shall be available, such as white acrylic or plastic cardboard sheets impregnated with a soapy solutio that allows visualizing the capture of organisms and prevents them from getting out towards the crop. The process of cleaning such sheets will be made with the necessary frequency with a bucket containing a soapy water solution.
- In the post-harvest area, shaking the bunches will be made within a chamber built for this purpose with walls that prevent the pests from escaping to clean areas.
- The chamber will have an illumination lamp over a table with a white, black, or bicolor surface, which will allow to easily detect the pest individuals.
- Pest individuals found will be treated by immersion in the recipient with the soapy solution.

2.3 Bio-Rational Control

Bio-rational control of pests uses natural substances coming from microorganisms, plants, or minerals or similar or identical synthetic substances found in nature. These products are characterized by having low toxicity for humans and other vertebrates, less persistence in the environment, and being specifically designed for controlling pests. Their effect on wildlife and the environment is less harmful than conventional pesticides.

The ICA defines as *bioproducts* those used for integral pest management or for improving the productivity of crops and soils. These products are massively manufactured based on live microorganisms, viruses, macroorganisms, and natural or biochemical products. This definition excludes antibiotics, toxins (i.e., β-exotoxin of *Bacillus thuringiensis*), and genetically modified organisms (ICA's Resolution 68370 of 2020).

The use of bioproducts in IPM is framed within the terms of ICA's Resolution 68370 of 2020 and is done with the purpose of complementing and strengthening the rest of pest control strategies, as well as helping minimize their impact on human health, the environment, and crops' health. The implementation of this tool must be

standardized and documented, and the responsible of IPM should directly ensure it.

Below is the description of bioproducts based on the classification currently set by ICA:

Bioproducts for agrícultural use	**Bio-Controllers** • Microbial agents • Macroorganisms (entomopathogenic, parasitoid and predator nematodes) • Plant extracts
	Biochemical Products • Diatomaceous earth • Oils • Semiochemicals (pheromones and kairomones)

Bio-Controllers

Biological control is the intentional use of natural enemies to maintain pest populations under harmful levels in crops. The use of bacteria, entomopathogenic fungi and nematodes, mites, and predator and parasitoid insects becomes more relevant day by day and currently makes part of the strategies applied by flower and ornamental plant producers.

Microbial Agents

These refer to bacteria formulations (*Bacillus spp., Burkholderia spp, Pseudomonas spp.*, among others), entomopathogenic fungi (*Beauveria sp, Metarhizium sp, Isaria spp,* before *Paecilomyces spp.*), and antagonistic fungi (*Trichoderma spp.*).

Bacteria Formulations

Bacillus thuringiensis (Bt)

» This is the best-known bacteria formulation to control pests, with results over juvenile lepidoptera and mites.

» *Bt* is a gram-positive bacterium that forms spores that produce protein crystals denominated delta-endotoxins. Crystals can reach 20% to 30% of the dry weight of cells and are released to the environment after finishing the sporulation phase. *Bt* is distributed throughout the world. It mainly lives in the soil and has been separated from the foliage, water bodies, stored grain, and dead insects, among others. The isolation from dead insects has been the main source for the formulation of insecticides.

» Formulations have a mixture of spores and crystals. For their control, it is necessary that the insects ingest the product. Their best effect occurs during the initial larval stages. After their application, they only persist for a few days over the foliage.

Other Bacillus

Bacillus subtilis, B. licheniformis, B. amyloliquefasciens, B. velezensis

» The suppression of phytopathogenic organisms by bacillus strains is the result of multiple mechanisms, including growth promotion, antibiosis, competition for space and nutrients, hyphal lysis of the pathogen, and systemic resistance induction. All these mechanisms can be found in the same strain, allowing them to be effective under different conditions (variety of pathogens, plants, environmental conditions).

» *Bacillus subtilis* has several characteristics that enable its survival and effectiveness as a biopesticide (Losick and Kolter, 2008; Rosas-García, 2009). It can live in aerobic conditions and can behave as a facultative anaerobe. This represents an advantage to survive in the rhizosphere, where the amount of oxygen fluctuates and is generally low. Additionally, it is a mobile bacterium that can easily get to the roots and move over their surface, a characteristic that allows new colonization.

Fungi Formulations

They represent the main group of bioproducts used in crops due to their easy handling. In general, they are applied to the soil or foliage, using the customary equipment and techniques in production farms. These can be separated into two (2) groups,

depending on whether they control pests or pathogens. The first group refers to entomopathogenic fungi and, the second, to antagonist fungi.

Hongos entomopatógenos

- The main formulations are based on *Beauveria sp., Metarhizium sp., Isaria spp.,* before *Paecilomyces,* and *Lecanicillium sp*.
- They are used for the control of larval stage lepidoptera, aphids, mites, white flies, flakes, and some species of Diptera and thrips.
- The modus operandi of entomopathogenic fungi varies, exercising their control in different manners, which may include from starvation to the production of toxins.
- Entomopathogenic fungi produce extracellular toxins and enzymes, such as proteases and chitinases that help penetrate the cuticle of the insects.
- In general, the control process begins with the adhesion of spores (conidia's) over the insects' cuticle, which will later germinate in favorable conditions, penetrating the insect's hemocoel, all the way to the internal organs, until it causes its death. The infection continues with the mycelial growth, the formation of new spores outside the affected insects, becoming a new source of contagion for other individuals.

Antagonist Fungi

- These include several genders which reduce plant pathogens' populations and, along with their controllers' effect, they can also regulate the physiological processes. They are highly specific in their control and have very low or no effect over non-target microorganisms (Adnan, M. et al., 2019).
- They are easy to produce massively. However, it is important to understand their mechanisms as biocontrol agents to use them correctly.
- *Trichoderma spp.,* the most important gender within this group, is an asexual fungus naturally present in many types of soil and decaying wood. It uses various mechanisms: direct antagonism, hyper parasitism, and competition. Recent studies demonstrate that the fungus not only acts as a biocontroller but also stimulates the plants' resistance to diseases, its growth, and development. Likewise, it increases the crop's production (Ghazanfar, M.U., et al., 2018).
- There are formulations of different species. For example, *Trichoderma harzianum, T. longiorum, T. viridae, T. koningii, T. koningiopsis,* each of them with high specificity for a defined phytopathogen.
- Formulations can be solid or liquid. When selecting a formulation, it is important to consider its stability, as well as its efficacy.

Guidelines for the Use of Microbial Agents

- Evaluate the compatibility of microorganism formulations with pesticides used in the crop.
- Assess the compatibility among microbial formulations to ensure their use without alterations.
- Know the formulation's life cycle and comply with the recommendations of use specified in the label.
- Make sure the proper storage conditions guarantee their functionality.
- Apply microbial agents with equipment free of chemicals that could interfere in their performance.

Entomopathogenic Nematodes

These organisms exercise biological control over some foliar and soil pests. They can be forced or facultative parasites and have many attributes that make them a good tool as a biological control agent.

The common biological control species are from the *Heterorhabditidae* and *Steinerneatidae* families (Grewal et al.., 2005). Within the integrated management programs, they are easily incorporated since they are considered harmless to humans and relatively specific for the pests they control (Shapiro-Ilan et al.., 2006).

The beneficial nematodes parasitism results from the suppression of the immune system of the hosts (Dowd and Peters, 2002; Lewis and Clarke, 2012). The nematodes enter the host through natural

openings, such as the mouth, the anus, the spiracles, or the cuticle's intersegmental membranes (Bedding and Molyneaux, 1982) until they reach the hemocoel where symbiotic bacteria of their gut are released (Askary, 2010). The bacteria reproduce in the host's hemolymph, releasing toxins and hydrolytic exoenzymes that cause its death.

The entomopathogenic nematodes are safe for plants and vertebrates and have not presented any acute or chronic toxicity in humans. Therefore, they are exempt from registration requirements by EPA in the United States, India, Australia, and many European countries (Ehlers and Hokkenen, 1996; Ehlers, 2005; Dreves and Lee, 2015).

The critical aspects for considering them excellent biological control agents are the scarce and complex technologies for their production and application.

Implementation Guidelines

It is important to consider the following aspects to contribute to the successful use of entomopathogenic nematodes:

- The technology for the formulation of the product directly influences the survival in the search capacity of the prey, the tolerance to environmental conditions, and, in some cases, their persistence.
- Formulations have a short storage life spam. It is necessary to strictly consider this period to ensure the individuals' survival.
- Entomopathogenic nematodes in the soil may be prey to other microorganisms, such as the bacteriophage, predator spiders, and other nematodes.
- Some abiotic factors such as UV light, low soil humidity, low relative humidity, and temperature influence their survival (Shapiro-Ilan et al., 2006). Considering this, it is recommended to apply them at nighttime.
- The presence of high nitrogen content in the soil may affect the control using entomopathogen nematodes.
- Applications of compost or fresh organic matter can negatively affect their performance (Shapiro et al., 1996).
- Soil conditions affect the performance of entomopathogenic nematodes: texture affects the mobility, a pH between 4 and 8 is ideal for its performance, and values higher than 10 impede their work.
- Pesticides such as abamectin, acephate, dodine, methomyl, and parathion are harmful to entomopathogenic nematodes (Koppenhofer and Grewal, 2005). When deciding on their use, it is important to evaluate their compatibility with other pesticides.
- Before applying the entomopathogenic nematodes, it is indispensable to ensure the concentration of individuals offered in the product's label. There shall be at least 25 individuals per cm^2 (Shapiro et al.., 2002).
- Target the applications to the pests to be controlled: soil and the third lower part of the foliage for slugs, soil's surface for insect pupae, and foliar for insect larvae.

Predators and Parasitoids

These are natural enemy arthropods of pests used to exercise their natural control. Predators feed directly from their prey, while parasitoids are organisms that live inside or over their host.

The most common parasitoids are *Hymenoptera* wasps. They have complete metamorphosis, and the adults who have a free life can feed of pollen or nectar. They require a host insect to reach their adult stage. Females lay their eggs inside or close to their host. The parasitoid larvae emerge and ingest their host until its death, generating a new beneficial individual (Durling, J.C., 1999).

The flower sector in Colombia has experience with *Diglyphus* and *Dacnusa* genders to control *Liriomyza spp.* in pompon crops. These processes have been successful when the companies have their own farming. Currently, there are no local producers of these parasitoids.

It is important to highlight the natural presence of the tiger bee fly (Coenosia spp.) in pompon and gypsophila crops in greenhouses, predating adult leaf miners (*Liriomyza spp.*). Without a doubt, this would be an interesting case to investigate and develop to improve pest control.

A successful case in Colombia has been the use of predator mites *Amblyseius* (=*Neoseiulus*) and *Phytoseiulus* for the control of *Tetranychus spp.* in roses (Agrosavia, 2018).

Implementation Guidelines

- Use commercial products with registries from the competent authorities and recognized vendors and proven efficacy. It is also valid to use products from private massive production whose objective is not their commercialization but the internal use in farms. In such a case, an ICA registration is not required.
- The commercial product has a short storage life cycle. Therefore, it must be used as soon as it arrives from the vendor. Exceeding the time for its recommended use will affect the individuals' survival and functionality.
- Predator mites are incompatible with many chemical pesticides and other bio-controllers. Therefore, it is important to know this condition to ensure the success of an IPM program. It is important to ask the vendor of the biological product for a list of incompatible pesticides that comes from a reliable source.
- To ensure the predator's functionality, there must be a plan which, as a minimum, includes the following steps:

Previous Conditions

- It is necessary to have a predator vendor who supports the introduction process at the farm and guarantees viable product deliveries at the required frequency and volumes.
- Based on the monitoring information received, the IPM Manager shall define the area to be intervened with predator mites. These shall be areas with low incidence (if possible, lower than 20%) and low severity of the phytophagous mite, preferably located in the lower third part of the plants.
- Collect information about the pesticides and other chemical substances' application (insecticides, acaricides, fungicides, bioproducts, coadjutants) performed in the selected area during the last three or four months. Depending on the number of applications, a period for detoxification of the area will be defined, which consists of suspending the use of incompatible products and programing the use of innocuous methods for the predator.

Predator Release

- Once the detoxification period is completed, individuals are released in a determined number of focal points of *Tetranychus*, according to the vendor's recommendations. Treated sites shall be properly signposted.
- Seven (7) days after the application, each of the treated sites must be revised to confirm the presence of adults, nymphs, and eggs. If the different predator's development stages are not observed, it means it still has not been established probably, because the area continues to have toxic residues. In such cases, individuals shall continue being released every week until the establishment has occurred and is confirmed.
- Once the establishment of the predator in the area is confirmed, the general application in all sites will be initiated.

Follow-up and Monitoring

- The release frequency and application rate will be determined based on the weekly monitoring of the phytophagous mite and the predator. Therefore, it is necessary to evaluate the ratio between the number of predator individuals vs. the number of phytophagous individuals.
- Normally, the predator's establishment point is reached. However, it has been observed that it is necessary to continue making releases for their maintenance in the areas.
- There are situations in which, due to the incidence and severity increase of other pests in the area, some pesticides incompatible with the predator have had to be used. In those cases, it is necessary to adjust the application frequency and rate of the predator to recover the lost levels.

Plant Extracts

These are formulations of secondary metabolites extracted from plants, which have non-specific control effects over crop pests, such as repellence, anti-feeding activity, alteration of the behavior of arthropods, or the inhibition of germination and direct damages to the mycelium of some pathogens.

There are different types of botanical extracts, such as neem, garlic, tobacco, ginger, nettle, Swinglea, quillay, and tea, among others, to control pests and diseases of different crops.

Although, in general, they do not represent any risk for human health or the environment, it is important to assess their individual management since some can cause eye and respiratory irritation, and others, such as neem oil, can be flammable.

Implementation Guidelines

- Use products that are officially registered before competent authorities.
- Botanical extracts have less environmental persistence than chemical pesticides. Therefore, there are less toxic and demand more frequent applications.
- In general, they are not toxic to the plants or the environment, but there are some exceptions, such as the nicotine sulphate, whose formulations are classified by the WHO in the 1b toxicological category. There are also some acute effect reports due to inhalation, ingestion, and eye contact (Greene and Pohanish, 2005).
- The person responsible for IPM shall evaluate and ensure that products to be applied are efficient against pests to be controlled, not causing phytotoxicity. Likewise, their compatibility, when mixed with other products, shall be evaluated.
- Pest control effects are rarely due to direct toxicity and almost always due to repellence, behavior alterations, or anti-feeding activity.
- Product manufacturing with specific and consistent effects requires high technology. Otherwise, it is very probable to find a wide efficacy variability between the different batches. It is important to know and respect the life cycles of formulations since their active ingredients modify with time.

Biochemical Products

According to ICA's definition, these are natural substances, or substances of chemical synthesis, structurally identical to a natural chemical substance, which allow pest control when their behavior is modified. This group includes diatomaceous earth, oil and semi-chemical products (ICA Resolution 68370 of 2020).

Diatomaceous Earth

Diatomaceous Earth, (also know as “natural amorphous silica”), can be used in many ways and improve your phytosanitation and productivity. It is obtained from fossilized diatom deposits found in Miocene lakes and seas, originated millions of years ago.

It is an organic, easy-to-use product, recognized by its mechanical pest control, which causes no poisoning, but abrasion and desiccation of the waxy outer layer of arthropodes. Its dusting application is recommended and used for control of mites in roses and carnations.

Implementation Guidelines

- Start applications in recently established outbreaks.
- Consecutive applications are required for a better control.
- Control level ranges from low to medium, and there is no shock effect.
- May contribute as a source of silicon, improving plant quality and productivity, if the formulation is water-soluble

Oils

The use of oils as insecticides started centuries ago, and has been a safe and effective alternative vs. the use of pesticides. In Colombia, ICA has included plant-originated oils within the classificaiton of “biochemical products”, without specification of their origin. For EPA (USA), many oils used as pesticides, are regulated. There are exceptions for edible oils and other specific ingredients considered to represent minimal human health risks (Bogran, C. and other, 2006).

For an effective and safe use, the chemical nature of oils must be known, as well as their mode of action and application limitations.

Oil formulations which may exist in the market as plesticides, include petroleum distilled oils (also known as vegetable or mineral oils) and extracts of plants or animals. Many are used as insecticides, and others, as fungicides.

Implementation Guidelines

- Before using commercially, phytotoxicity tests under high temperature and low humidity conditions shall be made.
- It is important to identify the procurement process and purity of active ingredients. Organic oils must have a low content of unsaturated hydrocarbons and be very well refined to avoid phytotoxicity risks (Bogran, C. et al, 2005).
- Oils must not be mixed with products containing copper or sulphur, to avoid phytotoxicity risks.
- Take into consideration the expiration date and life cycle of.

Semiochemicals

These are non-pesticide chemical substances that convey a signal from one organism to another to modify the behavior of the recipient organism, facilitating pests' control.

Pheromones are semiochemicals used among individuals of the same species, while kairomones are used among individuals of different species.

The use of semiochemicals complements IPM, constituting an alternative to monitor and control pests.

Kairomone for Trips Control

- It is a chemical substance naturally produced by flowers of plant species that passes for food to attract trips. Currently, it is a product of chemical synthesis whose active ingredient is *Methyl isoniconitato*.
- Kairomones must be necessarily used in association with adhesive tape traps (white, yellow, or blue) that allow trapping trips which are attracted within the greenhouse. It is demonstrated that kairomone increase the capture of trips in the trap tapes (Teulon, D., et al., 2014).
- According to the direct and indirect monitoring of trips, the person responsible for IPM will define the areas requiring treatment with kairomone.
- He/she will also determine the amount and distribution of kairomone diffusers in the area to be treated, taking into consideration that, depending on the distributor, their radius of action is approximately 100 m^2, which means that at least 100 units/hectare are required.
- To minimize the risk of attracting trips from the perimeter to the cultivated areas, the kairomone diffusers shall be installed internally, at more than 10 meters of distance from the outer edges of the greenhouse.
- After opening the diffusors, kairomone's life cycle is of eight (8) weeks maximum. After that time, the diffusors must be replaced by new ones.

Pheromones to Control Lepidoptera

- These are chemical substances produced by female lepidoptera to sexually attract the males of their same species. The pheromone inhibits the mating of males and females, avoiding their reproduction in the crops.
- Currently, they are produced by chemical synthesis, formed by different active ingredients, according to species to be controlled (visit www.biochemtech.eu).
- The use of pheromones is done together with capturing traps to impede attracted individuals from escaping. The lifespan of pheromones for lepidoptera is three (3) months.
- Pheromone traps are installed around the greenhouses or the post-harvest area, supported by rigid poles, at 35 meters of distance (when the goal is to monitor the pest), or every 14 meters (when the goal is to monitor and massively capture the pest).
- Each trap is formed by a pheromone diffusor and a soapy water recipient to facilitate the capture and counting of trapped individuals.
- Readings are taken on a weekly basis, counting the number of captured individuals, ideally separated by gender (Copitarsia, Spodoptera, etc.). A record of this is taken.
- It is necessary to clean and maintain traps in operation, to maintain constant trapping of lepidoptera.

Soaps (Derived from Fatty Acids and Potassium Salts)

Apart from chemical and biological pesticides, the use of domestic and industrial soaps is frequent in the flower-growing sector to control some pests, such as mites, white flies, and aphids.

These are chemical synthesis substances, not classified as biological agents by the ICA, which do not exercise chemical control but have a physical effect when encountering pest organisms, weakening or obstructing their physiological processes, causing their death. That is why they are an important tool for IPM.

Objective

Use soaps to control pests, ensuring their efficacy and mitigating risks for human health.

Applicable Standards

Legislation for the registration of soaps as agricultural pest control products does not exist in Colombia. Some of the soaps registered at INVIMA have registration for cleaning or disinfecting domestic or industrial compounds. Others receive "Certificates of non-compulsory use" issued by ICA or INVIMA, through which these institutions state they do not have the competence to register those products, evidencing the absence of legislation.

On the contrary, in the United States, EPA demands soaps for pest control to be registered as agricultural insecticides.

Although currently there is not clear legislation about the use and management of agricultural soaps, it is important to say that entities such as EPA attribute health risks to those products. These include eye, skin, and respiratory irritation, which demand their safe use.

Implementation Guidelines

- Based on the monitoring reports, the IPM Manager will define the pest to be controlled, the area to be treated, the product, volume, and application frequency.
- If possible, use products registered by competent authorities.
- Use products whose efficacy has been previously duly proven.
- Use products according to label instructions.
- Ensure contact of the applied product with the control-target pest.
- Sprinkle a large volume of the product for it to contact the pest to be controlled.
- Frequent applications are usually required to enable efficient pest control.
- Preparation using low hardness water to enable proper control.
- Avoid applications with high radiation and low environmental humidity to reduce phytotoxicity risks.
- Use adequate personal protection elements, according to the nature of risks: eye, skin, and respiratory protection.

2.4 Chemical Control

This is the main method for controlling agricultural pests in the world and in Colombia's flower-growing sector. Currently, it is based on the use of agricultural chemical pesticides and other substances that have recently started to be part of the process, such as:

Chemical Pesticides for Agricultural Use (PQUA)	• Fungicides • Insecticides • Acaricides • Herbicides • Nematicides • Molluscicides • Antibiotics • Fumigants • Herbicides • Fumigants
Others	• Disinfectants • Silicon adjuvants

Chemical Pesticides for Agricultural Use (PQUA)

PQUA industry's evolution ensures greater amounts of formulations with less concentration of active ingredients, with more specific action spectra (insecticides, acaricides, fungicides, bactericides, nematicides, herbicides, etc.), with lower environmental persistence, prepared with adjuvants that strengthen their action and make them tolerable to extreme environmental conditions, among other characteristics.

Their biochemical mode of action is permanently revised and updated by private organisms such as IRAC (Insecticide Resistance Action Committee) and FRAC (Fungicide Resistance Action Committee) to maintain available this tool to minimize the risk of pests' resistance to pesticides.

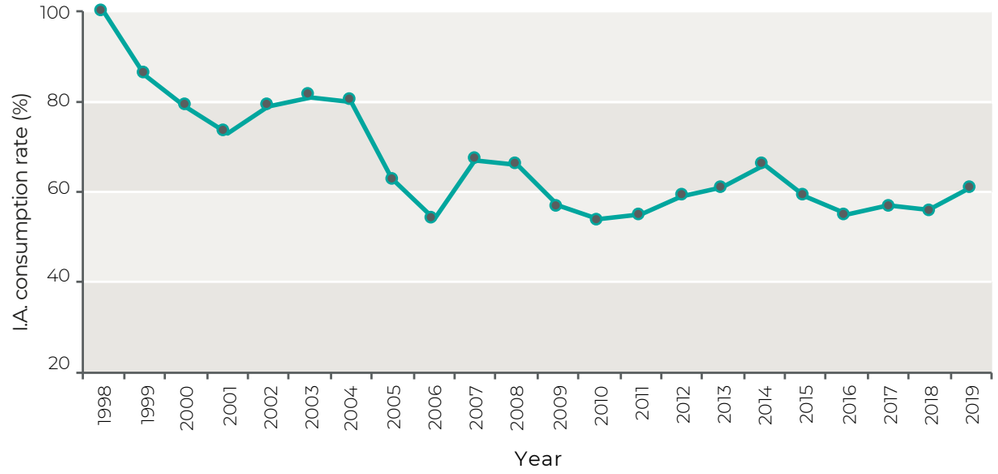
Additionally, PQUAs are classified according to the oral and dermal toxicity of the formulated products. In Colombia, such classification is ruled by the Andean Standard, which at the same time follows the WHO standard (WHO, 2009), and adjusts to the current Globally Harmonized System (GHS) approved by United Nations in 2002 with the purpose of normalizing and harmonizing the classification and communication of hazards of chemical products, which Colombia adopted through Decree 1496 of 2018 of the Ministry of Labor. Below is the current toxicological classification for the PQUAs:

Toxicological Category	WHO (2002 - 2019)	GHS (Since 2020)	Color Band
Extremely dangerous	Ia	1	
Highly dangerous	Ib	2	
Moderately dangerous	II	3	
Slightly dangerous	III	4	

It is important to mention that the implementation of the new categorization and signaling scheme of the levels of danger in the labels and safety sheets of chemical pesticides in Colombia, under the GHS, will have a transitional period of five (5) years that will finish in 2025. This means that products registered under the previous scheme will be available for use until 2025; those registered as of 2020 will have to do it following GHS' Guidelines.

Consumption of Agricultural-Use Chemical Pesticides in the Flower-Growing Sector

Although chemical control has been the most popular tool to control pests in the flower-growing sector, it is important to highlight that thanks to its optimization and the introduction of other IPM practices, it has been possible to sustainably reduce the consumption of pesticides, as shown in the indicator of the active ingredient of the floriculture socio-environmental indicators of Asocolflores. The following graph shows an average reduction rate of the use of chemical pesticides of 40% during the last 15 years (Asocolflores, 2020).



It is relevant to say that in recent years, the use of other chemical substances for pest control, such as disinfectants and silicon adjuvants, has been included since their consumption and safe management are of interest for flower-growers. Therefore, this part of the guidelines will emphasize the strategic standards to reach this objective. Soil fumigants and pesticides for immersion and devitalization of post-harvest flowers also require special attention.

The use of chemical pest control has motivated the current responsible management culture in the sector, which has been able to integrate the technical part of its application with the management of human health risks. Surely, this will enable the management of new substances and practices within the IPM process.

Next, emphasis will be given to product management aspects that, due to their recent introduction, their application methods, and the risks involved, are worth describing individually. These refer to the following substances:

- Antibiotics
- Soil fumigants
- Post-harvest fumigants
- Port-harvest herbicides
- Post-harvest immersion fungicides and insecticides
- Surface disinfectants
- Silicon adjuvants

Antibiotics

The word "antibiotic" is derived from the term "antibiosis." In the past, antibiotics were considered as organic compounds produced by a microorganism and elements which were toxic for other microorganisms (Denyer et al., 2004). Low concentrations of antibiotics may inhibit the growth or kill other microorganisms (Russell, 2004). However, this definition has been modified since antimicrobials are currently produced partially or totally by synthetic means.

In Colombia, antibiotics for agricultural use, specifically in floriculture, are registered as chemical pesticides under ICA's Resolution No. 1418 of 2016. Some, such as kasugamycin, oxolinic acid, and the mixture of gentamicin sulphate + oxytetracycline clorhydrate, are registered as chemical pesticides for use in ornamental plants. In contrast, some flower growers use antibiotics registered for animal use for control of phytopathogen bacteria, which in principle is not what the legislation demands.

The use of antibiotics in agriculture is usually considered a major contributor to the clinical problem of resistant disease in human medicine. Other studies establish there are no data conclusively supporting this statement (Qiuzhi, 2014).

In February 2019, FAO's phytosanitary commission presented a report indicating the existence of the risk of humans developing resistance to pathogen microorganisms due to the elevated consumption of antibiotics in agricultural crops. The fact is that pathogen microorganisms in humans can occupy the same spaces as plant pathogens, and antibiotic treatments are not necessarily selective of either group. Likewise, there are environmental risks derived from their incorrect use.

Considering these statements, it is possible to conclude and recommend that the use of antibiotics to control phytopathogens in floriculture should be limited to products registered for agricultural use.

Soil Fumigants

Colombia, by the Congress Act 29 of 1992, approved the Montreal Protocol related to the prohibition of substances that deplete the ozone layer. One of these substances is methyl bromide (MeBr), which at the time was used to control soil pests by some producers of flowers and ornamental plants.

After the approval of the Montreal Protocol, the few flower and ornamental plant producers that use MeBr started programs to substitute this pesticide with alternatives causing less environmental impact to such a degree that by 1995, according to information by Asocolflores' FlorVerde Program, the consumption of this substance has been abolished. FlorVerde Program today is the sustainability route of Asocolflores.

The Ministry of Health, through its Resolution No. 138 of 1996, prohibited the import, manufacturing, and commercialization of MeBr pesticide products and cancelled their registration. Currently, its use is limited exclusively to quarantine pest controls in agricultural products and wood packaging material in ports and country borders under total airtightness (Resolution No. 3587 of 2008 of the Ministry of Social Protection).

Among the alternatives to disinfect soils that replaced MeBr in floriculture are the use of steam and *metamsodium*, *dazomet*, and *dichloropropene + chloropicrin* pesticides, which continue to be used by some companies in the sector with important changes in their application methods.

The objective of chemical disinfection is to reduce soil dwelling phytopathogen microorganisms' populations, such as bacteria (i.e., *Erwinia*), fungi (i.e., *Fusarium*, *Pythium*, *Phytophthora*, *Rhizoctonia* and *Verticillium*), nematodes, and arthropods, which case agricultural production losses.

Post-Harvest Fumigants

During the last five (5) years, one of the main phytosanitary problems encountered by Colombian flower-growers when exporting their flowers to different global markets has been the permanent interceptions due to *Frankliniella occidentalis*.

For this reason, the agrochemical industry has developed new methodologies and products for controlling that pest in post-harvest, and the phytosanitary authorities now recommend them among the options to be implemented voluntarily by flower-growers.

We refer to the use of chemical fumigants applied to harvested products within airtight chambers. That fumigant is magnesium phosphide, which, when in contact with environmental humidity and plant material, releases the active ingredient, turning into phosphine gas, which finally poisons the insect.

Since 2016, the use of that insecticide by some flower-growing companies follows regulations. It was then when the product was registered by ICA for use in ornamental plants.

Without a doubt, up until now, this has been an efficient tool to control trips; thanks to it, interceptions have decreased.

However, the use of phosphine demands following strict standards for its proper and safe management. This insecticide is classified as Ia toxicological category (extremely dangerous). Therefore, the vendor must give support to the companies in terms of following the application method and necessary care for the product's storage, application, and waste management, as well as the installation of necessary infrastructure for its application.

Devitalization Herbicides

This is a procedure that eliminates the germination, growth, and reproduction capacity of plants or spreadable plant parts (FAO, 2016).

This treatment is demanded by the AQIS (Australian Quarantine and *Inspection Service*) for exporting cut flowers and foliage of spreadable ornamental species, such as rose, carnation, chrysanthemum, Hypericum, and Ruscus, among others. It is done through the immersion of the stems' base in an herbicide solution with sole dose, according to the depth and time frame established by AQIS.

The companies exporting cut flowers or foliage to Australia must be registered at the ICA in the devitalization protocol. This institute publishes the updated list of companies in compliance with the protocol.

To devitalize stems by immersion, the procedure required by the importing country is applied, using the demanded product (*glyphosate* 360), according to doses, volume, use directions, and treatment time required.

At the time of the shipment's arrival, the Department of Agriculture, Fisheries and Forestry (DAFF) of Australia evaluates the quality of the treatment by taking a random sampling of the received stems that are treated with hormone IBA and placed in rooting substrate for 4-6 weeks of quarantine. This shall eventually impede the growth of buds. If this does not happen, the imports may be suspended.

Fungicides and Insecticides in Immersion Post-Harvest

The immersion of harvested flowers in fungicides or insecticides has been a common practice in the Colombian flower-growing sector mainly to control fungi, such as *Botrytis*, and occasionally to control arthropods, such as trips and mites. This practice has not been accepted by those who know it since they consider there is exposure to chemical risks to the personnel working close to the area where the process is done.

There are few chemical pesticides registered in ornamental plants that include in their label the use recommendation for the immersion process to control these problems. Although some of them have demonstrated efficient control, they continue to be dangerous for human health and the environment.

For that reason, any pesticide application post-harvest shall minimally consider the same safety protocols for the protection of people and the environment as when it is applied to the crop.

Products Different from PQUA (Chemical Products used in Agriculture)

Disinfectants

Disinfectants are substances or mixtures of substances that destroy or suppress the growth of harmful microorganisms, such as bacteria, fungi, and viruses in the environment or inert surfaces (EPA Website, 40 CFR 158.2203).

This guide describes substances used for environmental disinfection in crops and post-harvest.

Applicable Standards

Colombia

- Some disinfectants are registered as fungicides for ornamental plants and appear in the list of chemical pesticides with ICA registration (visit www.ica.gov.co).
- The use of products using nebulization or thermo-nebulization in agriculture is not specified in the labels, and to this date, there is no legislation that demands the specification of how to use them.
- Currently, in Colombia, registration of disinfectant substances for agricultural use is not demanded.
- Antioxidants (hypochlorite, quaternary ammonium, chlorine dioxide, hydrogen peroxide) for disinfection of surfaces are considered suitable for residential use, and the concept of "Compulsory sanitary notification" issued by INVIMA is applied to them.

United States (Environmental Protection Agency – EPA)

- Agriculture disinfectants are considered *antimicrobial* pesticide products, registered under Section 7 of the FI-FRA and 40 CFR, parts 152 and 158.
- Their label must specify their mode of use, and their application is only allowed by nebulization or thermo-nebulization, as indicated.

European Union (Regulation 98/8/CE)

- Disinfectants are considered pesticides under Regulation 98/8/CE. They are registered under CE No. 1907/2006, which was complemented by Guideline 2009/128/CE about the sustainable use of pesticides, oriented to reduce environmental and health risks, maintain crop productivity, and improve the use and distribution control of pesticides.
- The label must specify the mode of use.

Objective

Reduce populations of phytopathogenic fungi in the environment through the safe use of chemical disinfectants.

Implementation Guidelines

In general, products used for environmental disinfection in crops and post-harvest correspond to phenols, quaternary ammoniums, biguanides, and glutaraldehyde. Below is a description of their effects for providing elements to better understand their control mechanisms.

Additionally, and considering the relevance of knowing and properly selecting these products according to the control expectations, Annex 1 includes a *Disinfectants Classification and Properties.*

Phenols (= carboxylic acid)

Phenols have bacteriostatic power in low concentrations (0.1 – 1%) and are bactericides/fungicides at higher concentrations (1% - 2%). Their bactericide activity improves with temperature and when mixed with EDTA (Ethylenediaminetetraacetic acid). It is affected by alkaline media and low temperatures, as well as by the presence of lipids and soaps (Merck's Disinfectants Manual, 2015).

Phenols cause irreversible damage to the microorganisms' cell membranes that attach and denaturalize proteins.

They are mainly used to disinfect surfaces, equipment, and tools. They are corrosive, cause skin and eye irritation, and may cause severe health damages. For that reason, their use as disinfectants is limited.

Cresols, halogen-containing diphenyl, alkyl esters, and certain essential oils of plant origin, such as thymol and eugenol (Lañez, E.) are derived from phenols (visit http://www.biologia.edu.ar/microgeneral).

Quaternary Ammonium (QUAC or QUAT)

The revision made by Diomedi et al. (2017) establishes quaternary ammonium corresponds to a family of compounds whose basic structure is ammonium cation (NH4+), that when modified, have generated different disinfecting agents.

They are soluble in water and alcohol, acting in acid media, but mainly in alkaline media, having surface-active properties. Their activity decreases in the presence of organic matter. Their disinfecting action ranges from concentrations of 0.25% or higher, mainly for use in medical furniture surfaces and hospitals' physical facilities. They are used in water solutions or mixed with detergents to combine cleaning and disinfection actions in one application.

They are generally associated with tertiary amines in disinfecting formulas, increasing their biocide action. Quaternary ammonium salts are generally recognized as colorless or yellow-colored compounds, odorless, deodorant, and non-irritating when used in their usual concentrations.

With time, quaternary ammoniums have been modified to overcome resistance, improve their action range, and the environmental conditions which affect them. Following are the different generations of quaternary ammoniums:

First, Second, and Third Generation

Benzalkonium chloride was the first compound used as an antiseptic and is still commonly used for hospitals' disinfections. This molecule had an alkyl group with a higher number of carbons, demonstrating a greater antimicrobial power.

Second generation quaternary compounds, such as ethyl benzyl chloride and third generation quaternary compounds, which are mixtures of first and second-generation molecules, have importantly increased their disinfecting activity and potentially lowered microbial resistance vs. the repeated use of a sole compound (Diomedi, A. et al., 2017).

Fourth and Fifth Generation

Fourth generation compounds, such as didecyl dimethyl ammonium chloride, are mainly characterized by their high tolerance to hard water and protein loads. They are also used in the food, beverages, textile, and paper industry, among others.

Fifth generation compounds are second and fourth generation mixtures of molecules, such as alkyl-dimethyl-ethyl benzyl ammonium chloride and dodecyl dimethyl ammonium chloride, plus other molecules, according to the different formulas, which have better microbicide effect, especially in difficult environmental conditions, and are safer to use, a characteristic of these compounds as their generations advance.

Biquanidines

These compounds have high bactericide capacity and very low toxicity. They have a broad spectrum and low risk of resistance because they do not have a specific action mechanism. Therefore, they are used to lower the resistance generated by bacteria due to the continuous use of the same disinfectant. They act over the cell membranes of gram-positive bacteria and some fungi and have sporicidal capacity. They are used in domestic, industrial, institutional, and food applications.

They are very active in neutral or slightly alkaline pH. Their activity decreases in the presence of hard water, detergent, or anionic soaps.

Chlorhexidine is broadly used in clinical environments and cough control medications.

Glutaraldehyde

They have broad spectrum biocides and are efficient against bacteria, molds, viruses, and micro bacteria. Also, they activate when the solution is alkaline (pH 7.5 to 8.5) and have sporicidal activity.

They act by the alkylation of chemical groups of proteins and nucleic acids of bacteria, viruses, and fungi. Glutaraldehyde acts over proteins by denaturalization and over the nucleic acids and proteins by alkylation.

Silicone Adjuvants

Silicone or organo-silicone surfactants are adjuvants with the highest capacity to break water surface tension. They are used in pesticide formulas to improve the efficacy of the active ingredient or, in product

blends, to optimize drops distribution and the aspersion coverage on plants foliage.

Recently, and thanks to its surfactant characteristics, organo-silicone surfactants are used to control pests, including mites, aphids, and white flies. In this case, it acts by obstructing the spiracles and causing damages in the cuticle structure, interrupting important physiological processes, and causing their death (Cowles et al., 2003).

Adjuvants in Colombia are not classified as pesticides and are registered at the ICA under Resolution 2713 of 2006.

Currently, there is an important number of silicon adjuvants for foliage washing, which are promoted and used to control mites. However, they have not been registered as adjuvants or acaricides. For this group of products, the ICA grants a "Certificate of non-compulsory use," and they are labeled as "Foliage Polishers".

Organo silicon adjuvants, although considered harmless, represent health and environmental risks, causing direct effects to beneficial insects (Cloyd, R., 2019). Mesnage R. and Antoniou, M (2018) alert us on the risk generated by organo-silicon adjuvants and their high tensioactive capacity over human skin.

Considering their current use in integral management programs and the resulting increase in consumption volumes, it is important that their management is done safely. To contribute to this process, there are criteria set by EPA in the United States of America to define the implied risks: biodegradation rate, degradation products, and toxicity level in water bodies (visit www.epa.gov/saferchoice/safer-choice-criteria-surfactants).

Applicable Standards

» ICA's Resolution 2713 of 2006 *Regulatory provisions for physiological regulators and adjuvants for agricultural use.*

Objective

Use silicon adjuvants for physical pest control as a complementary measure of chemical control.

Implementation Guidelines

» Use only products with an ICA registry.
» Always follow safe management procedures, as done with pesticides.
» The IPM Manager will evaluate the Phyto-compatibility of adjuvants to be used and will ensure they do not generate plant toxicity when applied according to doses and application frequencies recommended in the label.
» It is recommended to apply them by themselves and not mixed with other products, avoiding high temperatures and low relative humidity since phytotoxic effects have been observed in some ornamental species. Also, ensure the good hydration status of the crop before their application.
» The IPM Manager will establish which pests need to be controlled and the doses, volumes, methods, and application frequencies for adjuvants.
» It is important to validate their efficacy over the target to be controlled.
» Consider their application within a rotation scheme and define the application frequencies considering their phytotoxicity risks.

3. Use and Management of Pest Control Products

The responsible management of pest control and the minimization of risks for human health, the crops, and the environment are the pillars to govern the use of chemical pesticides, bio-products, and other chemical substances from the time the products to be used are chosen until finalizing their application in the field.

The management of each stage in which pest control products are used and managed at any of the phases of the productive process (propagation, production, post-harvest) shall be the IPM Manager's exclusive responsibility with the participation of those responsible for the involved areas or processes.

The term "product" hereinafter refers to the active ingredient(s) and the rest of the components of the chemical pesticide, bio-product, or any other chemical substance used to control pests in the way in which it is packaged and sold (FAO, 2006).

Products Selection and Purchase

When choosing pest control products, it is necessary to do it under technical criteria for their appropriate use and in accordance with the legislation requirements.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Act 55 of 1993 by the Ministry of Social Protection. *Safety in the Use of Chemical Products at Work.*
- Resolution 3759 of 2003 by ICA. *Provisions for the Registration and Control of PQUAs.*
- Resolution 2713 of 2006. *Regulatory Provisions for Physiological Regulators and Adjuvants for Agricultural Use.*
- Resolution 1418 of 2016 by ICA. *Registration of Agricultural Use Chemical Pesticides and Biologicals in Ornamental Plant Crops.*
- Decree 1496 of 2018 by the Ministry of Labor. *Adoption of the Globally Harmonized System (GHS) for Classification and Labeling of Chemical Products.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Choose and acquire the chemical pesticides and biological products for agricultural use and other chemical substances for pest control in compliance with the applicable standards and according to technical criteria.

Implementation Guidelines

Legal Criteria

- To program, acquire, store, and use only products for pest control that have registrations before the competent authorities (ICA or INVIMA, as applicable).
- The registration process of a product before competent authorities obliges the applicant to comply with all protocols and tests officially supervised. A legally registered product is more trusted by users than those that do not have such registries.
- Currently, there is a special situation with some products used in the flower-growing sectors over which there is no clarity with respect to their legal registration for agricultural use. This is the case of soaps and disinfectants under the "Certificates of NON-compulsory Use," issued by INVIMA or ICA. Through those, these entities declare not having competence for registering them, making quite evident the lack of legislation in that respect.
- Something similar occurs with the products registered at ICA as fertilizers, which in practice are being used as pesticides.
- Every chemical pest control product used must have the label and Safety Data Sheet (FDS for its acronym in Spanish) in agreement with requirements by the GHS. (visit: (http://www.unece.org/trans/danger/publi/ghs/ghs_rev08/08files_e.html).

- Pest control products to be used in the farm shall be purchased in stores having updated registers granted by competent national authorities to perform such sales.
- Chemical pesticides and biological products to be used must be prescribed by an agricultural engineer or competent professionals.
- Chemical pesticides must be recommended for use in at least one (1) ornamental species.
- Maintain available and updated lists of chemical pesticides with valid ICA registers and use recommendations in ornamental crops or for the cultivated species. (Visit: www.ica.gov.co or www.florverde.org).
- Do not use forbidden pesticides, those with restricted use by ICA, or pesticides appearing in Florverde's list of prohibited pesticides. Maintain available and updated lists of officially forbidden, cancelled, and restricted pesticides in Colombia. (Visit: www.ica.gov.co and www.florverde.org).
- Do not use pesticides that have been officially prohibited in the destination countries of the material to be exported.
- Do not use chemical pesticides whose use has been restricted by users in the destination countries of the material to be exported.
- Read the products' labels before their use. Following the recommendations in the labels of the product is mandatory.

Technical Criteria

- **Toxicity:** Choose products with minimum risk for human health.
- **Active Ingredient Concentration:** If possible, select products with the lowest concentration of active ingredients.
- **Efficacy:** Choose the most efficient products against the biological target to be controlled. The flower-growing companies must know the efficacy of the products they use through formal communication from the marketers or controlled evaluations developed under objective methodologies with reliable results.
  - The Company must have an annual product assessment program with respect to each pest, both for products already in use, as well as for those used for the first time. Based on the evaluation results, define a rotation program of products per pest.
- **Phytotoxicity:** Select products that are not toxic for the plants. The IMP Manager must apply procedures to evaluate the products' safe use over the plants or harvested product before selecting them for the application at commercial levels.
- **Risk-Benefit Ratio:** This is an analysis made by the ICA, based on the toxicological technical opinion that assesses the toxicity risks of PQUAs in human health as a previous condition to grant the register for the use of pesticides in the country, trying to prioritize products whose benefits are higher than their risks.
- **Mode of Action (MoA):** With the objective of minimizing the risk of appearance of pest resistance to the PQUAs and some biologicals, rotation criteria of the MoA is recommended by the FRAC (*Fungicide Resistance Action Committee*) and the IRAC (*Insecticide Resistance Action Committee*).
  - The FRAC assigns MoAs to biological products such as mineral and organic oils, bacteria (i.e., Bacillus subtilis), fungi (i.e., Trichoderma spp), and plant extracts. The IRAC does the same with biologicals such as bacteria (*Bacillus thuringiensis*), fungi (*Beauveria bassiana, Metharhizium anisopliae*), oils, botanical extracts, and diatomaceous earth. Therefore, when biological products are used for pest control, it is mandatory to consider their MoA within the pesticide rotation program.
  - To minimize the risk of resistance, advise is not to use more than two (2) applications of the same MoA during a life cycle or the same pest generation. The IPM Manager will oversee the definition of the rotation schemes based on application frequencies used for each biological target.
  - Rotation programs will include multi-action pesticides and biologicals, as well as physical action substances that

minimize the probability of appearance of resistance for those with chemical action.

- It is necessary to know the MoA of chemical disinfectants in use and include them in a rotation program that minimizes resistance of pathogens to these substances.

Storage and Inventory Management

Storage of chemical pesticides, biological products, and other chemical substances used for pest control must be adequate and safe.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Act 55 of 1993 by the Ministry of Social Protection. *Safety in the Use of Chemical Products at Work.*
- Decree 1496 of 2018 by the Ministry of Labor. *Adoption of the Globally Harmonized System (GHS) for Classification and Labeling of Chemical Products.*
- Resolution No. 63625 of 2020 of Instituto Colombiano Agropecuario (ICA): *Requirements to Register as Producer, Exporter, and Importer of Flowers or Cut Branches of Ornamental Plants to be Exported.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Provide guidelines on the storage conditions of pesticides, biological products, and other pest control products in the company.

Implementation Guidelines

Storage

- The site must be for the exclusive storage of pesticides and biological products for agricultural use. In the event the company uses other chemical pest control products, these can share the space with the pesticides and biological products only if there are no chemical incompatibilities between them. (Visit: www.arpsura.com).
- Disinfectant chemical products used must be stored in a different area because they are corrosive, oxidizing substances, or flammable (among other characteristics) and probably incompatible with chemical pesticides.
- In the storage site of pesticides and biological products, do not store preservatives or flower dyes, fuels, or any other element or product for human or animal use or consumption.
- The products must remain inside their packages, well-closed, and properly identified with their original labels in good condition.
- In the racks, the pesticides will be classified according to their toxicological categories. If they share a rack, the solid products (granulated or powder products) will be placed on top of the liquid products to avoid contamination in case of spills.
- Herbicides will be in separate racks and preferably locked to avoid confusion with the rest of the pesticides, which can cause the total or partial loss of plants in the crops.
- *Magnesium phosphide* (Mg_3P_2) must be kept inside an exclusive drawer or container due to its high level of danger, under lock and key, in a dry and well- ventilated place, away from electrical installations or ignition sources, and protected from heat and humidity.

Inventory Management

- Permanent crop monitoring will generate the necessary data on the incidence and severity of pests to make controls at the right time, only in affected sites, and just using the right amount of product.
- Order pesticides, biological products, and other chemical substances for short periods (i.e., one or two weeks maximum).
- Application programs will be executed as soon as phytosanitary problems are reported.
- Entrance and exit controls will be made, as well as the current product stock available to avoid purchasing those already in inventory.
- This register will facilitate control of entrance and exit of containers, packages, and crates to be reported to competent

authorities, including solid waste management of pesticides and other pest control products.
» It is important to apply the first in-first out (FIFO) method for inventory turnover to guarantee low stock and avoid expired products. If expired products are found, these must be duly identified and separated from those in use.

Measurement and Weighing

Accurate measuring and weighing of pest control products will enable having better results.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Make sure the measurement and weighing of pest control products are accurately done.

Implementation Guidelines

» For measuring and weighing the products used for pest control, accurate, reliable, and in good condition instruments will be used.
» Measurement and weighing tables must be stable, built on rigid materials, and placed on a flat floor.
» The site shall have sufficient ventilation and the right lighting, as well as the proper comfort necessary for doing a good job.
» Products' measurement and weighing will be done according to product application programs and the requests by the IPM responsible.
» Product orders shall reach the warehouse with sufficient anticipation to the moment of their application in the field.
» The warehouse will deliver the products according to the orders made. They will be packed in closed containers, clearly identified and labeled, indicating the name of the product, quantity, destination area, and date of re-packaging.
» Within the weekly routines of the IPM responsible, it is the supervision of the measurement and weighing of products in the warehouse to identify and correct potential faults. A check list is recommended to make it in an orderly manner.

Internal Transportation

Internal transportation of pest control products shall be properly done to avoid damaged or lost products.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Guarantee internal transportation of pest control products to avoid damaged or lost products and ensure the programs' compliance.

Implementation Guidelines

» Early in the morning, a person appointed by the IPM Manager will go to the warehouse to pick up the products to be applied during the day.
» The person receiving the products will verify that they come in closed packages clearly identified and labeled, indicating their name, quantity, area of destination, and re-packaging date. He/she will only accept products under the proper packaging and identification conditions.
» Products received will be transported in a safe vehicle, in a closed and labeled container, to the mixture preparation area, where they will remain until the moment of use.

Preparation of Mixtures

An adequate mixture of pesticides, biological products, and other chemical substances will enable better pest control results.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Follow recommendations for the preparation and mixture of pesticides, biological products, and other chemical substances given by the manufacturers on the labels of pest control products.

Implementation Guidelines

Previous Conditions

- The person responsible for IPM, through the revision of literature and the execution of reliable tests, will know about the physical and chemical compatibility required so products can be mixed to ensure there are no antagonist reactions between their action modes and mechanisms.
- Phyto compatibility tests must also be made for the individual products, as well as the mixtures to be used, to make sure they will not cause plant toxicity. The more products are mixed, the higher will be the risk of generating plant toxicity.
- Knowing the quality of the water used for the mixture and application of products. Clean water and free of dirt, which may obstruct the application equipment nozzles or interfere in the products' action, shall be used. Before mixing, make sure the total water hardness is lower than 100 ppm and pH ranges between 5.5 and 6.5. If necessary, these variables can be corrected according to the products to be prepared.
- Products and quantities to be mixed will arrive in closed, well-identified, and labeled containers by the warehouse personnel.
- Mixing tanks must be clearly marked to make sure the precise mix volume is prepared.
- Tanks shall have an agitation system to ensure a homogeneous mixture during the time the application may last.
- Within the weekly routines of the IPM responsible, it is to assure the mixture of products to be applied and to identify and correct any faults. A check list is recommended to do it in an orderly manner.

Preparation of Pesticides and Biological Products Mixtures

- According to the physical and chemical characteristics of the water used for the application of pesticides and biological products, the person responsible for IPM defines the dosage of water hardness and pH corrector if required.
- It is necessary to have reliable elements or instruments to measure the hardness and pH of the water available.
- Fill the tank with water according to the total volume to be prepared.
- Turn on the mixture agitator and maintain it in operation until the application is finished.
- Add the amount of water hardness corrector (if required) corresponding to the total mixture volume to be prepared.
- Add the amount of water pH corrector (if required) corresponding to the total mixture volume to be prepared.
- Add the amount of adjuvant corresponding to the total mixture volume to be prepared (if required).
- Using prepared water from the tank, individually dilute each of the products in a bucket.
- Each diluted product is added to the mixing tank until the last one. Products are diluted in order, first with the most difficult and last the easiest ones to dilute, as follows: wettable powders, dispersible granules, soluble powders, concentrated suspensions, emulsion concentrates, and soluble liquids.
- Each container is washed three times, the rinses are drained inside the mixing tank.
- The process ends by verifying the final hardness and pH of the mixture and making the necessary adjustments.

Other Chemical Substances Mixtures Preparation

- When preparing mixtures of other chemical substances used for pest control, manufacturers' recommendations in the product labels must be followed.

Application

The application of pest control products is an activity that imposes the challenge of making sure the active ingredients are placed in the environments or parts of the plant where pests are found. To achieve application efficiency, it is indispensable to standardize the procedures, permanently assuring their execution, correcting faults, and adopting the new and best practices identified.

The following guidelines, which are delivered for implementation in each of the application modes of pesticides and other chemical substances for pest control, only have one (1) objective: ensure the responsible use and management of products under technical criteria to achieve the best results and guarantee the plant's health and crop's productivity.

Aspersion

Aspersion (or pulverization) is the application of diluted products in high volumes of water with hydraulic pressure equipment that produce a cloud of different-sized droplets, through which the active ingredient is transported to the place of the plant where the biological target is found.

The initial condition for success in high volume aspersions of crops is that the surface of leaves is completely wet without generating runoff. Any increase in the aspersion volume only produces waste and not a greater amount of pesticide over the plant. In practice, it is very difficult to wet the plant in a uniform manner, meaning that the external leaves can reach a run-off degree before being able to wet the interior part of the plant.

Approximately 80% of the global offer of agricultural pest control products is sprayed. Under ideal environmental conditions and making the best of applications, the amount of liquid deposited on a spray over the biological target rarely reaches 60% (Mathews, 2000). These arguments force us to ensure product sprays are rigorously done under technical and safety standards, which mitigate inefficient factors, guarantee the integrity and health of crops, and protect human health and the environment.

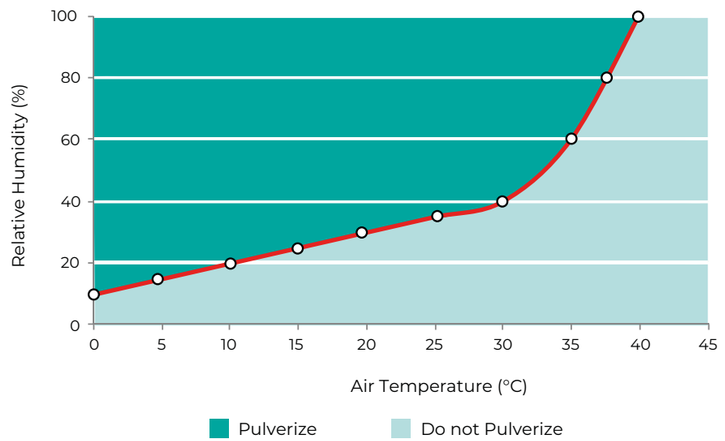
Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

Previous conditions

- Use products with registers from competent authorities, whose label has the application recommendation by aspersion.
- Use application equipment and elements in good condition, adapted so their operators can execute their work without problem.
- Take into consideration the appropriate weather conditions for spraying, reducing the possibility of evaporation of droplets in the environment.
- Wind speed between 3 and 7 kms/hour or light breeze (FAO, 2002).
- T °C < 30°C, Relative Humidity >60% and wind speed < 10 kms/hour (ANDI, 2003).
- The next graph shows the conditions of relative humidity and air temperature in which aspersions or pulverizations of agricultural pesticides are recommended (Etiennot, 2010) with the purpose of avoiding or delaying the evaporation of sprayed droplets.



» The application pressure of the equipment will be the pressure recommended for the nozzles being used, measured in the application site.

Aspersion Method

» The method should be standardized and documented in an aspersion manual that describes, among other aspects, the types of implements and their operation forms, mixture volumes, and travel times per area unit, according to the type of crop and biological target to be treated.
» Aspersion control will be executed by a supervisor assigned to that job with the competence to give accurate instructions and coordinate the work from the group of sprayers. Forming fewer working crews with more sprayers per group makes the controlling easier for the supervisor.
» Aspersion implements must be in good operation condition, without cracks or leaks, and without obstructions or clogging.
» Each aspersion will have a previous inspection to verify the area is free of obstacles and the personnel is wearing the required PPE, followed by the assignment of areas for each sprayer, the connection of the spraying implements, and the instructions to the group's supervisor about the objective and application method to be used.
» There will be an assistant at the mixing point, who will be responsible for the operation of the equipment and the pumping of liquid to be applied. He/she will be in permanent communication (by radio or mobile phone) with the application supervisor to coordinate the initiation, progress, and finalization of the aspersion.
» At the mixing point, the pump will be turned on at the operating pressure level established in the program. The agitation system will be turned on in the mixing tank and will continue in operation until the aspersion finishes.
» A volume of water with dye is injected in an amount enough to fill the conduction network corresponding to the area to be sprayed (volume established according to the distance from the mixing point).
» After injecting the dye volume, the product mix will be pumped.
» As soon as each sprayer detects the change of color in the device's nozzles and the mixture of product to be applied starts coming out, he/she will initiate the aspersion in the assigned area.
» From the beginning to the end of the aspersion process, the supervisor will permanently monitor the travel time per bed to the position of the device of each sprayer and the obstruction and cleanliness of the nozzles to ensure a uniform procedure in all applications.
» Once the total volume is pumped, a new volume of water with dye is injected at the mixing point. Once it is detected in the device of each sprayer, it will indicate the aspersion is over. This is how the conduction networks and hoses will be loaded with water without any residue of product mixtures.
» The person responsible for IPM will make sure there is at least one (1) aspersion per week. He/she will use a checklist to record findings, informing them immediately to the group of sprayers and establishing the corresponding adjustments.

Harvested Plant Material Aspersion

» This practice is done by some producers with the objective of controlling pests coming from the crop. Usually, it is done before the harvested product enters the classification and packaging room.
» Use pesticides or substances registered for use in ornamental plants with a recommendation of aspersion application.
» The produces, doses, mixture volumes, and amount of plant material to be sprayed will be defined by the person responsible for IPM, according to the monitoring reports.
» Products to be used will be measured, weighed, packaged, and labeled by the warehouse, according to a written order by the IPM Manager with the application frequencies required. At the aspersion site for harvested material, only the products used during the day will be accumulated. Those which are not used on the day will be returned that same day to the warehouse.

- Use adequate application equipment and facilities, which avoid exposure of unauthorized personnel to the chemical products.
- The harvested product aspersion must be done inside chambers, rooms, or tunnels enclosed in plastic walls in good condition and without holes that allow the evacuation of odors and vapors without exposing close-by personnel.
- Aspersion will be done by authorized personnel, preferably assigned to the IPM process, with adequate training and using the PPE defined for such work.
- Application sites will have informative and preventive signals to avoid the access of unauthorized personnel.
- Sprayed material will dry off through passive (natural) or active (mechanical) ventilation before passing on to the classification room.
- Sprayed material entering the classification room must be handled by personnel using gloves to avoid contact with chemical residues.

Immersion

Immersion of plant material in pesticide solutions or other chemical substances is a procedure to be executed under technical and health-safety parameters.

This process consists of submerging during a short time the plant material in a fungicide or insecticide solution for pest control. The specific procedure shall be defined by the company using it.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

Immersion of Flowers, Foliage and Cuttings

- Products used must be registered by competent authorities, be recommended for immersion use, and their solutions must be prepared according to the recommendations in the products' labels.
- It is important to have containers with sufficient capacity to avoid spills.
  - Products shall be physically separated from areas where people not involved in the immersion process are found, preferably outside of the classification and packaging rooms. Isolation will depend on the type of substance applied, to avoid splashes, odors or vapor being in contact with personnel.
  - There shall be sufficient ventilation to evacuate product odors and vapors to places without personnel.
  - Are shall have containers with sufficient capacity in order to avoid product spills.
  - Confinement structures are necessary to contain splashes, run-offs, and potential liquid spills.
  - Place informational and preventive signs closes to, or on the access doors to avoid entry of personnel not using adequate PPEs.
- Let treated material drain inside the chemical solution container, before entering the cooling and storage areas.
- Solution remainders at the end of the day will be properly disposed of, avoiding their discharge in sewage systems, or water sources or reservoirs. This water can be reused in the crop.

Devitalization of flower stems in immersion

- Devitalization procedure sites must have the adequate conditions for executing the work:
  - Sites must be separated from areas where people unrelated to the process are, in order to avoid their contact with spills, odors, or vapors.
  - There shall be sufficient ventilation to evacuate product odors and vapors to places without personnel.
  - Are shall have containers with sufficient capacity in order to avoid product spills.
  - Have confinement structures to contain splashes, drainages, and potential liquid spills.

- Place informative and preventive signs at the application area to avoid the access of unauthorized personnel.

» Allow sprayed material to drain within the same container of chemical solution before going to the cooling and storage area.

» Remaining herbicides at the end of the day of work will be properly put away, avoiding their drainage in siphons, sewages, water sources, or reservoirs. They can be used for weeds control outside the greenhouses.

Fumigation

It is a method for applying chemical pesticides in gaseous form, released in the air or dispersed on the soil to control plagues.

On the soil, they are used to control weeds, nematodes, insects, and fungi harmful to plants. In harvested plant material (flowers, cuttings), it is mainly used to control trips.

Most fumigants used are highly dangerous products, harmful to human health. For that reason, during their manipulation and application, it is mandatory to be accompanied and supported by the manufacturers or marketers.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*

» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

Soil fumigation

» Before preparing the sowing plot, soil analyses will be made at an independent laboratory to evaluate the presence of pests or pathogens that justify fumigation. Results will be available before preparing the soil and will define the treatment needed.

» Soil preparation can be done manually or mechanically, depending on the area to be fumigated. The method will consider the tillage depth, texture, structure, incorporation of modifications, and total removal of plant residues because organic matter neutralizes the active ingredients, reducing their biocide action.

» The fumigant's application method must ensure the distribution of the product on the surface and in the depth of the soil to be treated is done as uniformly as possible to avoid leaving places un-intervened.

» Products to be used must have registers form competent authorities and fumigation use recommendations.

» After finishing the fumigation treatment and before sowing the plants, make soil analyses in a laboratory independent from the fumigant vendor to evaluate the effect of the application on the targeted pests.

» The analysis of the results must be done together with the product's vendor, comparing the initial and final data, identifying the faults, and establishing corrective actions.

Soil Fumigation – Application of Products in Liquid Presentation

» There are two (2) application methods:

- Drench by stationary pump or manual injection for small areas.
- Injection with Venturi in the irrigation system for larger areas.

» After preparing the soil, the beds are formed and leveled. The process finishes with the installation of the dripping lines through which the fumigant will be applied.

» Dripping lines of each bed shall be well secured to the floor without clogging of droppers to guarantee a uniform product application.

» Before the fumigation and use of the irrigation system, soil humidity will be maintained between 50 and 70% of the field capacity to facilitate the continiuos development of weed, fungi, and nematodes' seeds.

» The fumigant application is the responsibility and must follow the protocols defined by the product supplier.

- Bed sealing is done with plastic covers in good condition, without holes, to ensure airtightness and retention of soil gases.
- The treated area is covered during the time recommended by the supplier (normally between 12 and 15 days).
- Once the treatment time is over, the plastic cover is picked up to air the soil. After that, bed irrigation should continue during five (5) to seven (7) days after sowing the plants. During this period, lettuce or radish seeds germination tests will be made to discard the presence of harmful gases for plants to be sowed.
- A minute should be written reporting all steps taken, from the soil preparationto the moment in which the area is delivered and ready for sowing.

Soil Fumigation – Application of Products in Solid Presentation

- After preparing the soil and leveling the plot or beds, the area is ready for applying the fumigant.
- Before the fumigation and use of the irrigation system, soil humidity will be maintained between 50 and 70% of the field capacity to facilitate the normal activity of organisms.
- In large areas, the mechanical application allows the dosing, distribution, incorporation of the product in the plot, and the sealing in a sole step and in a more uniform manner than when it is done using a manual hopper in the individual beds.
- Incorporation of fumigant in small areas or semi-confined beds can be done with a motorized plough or through double manual shoveling. In either case, it is important to make sure the fumigant is in the bottom so the soil portion to be disinfected is larger.
- Once the product has been incorporated and after the plot has been leveled, the sealing irrigation is done to avoid soil structure losses.
- The disinfected area is covered with a new plastic cover (or a cover in good condition), without holes to contain the fumigant gases during the time recommended in the product's label.
- After the coverage period ends, the plastics are picked up, and the plot is aerated during two (2) or three (3) days. During that time, germination tests of lettuce or radish seeds are made to certify the absence of harmful gases for the plants.
- A minute should be written reporting all steps taken, from the soil preparation to the moment in which the area is delivered and ready for sowing.

Fumigation of Harvested Material

The product

- The product applied is magnesium phosphide (Mg3P2) at 56% in solid presentation. When applied to the environment, it interacts with air humidity and releases its active ingredient as phosphine gas (PH3), which disseminates and contacts the material to be treated against trips.
- Its use is recommended in refrigerated (1°C to 3°C) and room temperature (13°C to 18°C in ornamentals (rose, carnation, pompom, alstroemeria, Limonium, and gerbera).
- Mode of Action IRAC 24: The product inhibits the mitochondrial respiration at complex IV level of the electron's transportation chain (IRAC, 2019).
- Currently, in Colombia, the custody of the product is the supplier's responsibility, who must provide technical assistance to users from the infrastructure's installation and commissioning for fumigation to the staff training and support given to the company executing the treatment.
- The IPM Manager makes controlled assessments to register the product is safe for plants under treatment before its full application.

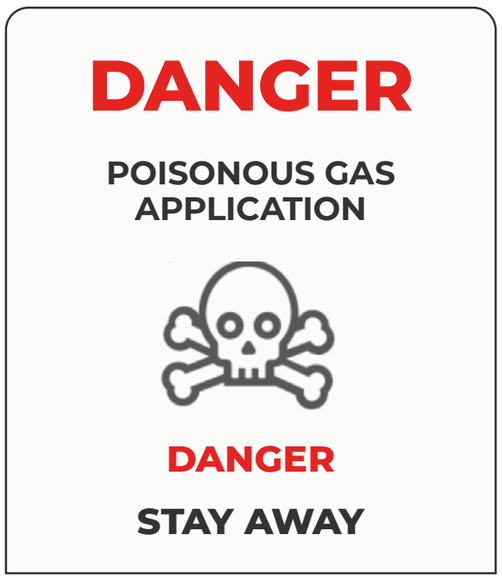
Chamber for the Application of Phosphine

- Chambers shall be airtight for the application of phosphine. These can be sea freight containers or cold rooms with the dimensions required according to the company's needs.
- The chamber for phosphine application shall be away from offices or areas where there is transit and concentration of people.

- It is ideal, although not mandatory, that the phosphine chamber has a forced ventilation system that expedites the entrance of fresh air and the exit of post-treatment contaminated air. It shall have a probe to measure the internal gas concentration during the treatment.
- The person responsible for post-harvest will define if treatment is done in refrigeration or room temperature conditions.
- Airtightness of the phosphine chamber is to avoid gas leaks, guarantee the treatment's efficacy, and be safe for those executing the treatment.
- Airtightness of the ceiling, floor, doors, and smokestack of the chamber are needed to ensure the entire structure and rubber seal joints are in good condition, without perforations that allow leaks.
- Smoke tests can be done by burning cardboard or newspapers inside the chamber to see from the outside the leaking spots to be corrected.
- Additional leaks to be sealed can be seen from inside the chamber with backlighting.
- Lastly, a test with phosphine gas shall be made before the normal fumigation operation. The fumigant is applied inside the chamber, closing it, and waiting for two (2) hours, after which leaks are searched for, using a Drager Pac 700 Ph3 phosphine detector. Leaks detected shall be immediately corrected, according to procedures recommended by the product's vendor.
- Afterwards, airtightness shall be monitored at least once every seven (7) days, using the indicated detector during the routinary plant material treatment. The detector shall be frequently calibrated in a laboratory recommended by the manufacturer.

Phosphine Treatment

- Those responsible for IPM and post-harvest, based on the information on trips monitoring, will define the material requiring phosphine treatment.
- The treatment shall be made at night to avoid the presence of people close to the process area.
- Two (2) people shall fumigate: one will manage and place the product in the application chamber at the beginning of the treatment and will remove and make the final disposal of the product once the process ends. The second person will accompany the first person all the time and will be ready in case of an emergency.
- The material to be treated shall come from cold or pre-cold processes, as defined by the person responsible for post-harvest.
- The phosphine chamber load volume must be between 50 and 75% of its maximum capacity to ensure gas mobility inside the chamber.
- The fumigant dose to be used is calculated according to the chamber volume and the treatment modality, depending on if it is in refrigeration (1 °C to 3°C) or at room temperature (13°C to 18 °C). Check the recommended dosage on the product's label.
- Once the chamber is loaded, the amount of product to be applied is taken out of the package and suspended in the ceiling, so it starts releasing the phosphine.
- The chamber door is immediately closed, and it remains closed during the entire flower treatment.
- An informative and preventive, easy-to-read sign shall be placed on the chamber doors, reading as follows:



- Maintain doors closed during the time established (from 12 to 17 hours), depending on the dose and treatment modality.
- Before finishing the treatment, the maximum concentration of phosphine gas will be measured inside the chamber to make sure it is > 200 ppm. Measurement is done using a disposable colorimetric tube for high concentrations installed in the external suction probe outside the chamber. This measurement shall be taken at least once per week.
- After the treatment time is over, forced ventilation activates (if available), the chamber doors are opened, and, after an hour, the maximum concentration allowed is measured: it shall be < 0.24 ppm. This is done with a Drager Pac 7000 Ph3 phosphine detector or through a disposable colorimetric tube for low concentrations installed in the suction probe outside the chamber. This shall be measured at least once per week.
- Once the allowable maximum concentration is reached, < 0.24 ppm, personnel may have access to the chamber to remove the load.
- Ensure treatment efficacy: take sample of treated bouquets, shake over a white surface, count, and verify insect mortality.

Thermonebulization

Thermonebulization is the vaporization of liquid substances to produce very fine droplets with the use of thermopneumatic energy (temperature and air pressure). Vapor produced is heated up from 60 ºC to 100 ºC (depending on the type of dilutor used in the mixture: aqueuos or oily), cooled and rapidly condensed when in contact with fresh air. This way, difficult access spaces are occupied.

This practice is used in the sector, mainly for application of chemical disinfectants and smoke-generating products, in closed environments contaminated by phytopathogenic fungi.

There are few chemical disinfectants with official registration and usage recommendations available in the market for ornamental crops. Most products available are for healthcare and veterinarian facilities, as well as for food processing plants.

Currently, the Colombian market does not have any chemical pesticides or bio-supplies for agricultural use which ICA registration and recommendation for thermonebulization application in ornamental crops. Therefore, usage of these products with such method has not been approved by competent authorities.

Before using substances for pest control with this application method, it is necessary to know about the physical and chemical properties of the products, their stability under usage conditions, additional potential risks represented by the substances and application devices, and have an approximate idea of their efficacy to control pests.

Applicable Standards

- Act 55 of 1993 of the Congress of Colombia. *Safety in the use of chemical products in work sites.*
- Florverde Standard for sustainable production of flowers and ornamental plants.

Implementation Guidelines

Application Method

- Equipment management and the substance application method must be standardized and documented in a company manual shown to the people making the applications.
- According to the nozzle to be used, it is necessary to know the precise machine flow (measured in ml/min). Based on that, calculate the volume to be applied (liters/ha) and the application rate (time/area). The nozzle flow will be measured with a defined frequency to monitor the nozzle wear and to be sure it is within allowable ranges. Once the nozzle flow exceeds the allowable limit, it will be replaced with a new one.
- Equipment vendors recommend chemical substances thermo-nebulization applications to be done under relative humidity conditions of air greater than 60% and at a temperature lower than 15 °C, so the fog produced is easily condensed when in contact with fresh air. The vendor's recommendations must be followed.
- According to the monitoring results, the IPM Manager will define the areas, frequency, substances, and rotation scheme of MoA, volumes, and dosages to be applied by thermo-nebulization.
- As in the case of chemical pesticides, the application of chemical substances by thermo-nebulization will also be registered.

» Thermo-nebulizing equipment vendors must be able to demonstrate and guarantee the droplets' size generated by their equipment is the adequate one, according to characteristics of pathogens to be controlled.

Utilized Substances

» Chemical disinfectants used will have a health or sales registration issued by the competent authorities (INVIMA or ICA)
» Product labels will include usage recommendations for the nebulization.
» The IPM Manager will make Phyto-compatibility tests before the commercial use of the technique and the chemical substances to ensure there is no toxicity affecting the plants.
» Application of chemical disinfectants by thermo-nebulization is made based on products' efficacy data over phytopathogens and their monitoring data, both in the environment and in the cultivated plants.
» To reduce the chemical load over the plants, the recommendation is to have thermo-nebulization treatments on a day different from those in which pesticides are sprayed.
» Empty packages and containers of chemical substances used will be washed three (3) times before their final disposal by the authorized personnel. Rinses of the tree (3) washes will be incorporated inside the product's application in the field.

Application Area Conditions

» The areas must allow the confinement and condensation of the applied product. In indoor areas, the doors, lateral drapes, and ceilings will be closed during and one (1) hour after the application ends.
» Optimal environmental conditions during the application are relative humidity (RH) > 60% and temperature < 15 °C.
» Before allowing entrance to treated areas, they must be ventilated at least one (1) hour to avoid personnel having contact with odors or vapors remaining from the application.

Smoke Generators (Fumigators)

Flower storage and refrigeration rooms commonly use smoke generators or fumigators for environmental disinfection and control of pathogens, which can affect refrigerated material.

Fumigators come in solid presentation with controlled combustion (without flame), which sublimate (passing from solid to gaseous form) to emit or release the active ingredient in the air or environment.

They normally are packed in metallic cans or containers and have a wick for ignition and activationof the sublimation in the space to be treated.

Once the sublimation starts being assisted by the air's humidity, the active ingredient condensates and is transported by the smoke to the air.

There are insecticides, fungicides, herbicides, and disinfecting fumigants commonly used in fruit and post-harvests tubers, in food cold rooms, poultry sheds, and animal barns, among others. In the flower industry, some of them are used to decontaminate storage cold rooms.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

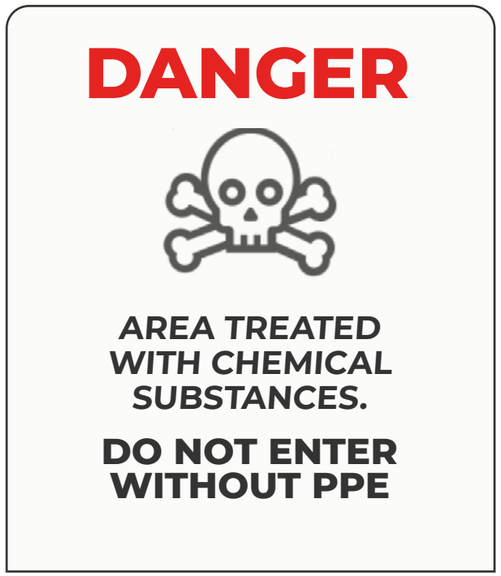
Implementation Guidelines

» Use products registered by the competent authorities (ICA or INVIMA).
» Personnel responsible for IPM and post-harvest will define the product(s), amounts to be used according to cold rooms to be treated, and the application frequency and schedules.

Product Application

» Treat at night to avoid the presence of people.
» Airtight closure of cold rooms before and during the time taken by the treatment.

» Open the fumigant product container wearing the necessary PPE.
» Place the open product package over a non-flammable surface (on the floor) and ignite the wick.
» Put the following sign on rooms being treated: DANGER. AREA TREATED WITH CHEMICAL SUBSTANCES. DO NOT ENTER WITHOUT PPE. The name of the product applied, the application date, and the re-entry date and time must be indicated.



» First thing in the morning, open the rooms to ventilate them for one (1) hour before allowing people's access.
» Keep records of the fumigant products' application in cold rooms: product name, date, and time of application, the amount applied, and the name of the person making the application.

Drench

In the national flower sector, the term "drench" refers to incorporating pesticides and other agricultural chemical products diluted in high volumes of water through the irrigation systems to control pests attacking plant roots in the soil. This is a process commonly used to control downy mildew and symphylan in roses, rotting of neck and root of chrysanthemum, alstroemeria, and carnations, among others.

The limitations of this application method to reach the biological target are well known. There are a number of variables involved, such as the physical and chemical properties of the soil and the products, the way in which the active ingredients move and interact inside the soil until they get in contact with the roots and other plant structures, the uniformity in the application distribution, and the mobility with which many organisms helped by the water are able to evade the pesticide action, among many other factors.

Before deciding on the application of pesticides by drench, it is necessary to study the characteristics of the products to be used, the soils, and the condition of the pests to be controlled. The pH, porosity, mineral content, organic matter of the soil, its Koc (coefficient of organic carbon or soil adsorption), pKa (capacity of ion dissociation), and water solubility of the pesticides are some of the elements conditioning the drench's efficacy. For that reason, its limitations must be seriously considered.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

Previous Conditions

» The decision to apply pesticides drenching the soil must be taken based on monitoring data or soil analysis, which verify the presence and incidence and evaluate the status of pests to be controlled.
» Products applied must have a register in at least one ornamental species and a recommendation on how to make the application drenching the soil. Currently, pesticides of common use in flower crops do not have a drench application recommendation for any ornamental species.

» The IPM Manager and technical director of the farm will define intervention areas and products to be applied, as well as the application volumes, frequencies, and methodologies.
» Soil humidity shall allow the product's action.

Treatment: During and After

» Use equipment that guarantees uniformity in the distribution of liquid in treated areas. It is recommended to revise the model *Unidrench* by Villalobos and Montoya (2010). In this equipment, which is coupled as Venturi to the irrigation system, the injection proportion depends on the homogeneity of the pressure and the flow stability.
» Equipment must be calibrated, and the flow must be measured in accordance with working pressure to calculate the application time per treated area.
» A supervisor must control the applicator's speed to ensure there is no excess product and that all areas have been covered.
» Once the application is finished, the equipment is washed, and the rinse is drained in the treated area.
» Products applied with drench shall be registered.

Incorporation of Solid Pesticides on the Soil

Consists of burying solid pesticides in granule form in the soil, so active ingredients get in contact with soil-dwelling organisms.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

» The IPM Manager will define the areas to intervene, products and quantities to be applied, and application frequency based on information of soil pests monitoring.
» Products applied must have a register for at least one (1) ornamental species and soil application recommendations.
» Soil humidity must be at soil capacity to allow products action.
» Products shall be applied in ditches or rows close to the plant's roots or in the sowing line of the crop. This is done by covering the applied product with soil.
» Keep a record of applications of pesticides on the soil.

Attractive Baits

These are pesticides generally used to control slugs, constituted by active ingredients and inert materials which are attractive or palatable for pests.

Their commercial presentation comes granulated, ready to apply. They can also be manually prepared by mixing pesticides with materials, such as saw dust, fermented cereal bran, unflavored gelatin, and molasses.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Implementation Guidelines

» The IPM Manager, based on slug-monitoring data, will define the areas to be intervened and the products, application quantities, and frequencies.
» Applied products must have a register for at least one (1) ornamental species.
» Manual preparation of baits shall be done considering the safety precautions for people handling them due to their exposure to chemical pesticides.
» Baits shall be uniformly applied and distributed in the surface of the cultivated area to be treated, close to the plants, or in the crop's sowing line.
» Baits should preferably be applied in the afternoon to delay its degradation and facilitate its action, according to the pests' night activity.
» Potential bait deterioration caused by the soil humidity or presence of water from the crop's irrigation shall be considered.
» Keep a record of attractive baits applied.

Equipment Cleaning and Personal Hygiene

After the application of chemical and biological pesticides for agricultural use or any other chemical pest control substance, it is necessary to clean the equipment and personal protection elements and consider the personal hygiene of the workers. This demands the allocation of adequate resources and facilities to make it in a safe and responsible way, considering the workers' health and the environment.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Decree 1076 of 2015 by the Presidency of the Republic. Sole Regulatory *Decree of the Environmental Sector.*
- Resolution 631 of 2015 by the Ministry of Environment. *Parameters for Specific Discharges with Pesticide Contents.*
- Resolution 1207 of 2014 by the Ministry of Environment. *Provisions related to the Use of Treated Wastewater.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Establish guidelines for the adequate cleaning of the application equipment, PPE, and personal hygiene to minimize human health and environmental risks.

Implementation Guidelines

Application Equipment and Implements Cleaning

Pesticides Aspersion

- Once the last aspersion of the day is done, the conduction networks, hoses, and implements must be loaded with dyed water. Therefore, only the implements (strainers, lances, nozzles) will have to be washed with clean water in the designated place. Such a place will have the necessary conditions for the collection, reuse, or treatment of rinses containing pesticide residues.
- Clean application elements will be stored in an orderly manner at the designated place.
- Once the last thermo-nebulization of the day is completed, the equipment will be rinsed with a cleaning product (to be selected, according to the thinner used for the applied substance) inside the tank and operating the machine until the cleaning product finishes.

Cleaning of PPEs

- After the last daily application of pest control products, personnel performing the application will go to the decontamination unit to wash their PPE with clean water and soap at the designated place. They will keep their gloves on while they wash their masks, jackets, overalls, and boots. The site shall have the conditions needed for the collection, reuse, or treatment of rinse containing pesticide residues.
- Clean PPEs will be hung from hooks, so they drain and dry in the designated place.

Personal Hygiene

- After washing the application equipment and PPE, personnel must take a bath with clean water and soap in the site's showers.
- The company shall allow sufficient time for personnel to bath and put on clean clothes.
- Resulting wastewater will be driven to the water treatment systems of the company.

Waste Management and Disposal

Refers to management given to waste generated by using pesticides and other chemical substances in the IPM process.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Decree 4741 of 2005 by the Ministry of Environment. *Regulations for the Prevention and Management of Hazardous Waste.*
- Resolution 1675 of 2013 by the Ministry of Environment. Management *Plan for Return of Products After Consumption of Pesticides.*

» Resolution 631 of 2015 by the Ministry of Environment. *Parameters for Specific Discharges with Pesticide Contents.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Adequate management of waste generated from the use of chemical and biological pesticides and other pest control substances in the company to their delivery for post-consumption programs officially authorized for their final disposal.

Implementation Guidelines

Hazardous Waste Deposit

» Have a deposit for transitory storage of pest control products' waste (PPE and application equipment not in use, containers, pesticide packaging, and crates), as well as other deemed dangerous according to the national legislation.
» The deposit must be indoors with restricted access, locked, ventilated, and adequate signage that allows the separation, classification, and organization of the different residues.

Solid Waste Management

» Guarantee all empty containers and packaging of pesticides and other chemical substances are rinsed three (3) times with water.
» Make sure the resulting rinse from the three (3) washes of containers and packaging of pesticides and other chemical substances are added to the tanks when preparing the mixtures.
» Separate the pesticide containers' caps and totally remove the aluminum safety cap. Perforate, cut, or crush the products' empty containers and packaging.
» Deliver the containers, packaging, and crates to recycling/return programs (i.e., Campolimpio Program) or entities approved by competent authorities for the disposal of this type of waste. It is necessary to have registers available to demonstrate their delivery to programs or entities authorized by the Ministry of Environment and Sustainable Development (MADS for its acronym in Spanish).
» Product manufacturers and distributors are required by law (Resolution 1675 of 2013 by the Ministry of Environment) to establish and actively participate in the implementation of mechanisms for the return of containers, packaging, and crates, as well as pesticides not being used (obsolete or expired).
» Updated records must prove delivery of residues for disposal by entities authorized by competent authorities.
» Plastic waste generated after the use of kairomones and pheromones will be treated as hazardous waste (according to EPA classification in the United States).

Management of Effluents

» Guarantee that the effluents resulting from the triple rinse of containers and packaging are sent to the mixing preparation tanks for their use in the crop.
» Have installed systems (injection of indicator dyes for the beginning and end of applications) or information on volumes (charts of filling volumes of connecting pipes) to guarantee no mixture surplus remains inside the networks or hoses.
» Mixture remnants resulting from the application of pesticides and other pest control substances will be reused in the same crop processes.
» Guarantee that rinse resulting from washing the application equipment and PPE are collected and reused in the crop (by downloading them in pesticide mixing tanks, dye tanks, or for irrigation in the ornamental areas of the company). These shall never be discharged in natural or artificial water bodies without previous treatment.
» Rinses in the product measuring sites (warehouse, mixing stations, or others) and immersion of post-harvest flowers must be re-used. These shall not be discharges in sewages, rainwater drainage canals, or natural or artificial water bodies without previous treatment.

Management of Phosphine Residues

» Considering the product is not totally consumed during the treatment, its remnant shall be managed in an active or passive manner, as follows:

Deactivation with Water (Active)

- Remove the residue from the chamber, not getting it wet with water. The product is flammable and ignites with water.
- Take to an open site with abundant ventilation.
- Deposit the residue inside a metallic container.
- Pour water over the residue, avoiding exposure to smoke generated.
- Resulting ash will be managed as hazardous waste.
- Accumulated residues will be delivered to the product vendor for their adequate final disposal.

Passive Deactivation

- Remove the residue from the chamber, not getting it wet with water. The product is flammable and ignites with water.
- Take the residue to a place close to the ceiling of the hazardous waste collection center, with good ventilation, which is protected from the rain and does not expose any person.
- Let the product ventilate for two (2) to three (3) days for its total deactivation.
- Deactivated accumulated residues must be delivered to the product vendor for their adequate final disposal.

Reuse of Water with Pesticide Residues

- This refers to the use of wastewater in compliance with quality criteria required for its future use. The re-use of water can be done for the following purposes:
  - Non-food crops for humans and animals.
  - Parks or sport-fields maintenance and adornment.
  - Non-residential gardens.
- Discharges with pesticides ARE NOT ADMITTED in rainwater canals.
- Companies with specific pesticide residues discharges into surface water bodies or the public sewage system are obliged to treat and make lab analyses to assess the content of categories Ia, Ib, and II pesticide waste (soon to be denominated categories 1, 2, and 3).

Disposal of Expired Products

- A good management of pest control products should be reflected in not having expired products.
- In case of having expired products, or products not in use, you must have records that prove they have been eliminated by an entity approved by competent authorities or returned to the vendor.

4. Risk Management

All pest control activities within the IPM process involve risks, which may affect people's health and the environment. Those who use pesticides and other chemical substances represent a higher risk. Therefore, this part of the guide will emphasize the identification of such risks and will establish the guidelines for the prevention and mitigation of their potential effects.

The area in charge of the Occupational Health and Safety Management System (SG-SST for its acronym in Spanish) shall identify chemical risk factors in each of the stages of use and management of pesticides and other pest control substances based on which the chemical risk management program must be defined.

People handling or applying pesticides and other chemical pest control substances must be covered by the chemical risk management program of the company. This includes those in charge of the storage, measurement, and weighing, internal transportation, preparation of mixtures, application supervision, application in all its modalities and during all production stages, and the final disposal of pest control products' waste.

It is important to remember the definitions of danger and risk:

Danger: Intrinsic condition of a substance, machine, or activity, which can cause harm to human health or the environment. For instance, the chemical pesticides in the farm's warehouse represent danger.

Risk: Probability of occurrence of an event that causes adverse events for human health or the environment. The probability depends on the presence of danger and the exposure level to it. Risk is minimized by intervening exposure level. It is not easy to change the intrinsic danger of a substance (except by not acquiring or using it). For instance, a person who manages chemical pesticides using correctly the adequate PPE is at less risk than a person not using them or using them incorrectly.

To identify the characteristic dangers of chemical substances to which we may be exposed, there are two (2) documental tools legally required for pest control products with official registers, whose information allows knowing the own characteristics of the products and to adopt the adequate safety measures before, during, and after their use. These two documents are the labels and the Safety Data Sheets (FDS for its acronym in Spanish).

The Colombian legislation, by means of Decree 1496 of 2018 by the Ministry of Labor, adopted *the Globally Harmonized System of Classification and Labeling of Chemical Products (GHS)* developed by the United Nations and ILO, which establishes the parameters and contents to be written in the labels and FDS of chemical products, converting them in elements for the identification and communication of intrinsic dangers of the chemical substances with the purpose of mitigating hazards, protect the health and take care of the natural environment.

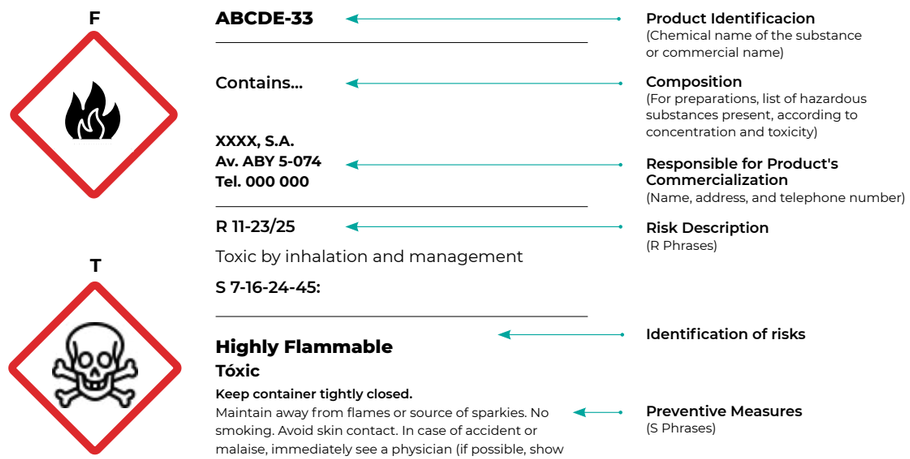
The manufacturer or distributors must give the product users the labels and safety data sheets with updated, comprehensive, and coherent information, which has been officially registered and approved by the corresponding authorities, as well as being responsible for its quality.

Therefore, the guidelines provided here to minimize the chemical risk of using pesticides and other chemical substances are based on the use of labels and FDS as supporting material for the technical and safe management of the entire life cycle of those products. For that reason, these documents must always be available for permanent consultation and become routine working tools of the IPM programs responsible and the SG-SST area of the company.

The Label

The label is defined as a set of elements of written, printed, or graphical data related to a dangerous product, which are adhered or printed on the product's container, packaging, or external crate (SGA, 2019).

The label has data to identify the product and be aware of its dangers and risks. The following figure shows the general label model for any dangerous chemical substance under the SGA:



The classification and labeling of chemical pesticides for agricultural use will continue being done according to provisions in the Andean Technical Manual of the Andean Community of Nations (ACN), Resolution 2075 dated August 1, 2019), incorporating the model for signaling danger of SGA. To comply with this standard, the PQUA-producing companies will have a transitory period of five (5) years, until August 1, 2024. This means that until then, it is possible to find products with the previous system and products with the new hazard identification system in their labels.

The label of a pesticide is generally formed by three (3) sections: one (1) on the left side (Block 1), one in the center (Block 2), and one on the right-hand side (block 3). The figure on the next page summarizes the contents of a PQUA label.

The left section (Block 1) shows a series of precautions and warnings focused on the safe management of the product and the protection of human health and the environment.

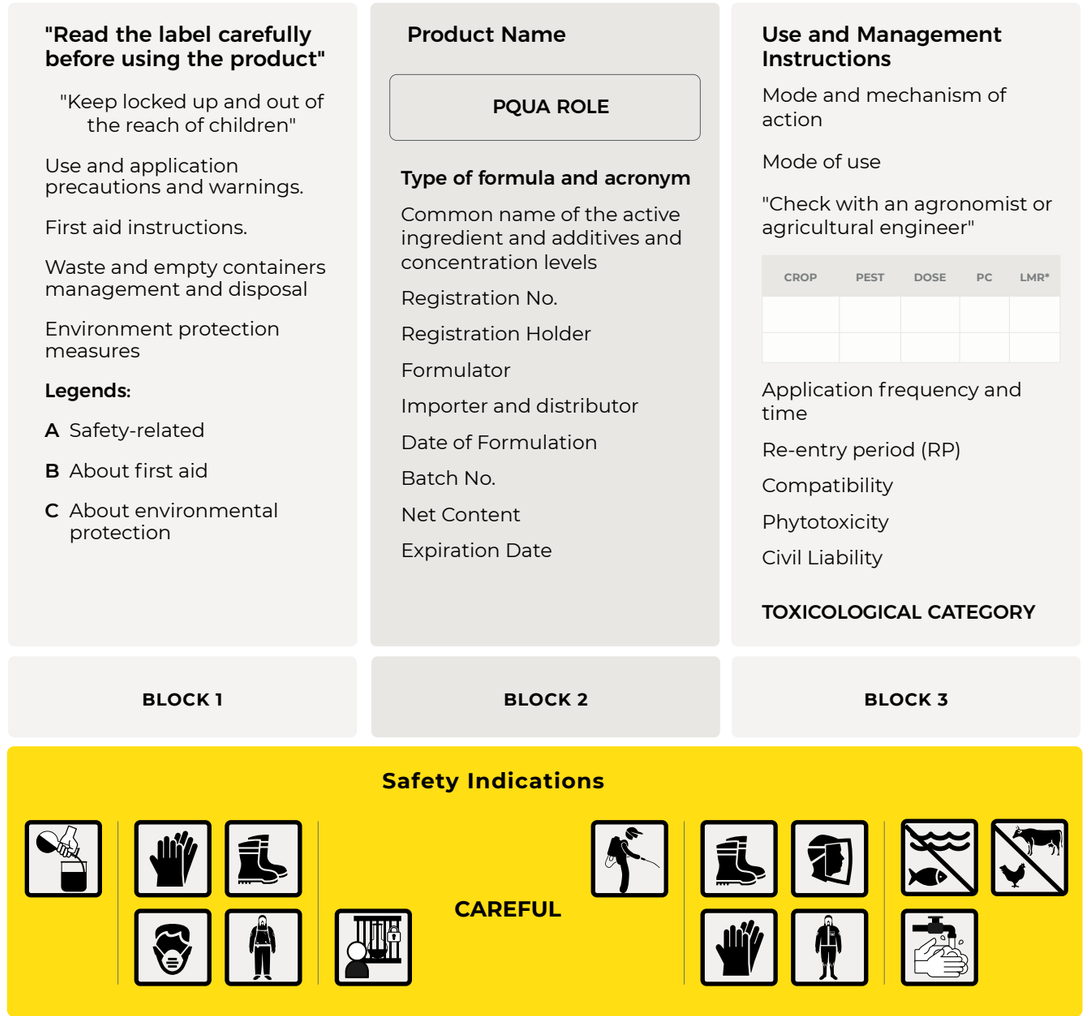
In the central section (Block 2) is the commercial name of the product, its presentation, role, composition, and concentration of active ingredient(s), its official registration number, batch number, content amount, manufacturing and expiration date, and the manufacturer and distributor's information.

On the right section (Block 3) are the product's technical use recommendations: crops to be protected and pests to be controlled and use dosage and mode of use, among others. Information registered in the product's labels is mandatory. Any use of the product not following the label's recommendation will be considered a legal breach, in principle.

Based on the three (3) sections above, there is a colored band (red, yellow, or blue), which corresponds to the toxicological category of the pesticide with pictures indicating the PPE to be used while handling the concentrated product (left side) and during its field application (right side).

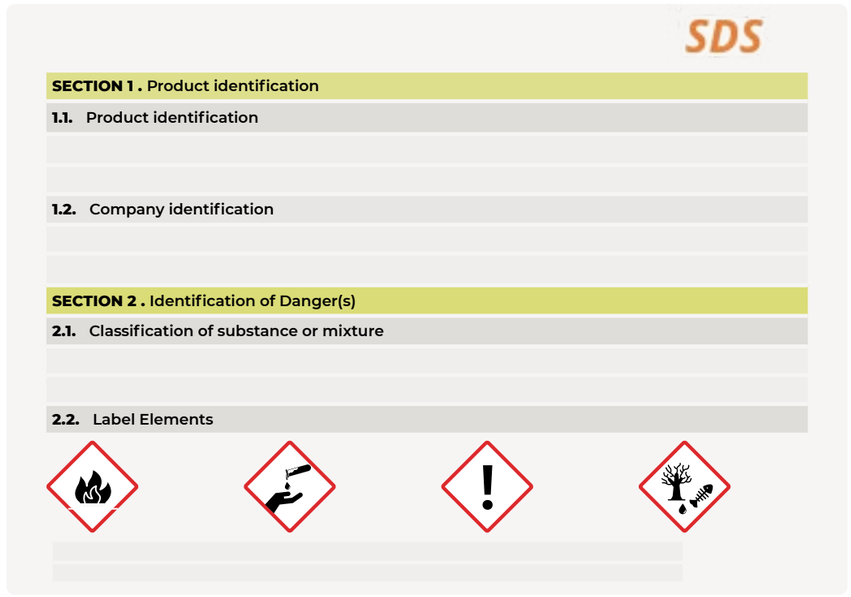
Technical Data Sheet

This is a commercial, non-official document that has summarized technical information about the product. It does not replace the data or usefulness of the label.



Safety Data Sheet (SDS)

This document describes the physical and chemical properties of a hazardous product, providing information on how to handle, store, and use the product safely and how to act in case of an emergency. The main purpose of the SDS is to inform about how to protect the physical integrity of the people while manipulating a substance and the environment.



Many times, emergencies occur because, from the beginning, substances are not properly managed and stored. The SDS indicates the storage conditions required to prevent emergencies.

An SDS has the following 16 sections:

Section	Content
1 to 3	Product or substance identification data
4 to 6	How to act in case of an emergency
7 to 10	How to avoid dangerous situations
11 to 16	Additional useful information about the product or substance

Following is the specific content of each SDS section:

Section	Content
1	Product and manufacturing company's identification data
2	Hazard identification
3	Composition, ingredients information
4	First aid measures
5	Measures against fires
6	Measures against accidental spills
7	Product management and storage
8	Exposure control and personal protection
9	Physical and chemical properties
10	Stability and reactivity
11	Toxicological data
12	Ecological data
13	Considerations on the proper final disposal of waste
14	Transportation information
15	Regulatory information
16	Additional information

Manufacturers are obliged to provide the SDS of each of the products used, written in Spanish, so they can be consulted by users in case of emergencies with pesticides. (Visit: http://www.fao.org/pesticide-registration-toolkit/information-sources/hazard-classifications/es/)

SDS shall be always available and accessible and close to working sites or wherever pesticides or other pest control chemical substances are stored, handled, or applied to be used in case of emergency. They shall never be stored under lock at offices or places with difficult access.

The company shall use SDS as training material for personnel working with pesticides and other pest control chemical substances to increase the knowledge of substances used daily.

Below are some important guidelines to be considered to minimize the risk during the use and management of pesticides and other pest control chemical products.

4.1 Chemical Risk Management

Facilities and Process Equipment

Management of pesticides, biological, or chemical substances for pest control must be performed in safe facilities and equipment for people's health, the crop's health, and the protection of the environment.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

The facilities and equipment related to the use and management of pesticides and other chemical substances must have the minimal safety conditions required to reduce health and environmental risks.

Implementation Guidelines

Pesticides, Biologicals, and Pest Control Products Storage

- The store shall be away from homes or schools, as well as water sources or bodies and floodable areas. It will not ventilate towards the locker rooms, W.C., canteens, dining areas, offices, or social areas.
- A solid wall will separate the materials storage area from the rest of the general warehouse.
- Floors, walls, and racks must be built of rigid, non-absorbing, easy-to-clean materials with a solid structure, resistant to heat, fire, and low temperatures, so products are protected against extreme conditions.
- The room must have a door with a lock to restrict access to people authorized and trained for the safe management of pesticides and other chemical substances.
- An informative and preventive sign shall be located over the entrance door, indicating the hazards and PPE to be used before entering the room.
- The room shall have an exclusive door or window for products delivery. In that way, those requiring the products will not have to enter the room. Emergency exits will be clearly signalized.
- Abundant and permanent ventilation and lighting (natural or artificial) through windows corresponding to an area greater than 25% of the floor's surface, or artificial lighting greater than 8 watts or plugs by square meter (Decree 1843 of 1991 by the Ministry of Health).
- In the case of natural ventilation and lighting, avoid sunlight and rain to directly affect and damage the products.
- Inside the warehouse, electric outlets shall be well maintained and far from the racks to avoid fires. Have available an ABC-type extinguisher in case of fire.
- If there are water faucets, the drains or rinses with contents of substances generated must be collected and taken to mixing tanks for their re-use in the field.
- Have a confined area in the floor to control potential spills with the capacity to contain 10% more than the total liquid pesticide volume contained in the largest container.
- There shall be no floor siphons, and there will be elements, absorbing elements, and facilities available in case of spills (sand, broom, trash collector, waste-baskets, etc.).
- SDS for all products stored shall be available and very close to the warehouse, in Spanish, and ready-to-use in case of emergencies.
- Inside the warehouse and in a visible place, there must be a simple and easy-to-understand brochure with instructions in case of emergencies (spills or intoxication). That brochure shall have emergency telephones (ARL, closest hospital, CIS-PROQUIM 01 8000 91612, Police Department, Firefighters, etc.).
- Shelves and racks shall be stable, of rigid material (metal or cement), non-absorbent, and easy to clean in case of possible spills and resistant to cold, heat, and fire.

Places for Product Measurement and Weighing

- The designated area for the measurement and weighing of products must have, as minimum:

- A firm weighing table in a resistant material.
- Sufficient lighting and ventilation (natural or artificial) that facilitates accurate measurements and allows the evaluation of odors and chemical vapors.
- Reliable equipment (scales, test tubes) to measure liquids, powders, and granulated products.

Mixing Stations or Preparation Points

The following conditions shall be adopted according to the type of installation (fixed stations, semi-stationary, or mobile equipment) of the company for mix preparations:

» Be of a solid structure material (brick walls or closing fences, cement floors).
» Have a door with a lock, restricting access to the personnel trained on safe management of pesticides.
» Have informative and preventive signs close or on the access doors.
» Have sufficient and permanent ventilation and lighting (natural or artificial).
» There must be no siphons on the floor. The room shall have a confinement structure without infiltrations around the mixing tanks with the capacity to retain 10% more than the volume usually prepared in the largest tank.
» In the case of semi-stationary or mobile application equipment, mixing tanks must be firmly attached to the floor over stable structures or tied to fixed structures to avoid spillage risks.

Facilities to Wash, Dry, and Store PPEs

» Have facilities for washing, drying, and storing PPEs and clothes after working with pest control products. No contaminated PPE will be washed together with clothes or elements of people not related to pest control work.
» Facilities must have floors, walls, and tables built in a compact, resistant, and easy-to clean material.
» Have sufficient and comfortable laundering basins to wash all PPEs used by the personnel.
» The place must have the necessary conditions for the collection or re-use of liquids with pesticide residues.
» Have sufficient clotheslines and dryers for clean clothes and PPEs with good ventilation to facilitate the drying of PPEs.
» Guarantee that none of the PPEs or other working clothes with pesticides are taken out of the company to be washed at workers' homes.
» Make sure PPEs are stored away from the place where pest control products are stored, mixed, or applied, as well as the application equipment, tools, and clean clothes.

Personal Hygiene Facilities

» Have facilities with compact, resistant, and water-resistant floors and walls that facilitate cleaning work.
» The place shall have the necessary conditions for the collection or re-use of liquids with pesticide residues.
» Have sufficient hot water showers (in areas where the temperature is lower than 18°C), which are clean and suitable for domestic use.
» Provide personal hygiene elements, including soap, towel, and flip flops.
» Have comfortable dressing rooms and individual double lockers per worker to store streetwear separated from working clothes.

Spraying Equipment

» Define and execute maintenance programs for pest control products application.
» Application equipment should operate properly: pumps, filters, conductive networks, hydrants, hoses, and nozzles should not be clogged, have leaks, or spill liquids. Manometers, pressure valves, mixing agitators, etc., must be in good operating conditions.
» Use the proper working pressure (PSI) recommended by nozzle manufacturers. It is important that the aspersion pump has properly operating manometers installed as close as possible to the nozzle discharging site, facilitating the actual pressure of the application.

» Nozzles are washed using clean water with a periodicity defined according to the type, life cycle, or usage frequency of the nozzles and to the opinion of the person responsible for IPM.
» All spraying nozzles shall be checked to avoid exceeding the allowable flow and replaced when necessary. Records of this shall be kept.
» Nozzle experts state that when the flow is 10% higher than the original discharge is when they must be replaced. Therefore, nozzles must remain unclogged, having always the same working pressure and being calibrated with a manometer installed in the applicating device.

Thermo-Nebulization Equipment

» Equipment in good operating conditions must be used. A periodical preventive maintenance program must be followed according to the recommendations of the user manual.
» Make routinary revisions and adjustments to the equipment to ensure there are not liquid leaks, all parts are duly adjusted, and the batteries and plug work correctly, as well as the cleaning of coal deposits inside the exhaust pipe.
» If possible, use equipment transported on safe vehicles (cars or manual wheelbarrows, cable-roads, etc.) to minimize ergonomic risk caused by heavy loads and direct contact of the worker with hot surfaces to avoid burning accidents.
» Over the protection grid covering the thermo-nebulizer exhaustion pipe clearly and sufficiently warn the user about the burning risk.
» Along with the thermo-nebulization equipment, have a type B extinguisher for fuel fires.
» The fuel tank and the tanks of substances to be applied must be filled with the equipment when cold, using funnels to avoid liquid spilling.
» At the end of the workday, adequate cleaning, maintenance, and storage of the equipment will be done. It is recommended that the distribution circuit rinse is done placing the cleaning fluid (to be chosen according to the solvent used for the applied substance) inside the tank of products and commissioning to the machine until all the substance is used.
» After washing the machine, let it cool off and store it in the place where pesticide application equipment is kept.

Criteria for Personnel Selection and Management

Personnel manipulating or applying chemical and biological pesticides and other pest control chemical substances must have the proper conditions for the execution of the job.

Applicable Standards

» Resolution 2400 of 1979 of the Ministry of Labor and Social Security. *Provisions on Housing, Hygiene, and Social Security at Working Sites.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Definition of the parameters to consider when selecting personnel who will handle or apply pesticides and other pest control chemical substances in flower and ornamental crops.

Implementation Guidelines

» When selecting personnel for the handling and application of pesticides and other chemical substances for pest control, it is very important to investigate their interests and motivations. In that way, you will be able to have workers who are willing and committed to work and positive results.
» Surveillance of workers using pesticides and other chemical pest control substances must consider specific factors that, in certain situations, may increase the risk of adverse effects for their health, such as the following:

Gender and Age

» To handle or apply pesticides, male personnel older than 18 years old will be designated. The Colombian legislation does not establish the maximum allowable age.

» People's normal physiological changes like the loss of muscle tissue with probable fat tissue increase, skin atrophies with augmented sensitivity, susceptibility to lesions, and a minor response of the cardiovascular system to physical exercise generate a higher risk of potential toxic effects due to pesticides and other chemical substances exposure. For that reason, the maximum age adopted as a parameter in the sector is 55 years old.

Health Condition

» The presence of skin changes increases the risk of possible absorption or entrance of chemical substances. Also, nutritional and metabolic changes can interfere with the synthesis processes of enzymes or products metabolism in the organism, increasing the person's susceptibility. The recommendation, therefore, is to avoid hiring personnel with these health conditions to handle pesticides.
» Respiratory diseases will be a factor to exclude personnel for this type of work.
» Personnel selected shall not have physical or sensorial disabilities.

Anthropometry

» Considering the space of action of applicators of pest control products, individuals shall be taller than 1.60 cm of height (depending on the height of cultivated flower species) and approximately 60 kgs. of weight (a body mass index between 19 and 27).

Cultural and Educational Level

» High school degree is recommended. This level allows for better technical learning and, therefore, better handling or application of chemical substances.
» Personnel shall be trained on the rational management of pesticides by a competent entity (SENA) or internal courses taught by company professionals or technicians. The company will be responsible for training its personnel in the safe use and management of other pest control chemical substances.

Personnel Rotation

» Sprayers' rotation periods have been defined from two (2) to four (4) months, according to arguments considered as best practices, which are not technical, scientific, or legal parameters.
» One of the arguments for rotating personnel is the high caloric expenditure of workers who apply pest control products.
» Another parameter used is the life cycle of PPEs. For that reason, PPEs are allocated to each person starting the working period with new implements. The period ends with returning the used elements for their disposal.
» Product application frequency, application number of hours per day or week, the availability of workers, as well as the cost and quality of PPEs are factors to consider when rotating personnel.
» The definition of personnel rotation periods will facilitate the optimization and reduction of training, medical exams, and PPE costs, among others.
» It is important that the company defines personnel programs or rotation shifts to facilitate training and follow-up programs, as well as the medical controls and the programming and procurement of personal protection elements.
» Rotation periods of sprayers, warehouse personnel, and tank managers and supervisors can be extended if periodical medical exams confirm people are fit to continue performing the job.

Target Population of the Chemical Risk Management Program

» All personnel handling or applying pesticides, biological products, or other chemical substances for pest control in the company must be included in the chemical risk management program.
» This includes warehouse personnel, application supervisors, assistants or firefighters, applicators of pesticides (and herbicides), biological agricultural use products, and other pest control chemical substances by spraying, fumigation, nebulization, drenching, immersion, environmental and plant

material disinfection (seeds, cuttings, and seedlings), application of fumigants in cold rooms and application of solid products.

Medical Exams

The medical capacity of people handling or applying pesticides or other chemical substances for pest control shall be proven by the results of medical and laboratory tests taken.

Applicable Standards

- Decree 1843 of 1991 of the Ministry of Health. *Use and Management of Pesticides.*
- Resolution 2346 of 2007 by the Ministry of Social Protection. *Regulation of the Practice of Occupational Medical Assessments.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Evaluate the efficacy of strategies implemented to minimize risks through medical and laboratory exams to personnel handling and applying pesticides and other pest control substances.

Implementation Guidelines

Medical Exams

- The worker will be evaluated by medical exams to certify a good health condition to be able to handle or apply pest control products and the associated risks, which apart from the chemical risk of using such substances, include biological and physical risks (due to the use of biological substances and equipment which may cause burns), and ergonomic risks (for carrying heavy equipment during long working hours).
- Medical exams must be preventive, striving to protect the health condition of workers. The occupational health medical exam allows the identification of pathologies that can eventually be complicated by working with chemical products, or due to work and environmental conditions. It is also important to detect risk factors that make the worker more vulnerable in terms of such conditions.
- Medical exams must be taken during the entrance or exit of the rotation periods or shifts defined by the company and before if the circumstances require it.
- As a result of the tests taken, records must be kept proving the fitness of the examined individual with the signature of the physician and worker, demonstrating that the patient has been informed about the results.
- It is necessary to revise the record of previous jobs managing pest control products and labor conditions during such jobs (products used, exposure hours/day, total exposure time, use of PPEs, work environment, etc.). With respect to the position's risks, these must be included in the Company's risk landscape.
- Annex 2 specifies aspects to be considered within an occupational health medical exam for the use and management of chemical pesticides, agriculture biological products, and other pest control substances.

Laboratory Exams

- Currently, less than 10% of pesticides used in ornamental crops belong to organophosphate and carbamate insecticides groups that affect the acetylcholinesterase synthesis. These correspond to the following active ingredients: acephate, cadusafos, chlorpyrifos, phenthoate, formetanate, malathion, methiocarb, methomyl, pirimiphos-methyl, pyrimethanil, profenofos, and propamocarb.
- For that reason, companies using such pesticides shall take samples for analysis of acetylcholinesterase on personnel handling or applying such products.
- Erythrocyte cholinesterase test (Type E) using Michel's electrometric method is the most recommended and accurate technique to measure the pH change (ΔpH) produced by the action of acetylcholinesterase over acetylcholine in the membrane of the red blood cells. This measurement is the closest

to what happens in the synapsis of nervous cells. Normal reference values: 90-160 UΔpH.

- The activity of plasma cholinesterase (Type S) in contact with pesticides decreases faster in the blood plasma than the erythrocyte cholinesterase. Therefore, its measurement does not reflect the actual effects on the nervous system. Its activity measurement constitutes an important aid for the diagnosis of acute intoxications. Normal reference values: 8-18 U/ml.
- The IPM Manager will give notice to the Occupational Health and Safety area of the rotating applications of organophosphate and carbamate pesticides to program lab samples with anticipation.
- The initial sample to know the levels of acetylcholinesterase in the worker in the absence of organophosphate and carbamate pesticides will be taken before the pesticide's first application within the rotation shift of the personnel. The result will be available when taking the medical exam to enter the rotation period or pesticide application shift.
- The last sample will be taken maximum two (2) hours after finishing the last application of the carbamate and 72 hours after finishing the last application of the organophosphate, programmed within the personnel's rotation shift. The result will be available when taking the medical exam to exit the rotation period or pesticide application shift.
- To check effects by other chemical groups, different from organophosphate and carbamate pesticides, on some organs or physiological processes, the following exams are recommended:
  - Full medical exam
  - Body weight (BMI, body mass index)
  - Complete hematologic panel
  - Proteinuria test
  - Urine test, BUN (blood urea nitrogen), or creatinine
  - GPT (glutamic pyruvic transaminase) and PTT (partial thromboplastin time).
- In the medical exam, evaluate personnel's susceptibility to chemical, biological, physical, and ergonomic risk, according to the work to be done.

Training

Personnel working with chemical or biological pesticides and other pest control substances must be trained to have a better job performance.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Make sure people who handle or apply pesticides or other pest control substances are trained to have better job performance.

Implementation Guidelines

- The Training Department of the company will oversee training sessions and ensure the compliance of training programs by IPM personnel.
- The IPM Manager will design training programs, establishing their frequency, coordinating and participating in the execution of training programs for his/her direct workers.
- The SG-SST Department of the company will participate in the execution of training in its area, including them in the IPM training programs.

Training in the Use and Management of Pest Control Products

- The flower-growing company must request the National Learning Service of Colombia (SENA for its Spanish acronym) of its jurisdiction to offer training courses on the rational management of pesticides for personnel requiring such training. It is necessary that such training sessions include all the different products currently used for pest control.
- SENA offers a theoretical-practical course and certifies the attendance of each person during the scheduled time (60 hours).
- With SENA's certificate, the Departmental Secretariat of Health issues the IDs as pesticides handlers.

» The expired IDs will be renewed by the company when needed.
» Before getting SENA's training course, the company must have an internal program of at least eight (8) hours, including topics as demanded by the law with the corresponding execution programs and records that give proof of compliance.
» The content of internal training includes the following:
  - Legislation on pesticides, biologicals, and other chemical substances for pest control in Colombia.
  - General information on products to be used (formulas, concentrations, toxicological categories, danger, precautions, etc.).
  - Different intoxication forms: eyes, skin, inhalation, and oral.
  - Early intoxication signs and first aid measures.
  - Proper use and cleaning of PPEs.
  - Personal hygiene after handling or applying products.
  - Content and mode of use of labels and SDS of the product.
  - Emergency procedures (intoxications or spills).
  - Medical surveillance of personnel handling or applying products.
  - Basic biology and control of pests attacking the crops.
  - Instructions for the proper and safe management and maintenance of application equipment.
  - Product mixture preparation sequence.
  - Measures to avoid environmental contamination: management of liquid and solid waste of pest control products.

Training on the Use and Management of Post-Harvest Phosphine

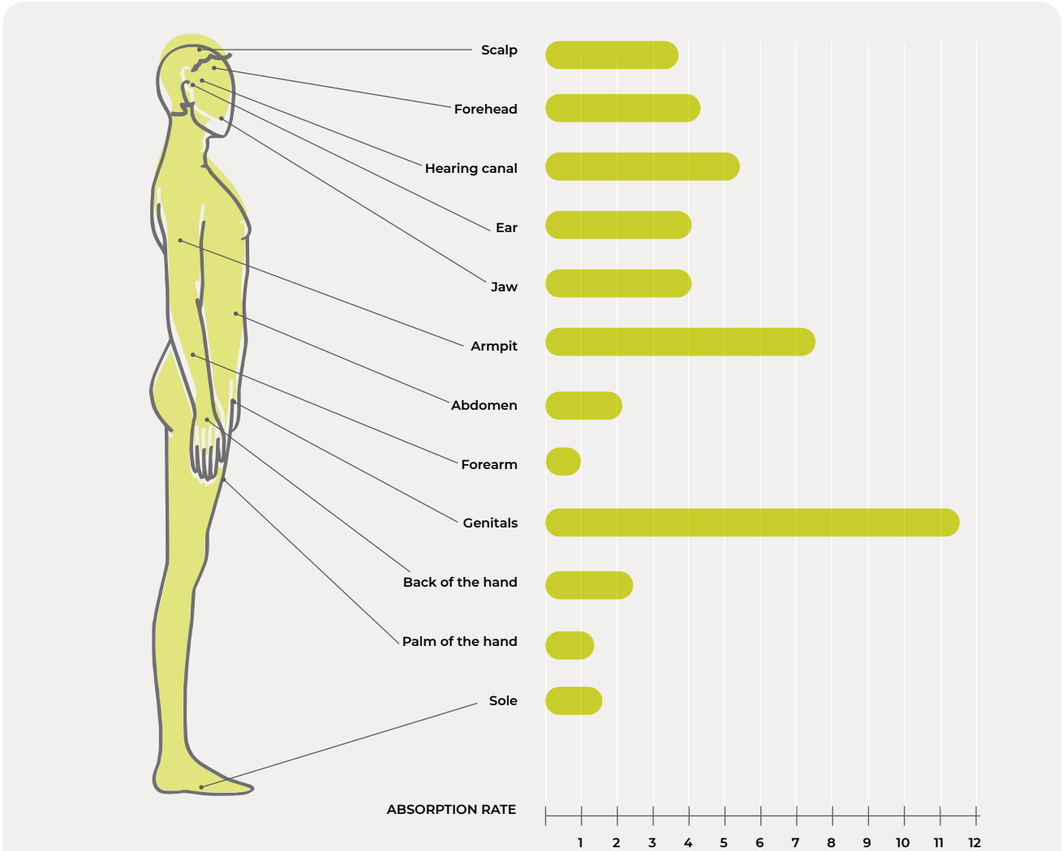
» Personnel who handle and apply magnesium phosphate inside the phosphine chamber, those who measure high and low concentrations in the external probe during treatment, and remove chamber residues for their deactivation must be trained by SENA on rational pesticide management. Additionally, personnel will receive specific training from fumigant vendors on the following topics:
  - Physical and chemical foundations of hydrogen phosphide or phosphine.
  - Types of products generating phosphine gas.
  - Product use records.
  - PPE and phosphine gas detection equipment (theoretical-practical).
  - Conditions, doses, and treatment times.
  - Lethal dose and minimum product concentrations.
  - Management of phosphine gas measurement equipment.
  - Gas application, evacuation, and deactivation of residues.
  - Best practices and successful cases of phosphine usage.

Training Evaluation

» The company shall keep records on training programs given, their schedules, the names and signatures of the attendees, and a personal evaluation of the subject learned.
» Reinforce areas in which personnel are weaker.

Personal Protection Elements (PPEs)

» The human body areas exposed to pesticides and chemical substances during IPM processes are the following: dermal, respiratory, ocular, and oral (ingestion).
» The skin is the area of greatest exposure to chemical substances. Human skin has an extension of approximately 2 m2, and it is estimated that 90% of occupational intoxications with pesticides occur on the skin. The following picture shows the dermal absorption rate of parathion insecticide in different parts of the body. While in the forearm, the absorption rate is 1.0, in the genital area, it is 11.8 times higher, while in the head, in general, it is 21 times higher (Johnson and others, 1999).
» Respiratory intoxication is caused by the inhalation of gases, vapors, and smoke. The total exposed pulmonary alveoli have an approximate area of 70 m^2, and the consequences of negligence are invaluable.
» Oral or ingestion intoxication causes the most serious consequences. It mainly occurs by eating, drinking, or smoking during activities with pesticides or other chemical substances. Discipline must make part of protection measures to avoid oral accidents.



» Therefore, only personnel with skin, respiratory, and eye protection elements will be able to work where pesticides or other chemical substances are applied for pest control or for disposal of the resulting waste.

Applicable Standards

» Decree 1843 of 1991 of the Ministry of Health. *Use and Management of Pesticides.*
» Florverde´s Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Make sure that personnel who handles or applies pesticides and other chemical substances for pest control or their waste have the proper PPE according to the nature of risks being faced.

Implementation Guidelines

» The company must ensure all people involved in the use and management of pest control products in any of the productive process stages (propagation, production, post-harvest) have the necessary PPE in good condition and properly use the protection elements.
» The PPEs must be defined by the SG-SST area of the company, following the label recommendations and SDS of products in use.
» When products whose labels and SDS do not provide comprehensive information about their safe management, precaution principles must be used in virtue of which “danger of serious and irreversible damage, the lack of certainty must not be a reason to delay the adoption of effective measures to avoid damage to human health and the environment.” In other words, in these cases, stricter measures than those normally taken for any of the products in use shall be adopted.
» The personal protection elements shall include different equipment to avoid exposure through the eyes, skin, or inhalation. The necessary elements are clothes (permeable or impermeable), boots, hood or helmet, glasses or goggles for visual protection, facial protector, and respiratory protector, as shown in the figures in the following pages.
» PPE measures should be according to the sizes of the workers to make sure they fit well, not generating other risks.

Permeable Clothing

» Normally composed of long-sleeve shirts with hood and separate pants, made of light cotton fabric. Placed under impermeable clothes to minimize the sweat and avoid friction against the person’s skin, mitigating physical risks. For that reason, these clothes are not considered as PPEs protection from chemical risks.

» Enough uniforms (at least two) shall be given to the workers to allow changing clothes every day (one in use and the other one being washed and dried). This will also depend on the frequency the company applies products.

Impermeable Clothing

» Manufactured in materials such as Tyvek, neoprene, or PVC.
» The fabric and type of clothing (jacket, pants, or apron) shall be chosen depending on the activity and body areas to be exposed.
» For the application of pest control products on flowers, it is common to use PVC impermeable jackets and pants.
» To guarantee full personal protection, these clothes shall not have holes or open seams. Once the work for the day is finished, clothes must be washed with water and soap.

Gloves

» Gloves are generally made of impermeable materials, such as rubber, neoprene, nitrile, and PVC. Rubber gloves are not very resistant to the penetration of solvent chemicals. PVC gloves must have a caliber of at least 0.5 mm. Viton gloves have good resistance to solvents but poor mechanical resistance.
» The length of gloves must cover at least half of the forearm. They must be washed inside-out with water once the work for the day is over. To verify if they have holes, fill them up with water and put pressure on them. If there are holes, they must be changed.

Boots

» Neoprene, PVC, or rubber boots lined with PVC are used. Socks must be worn, and the pant shall be long enough to cover the boots.

Helmet, Hat, or Hood

» These must be made of impermeable materials to avoid head contamination with splashes, spray clouds, or powder in suspension.

Visual Protector or Visor

» Manufactured in acetate, PVC, or other materials. They protect the eyes and face against contamination from splashes or aspersion clouds.
» The full-face model is optimal for coverage of face, eyes, mouth, and nose.

Respirator or Mask

» There are different models and types of filters or cartridges, depending on the type of substances being handled: powders, vapors, or gases.
» In the lower part of this page, there are some informative pictograms from pesticide labels, which include PPEs to be used during pesticides application.
» Respirators for dust or material particles can be disposable or have a face piece in PVC with a replaceable filter. There are

three types of respirators, depending on their capacity to filter particles smaller than 10 microns: Type A: 98% capacity, Type B: 95% capacity, and Type C: 90% capacity.

- Vapor respirators have a facial piece with one (1) or two (2) filters and one (1) or two (2) exhalation valves. The facial piece comes in different sizes and must be adjusted to the face, covering the nose and mouth, using rubber bands and a harness. In specific management of phosphines, inorganic acid gas filters are required (type B, class II).
- The respirator must be airtight and adjusted to the face. The user must not have a mustache or beard.
- No handkerchiefs, socks, or other elements shall be put inside the respirators because they will hinder their function.
- Filters must be changed once the life cycle period recommended by the vendor expires or before it if the user notices product odors are filtering or breathing becomes difficult.
- After finishing the work with pesticides, the filters shall be removed from the respirator, cleaned with wet cloths, and stored in a closed plastic bag.
- The rest of the mask can be washed with clean water and soap and let dry by air.
- The company shall keep records to prove the monitoring of the condition and timely replacement of PPEs.
- Workers must wash and clean their PPEs at the end of the day inside facilities dedicated to that purpose.
- PPEs must be stored away from the place where pest control products are mixed or applied, as well as far from application equipment and tools and clean clothes inside the company.
- Annex 3 establishes criteria to be considered for the selection, care, and maintenance of PPEs.

Buffer Zones

These are the minimal distances required between the areas of application of pesticides and other chemical substances and places with the presence of people, animals, or natural water bodies.

For the land application of pesticides, the Colombian law established a buffer zone of at least 10 meters.

For the application of other chemical substances, there is no legislation. However, it is a good practice to adopt the same standards ruling for pesticides.

Applicable Standards

- Decree 1843 of 1991 of the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Minimize exposure of people to drifts, vapors, or odors of the application of pesticides and other chemical substances for pest control through the enforcement of the minimal safety buffer zone established by the Colombian legislation.

Implementation Guidelines

- During the applications of chemical or biological pesticides, the minimal safety band of 10 meters of distance between the treatment area and the areas to be protected will be respected.
- Areas to be protected: natural water sources, traffic areas for people or vehicles, dining areas, flower classification and packaging areas, social or sports areas, and, in general, places with people concentrations near product application areas.
- By companies' initiative, the buffer zone distance can be increased, considering technical criteria, such as:
  - Product characteristics: presentation, dosage, toxicological category, application modality, and formulation.
  - Type of crop or exploitation, application site, and environmental conditions of the region.
- If, during pesticide applications, the treated areas or application sites are physical and biologically isolated with barriers that totally avoid product drifting to protected areas, the safety distances can be less than 10 meters.

Treated Areas Signaling

Informative and preventive signs must be used to avoid or restrict the access of unauthorized personnel to crop areas or places treated with pesticides or other chemical substances.

Applicable Standards

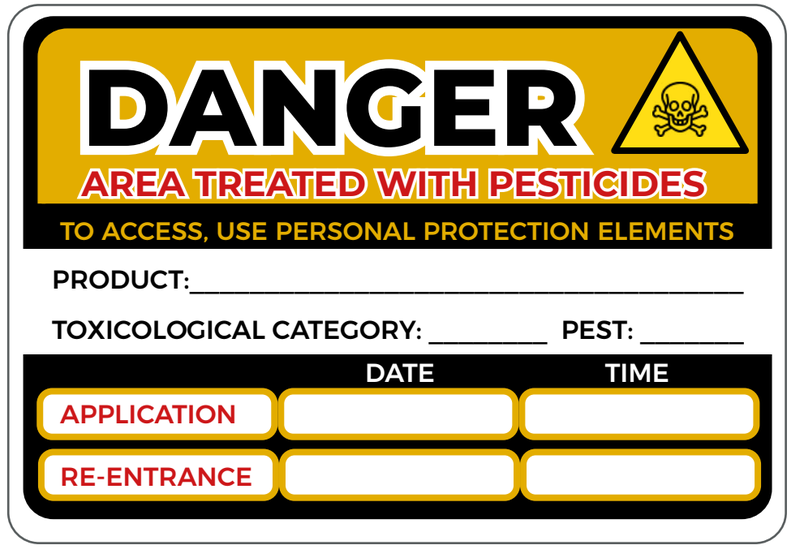
- Decree 1843 of 1991 of the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Use signs to indicate access ways to areas treated with pesticides, biologicals, or other chemical substances for pest control.

Implementation Guidelines

- Have sufficient signs and in good condition to indicate access ways to areas under treatment or those where treatments are using chemical and biological pesticides for agricultural use, disinfectants, adjuvants, and soaps under the different application modalities.
- For years, the use of signs focused on showing the places where pesticides were being applied, as demanded by Decree 1843 of 1991 by the Ministry of Health. Act 55 of 1993 requires signage during the application of any type of chemical substance without specifying the characteristics or information on the signs. Therefore, while the time to repair or change them comes, the current signs can continue to be used.
- Signs must be made of weather-proof material visible from a minimum distance of ten (10) meters and clearly readable text. The signs shall have the international symbol of danger (the skull and crossbones) and state: "Danger, area treated with pesticides. Wear Personal Protection Elements to enter", as shown here.
- Additionally, signs can include the following information: Name of the product(s) applied, their toxicological category, date and time of application, date, and time of re-entry.



- During application of phosphines and smoke products, signs shall be placed on the doors of the fumigation rooms or the treatment cold room, as applicable.
- Signs can only be removed or deleted when their validity expires; in other words, when the re-entry period to the area corresponding to the type of substance applied ends.
- Signs in crop areas must be complemented with the installation of ropes or ribbons to stop the access of people to treated areas.

Re-entry Periods (RPs)

Areas treated with pest control pesticides or other chemical substances must remain free of personnel if the contact risks with the applied substances remain.

Applicable Standards

- Resolution 3759 of 2003 by ICA. P*rovisions for the Registration and Control of PQUAs.*
- Resolution 11768 of 2019 by ICA. *Establishes Methodology to Determine Re-Entry Periods after PQUA Application.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Respect the minimum re-entry periods established for areas treated with pesticides and other pest control chemical substances according to the recommendations given in products' labels.

Implementation Guidelines

- Have a clear definition of PRs for each of the products. These are shown in the product's labels. The headlines of the product registers determine PRs according to methodologies and guidelines established by ICA.
- In the following cases, PRs are not demandable by agricultural authorities (Resolution 11768 of 2019 by ICA):
  - Direct application of fungicides, bactericides, and insecticides to the soil.
  - Early pre- and post-emergency application of herbicides.
  - Application of any PQUA in systemic treatments by injection, inside the trunk, stems, pseudo-stems, rhizomes, or stipites of the plants, as well as products used post-harvest.
- RPs indicated in the product labels must be followed in the areas where products are used.
- In areas where RPs are in effect, only personnel with the mandatory use of PPEs, who are going to make transitory or indispensable work without having direct contact with the recently treated plants will have authorized access.
- When mixing products, the strictest individual RP will apply.
- To comply with RPs, company efforts mainly focus on the coordination of crop labor to avoid their overlapping with pesticide applications, and re-entry to treated areas (when products with RP <24 hrs. are applied) is allowed on the next day (Quintero J., 2002).
- For products with RP <24 hrs., the companies must program applications on weekends and schedules in which the presence of crop workers is not necessary.
- For chemical substances different from pesticides that do not have a defined RP, EPA's recommendation on the labels of nebulizing disinfecting products shall be used as reference. Their recommendation establishes a period of one (1) hour after application and beginning the ventilation.

Emergency Care

Companies where pesticides and other pest control chemical substances are used must have a prevention and treatment plan for emergency cases that will be applied by duly trained personnel.

The purpose of the emergency plan is to establish and generate skills, conditions, and procedures to allow those remaining or visiting the company facilities to prevent and protect themselves in case of accidents putting their integrity at risk.

The most common emergencies when using pest control pesticides and other chemical substances are spillages and contamination of the environment or intoxication by contact with such substances.

The company must clearly define, document, and practice the procedures to prevent and take care of any emergency with these products. Procedures must be accessible at sites with higher emergency risks.

Within these procedures, it is necessary to add the emergency telephone numbers of the Fire Department, Police Department, and the closest Hospital or Health Center, ARL, and CISPROQUIM (Safety Information Center for Chemical Products, toll free line 01 8000 916012, telephone 57-1-2886012), among others.

The company, along with its ARL company, shall periodically program emergency drills to test and improve the emergency plans.

As a result of such drills, reports with conclusions and recommendations for improvement of the emergency plan shall be made. Emergency reports must follow the procedures and formats suggested by the ARL company.

To prevent and manage any emergency, it is necessary to know the nature and properties of substances being managed, as well as their potential risks. This is known through the SDS of the products, which inform the substances' characteristics, composition, hazards, mitigation means, and their storage and transportation conditions.

Commonly, emergencies occur because substances are not properly managed and stored from the beginning. SDS indicates storage and management required conditions to prevent emergencies.

Intoxication Management Caused by Pesticides and Other Chemical Substances

Intoxications are a physiological reaction caused by the entrance (by non-mechanical means) of a chemical substance to the organism, generating illness or even the person's death.

Exposure routes of the human body to pesticides and chemical substances in the IPM process are dermal, respiratory, ocular, and oral.

It is extremely important for the company to have clear and accurate procedures to take care of intoxications caused by pesticides and other chemical substances.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

To have clearly defined procedures to manage intoxications caused by pesticides and other pest control chemical substances.

Implementation Guidelines

- At the very least, the company's emergency plan shall include the actions described in the flowchart in Annex No. 4.
- The necessary resources shall be available to take care of and provide first aid to a person contaminated or intoxicated with pesticides or other chemical substances. These resources include trained personnel, abundant clean water, dry and clean towels, stretcher, contact telephone numbers, a vehicle to take the person to the closest medical center, and the person's identification documents and social security affiliation card, etc.
- First aid actions are provided at the accident site to avoid health problems and improve the victim's prognosis before receiving medical care.
- Any form of intoxication (dermal, by inhalation, or oral) shall be treated by a physician even if it seems mild.
- Intoxication of a person is manifested with symptoms such as headache, weakness, fatigue, dizziness, nausea or vomit, blurry vision, etc. People working with pesticides must be informed about these symptoms, so in case of feeling them, their work must be suspended, and immediate aid must be requested.
- Regarding other chemical substances used for pest control, it is necessary to know the risk they represent, their chemical compatibilities, their safe storage practices, and intoxication symptoms to ensure their safe management and know how to manage an emergency.

Management of Pesticides and Other Chemical Substances Spillage

It is common that, during the handling or application of pest control pesticides and other chemical substances, eventual situations that may generate product spillage occur.

The most sensitive places where these situations may occur are the warehouse during the product measurement and weighing and the preparation of product blends.

It is important the company has a clear procedure and the available resources for these emergencies.

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Have well-defined procedures to manage pesticide and other chemical substances' spills.

Implementation Guidelines

Actions in Case of Product Spills

- The company's emergency plan shall include actions described in flowcharts in Annex 5.

- The necessary resources must be available to manage spills of pest control products. This includes trained personnel, PPE for personnel taking care of the emergency, signals to identify the contaminated area, absorbing material (sand or soil), shovels or dustpans, containers for depositing contaminated material, etc.
- All spills of pesticides or other chemical substances can be toxic for people exposed to them. Therefore, these situations must be managed immediately to avoid complications.

4.2 Management of Biological Risks

Although bioproducts with live microorganisms are considered less toxic for humans, all pest control products must be managed with the same level of care, minimizing the exposure of people, animals, and the environment.

Exposure to biological products, as it occurs with pesticides and other chemical substances, involves the entire management chain, including their formulation, distribution, storage, preparation, application, and waste management.

Based on the information available at the SDSs issued for Colombia and for equivalent formulations in the United States, risks associated with biological formulations more commonly used in the sector are presented herein:

Microorganism	Associated biological risk
Bacillus thuringiensis	Ocular and dermal irritation
Bacillus subtilis	Inhalation, ocular, and dermal irritation
Metarhizium anisopliae	No identified associated risks
Beauveria bassiana	Dermal irritation
Trichoderma spp	Reversible medium ocular irritation
Steinernema carpocapsae	No identified associated risks
Steinernema feltiae	No identified associated risks

Applicable Standards

- Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*

Objective

Provide guidelines to minimize biological health hazards for people handling and applying pesticides and pest control chemical substances.

Implementation Guidelines

Mitigation of Risks during Handling and Application

- Ocular irritation: Use safely glasses.
- Dermal irritation: Use impermeable uniform covering the entire body.
- Respiratory irritation: Use a respirator.
- Signage of areas during product application.
- Complete ventilation after finishing the application.
- Compliance of Re-entry Periods (RPs) during and after the application..

4.3 Management of Physical Risks

During the execution of IPM activities, equipment generating physical risks for the integrity of operators is used. These risks must be duly identified and assessed for their appropriate management.

Applicable Standards

- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Proper identification of physical risks generated by the operation of equipment in the IPM process to establish mitigation measures.

Implementation Guidelines

UV Light Application

Risk of Exposure to UV Light

- Use adequate PPEs for ocular and dermal protection, according to the type of radiation.
- Establish buffer zones in treatment areas to avoid exposure of unprotected personnel.
- Place signs in treatment areas to avoid the access of personnel not using PPEs.

Thermo-Nebulization of Chemical Substances

Risk: Ergonomic and physical risk of carrying equipment and contact with hot surfaces

- If possible, thermo-nebulization equipment shall be supported and transported by safe vehicles to minimize ergonomic risks due to heavy loads and direct contact of operators with hot surfaces to avoid burns.
- Clear and visible signals on the protection grid covering the exhaust tube of the thermo-nebulizer, warning users of burn hazards.
- A type B extinguisher for fuels shall be next to the thermo-nebulizer for use in case of fire.
- Fuel tanks and tanks with substances to be applied will be applied when the equipment is off using funnels to avoid liquid spills.
- Use heat and fire-resistant PPEs to protect hand and body from burns.
- **Vacuums:** Limit the number of hours of work per day, alternating with other jobs.
- The sector should promote the development of mechanized equipment transported over vehicles to reduce workers' exposure.

4.4 Management of Ergonomic Risko

Ergonomic risks include those related to the use of nebulizers and vacuums and equipment that, due to their weight and having to be directly transported by their operators, may affect the workers.

This type of risk must be analyzed in detail by the SG-SST area of the company, and their management guidelines must be informed by the IPM Manager for their enforcement.

Applicable Standards

- Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Proper identification of ergonomic risks generated by IPM equipment management to establish and implement mitigation measures.

Implementation Guidelines

- **Thermo-nebulizers:** Must be transported and used with the support of carts, wheelbarrows, or cables.

III. Verification

Procedures and activities supporting the IPM process must be subject to monitoring, measurement, analysis, and assessment to ensure the achievement of reliable results. Therefore, it is essential that the IPM Manager sets priorities and defines and implements some procedures to guarantee the execution of the main activities of the process. Following are the guidelines to ensure some of these activities:

Monitoring Quality Assurance

This allows the IPM Manager to assess the quality of pest monitoring from each of his/her observers.

Applicable Standards

None.

Objective

Evaluate the precisions, truthfulness, and timeliness of the monitoring performed to identify and correct faults.

Implementation Guidelines

- All implemented direct and indirect pest monitoring activities will be guaranteed by the IPM Manager.
- The IPM Manager will personally evaluate on a weekly basis the pest monitoring quality for each of the observers, applying a standard method that allows obtaining measurable results by sampling.
- The IPM Manager shall select an area (block or greenhouse), materials (bunches, flowers), or elements (monitoring traps) recently revised by the monitor to verify the quality of the treatment applied.
- In the selected area, assisted by a drawing processed by the monitor, the IPM Manager will randomly choose at least ten beds (five with pest reports and another five without pest reports).
- Along with the monitor and during the same time and method of scanning the bed, the plants will be revised to verify reported and unreported findings.
- Hits and misses found are registered on the monitoring drawing (or another specific format that the company has for that purpose).
- Finally, the correct information percentage registered in the drawing is graded against what was verified at the field, and the result is informed to the monitor.
- In case of finding faults, these must be immediately corrected, and an improvement plan must be agreed on with the corresponding monitor.
- The weekly grade of the monitoring quality of each monitor can be plotted in graphs to follow individual and collective performance trends.
- With this information, the IPM Manager must define and implement concrete actions for individual and collective monitoring improvement.

Product Management Assurance

This ranges from the products' efficacy assessment, their delivery by the vendor to the farm, the measurement and weighing of amounts to be used, and the preparation of mixtures and their application.

Applicable Standards

None.

Objective

Guarantee product management is done following the minimal quality parameters to generate confidence in those expecting an efficient result from them.

Implementation Guidelines

- The IPM Manager will personally evaluate the quality of the product management activities on a weekly basis.
- Additionally, the person supervising field activities shall make daily controls and always verify the execution of key specific aspects to guarantee results and inform findings to the person responsible for IPM.
- A checklist like the one in Annex No. 6 is recommended to execute and keep a record of each of the following activities:

Products' Efficacy

- There is an efficacy assessment for products in use and for those expected to be rotated.
- Efficacy of products currently in use at the farm is known.
- There are records of efficacy results available for products evaluated during the last year.

Quality of Products Delivered by the Vendor

- Status and quality of the labels: original labels in perfect condition with fully legible information.
- The batch number in the product's label matches the batch number registered on the invoice.
- Expiration date is not expired, and it is within usage time limits.

Liquid Products

- External band (generally in transparent or white PVC) of the cap shall be in good condition (not broken).
- Cap with band and safety ring in good condition (not broken).
- Seal (generally in aluminum) in perfect condition (not broken).
- Bottle containers without liquid leaks, nor evidence of ruptures or dents.

Solid Products

- Fully sealed packages or bags without product leaks.
- Products free of humidity that can damage them.

Measurement and Weighing of Amounts to be Used

- Accurate measuring and weighing instruments and elements.
- Results of the chosen samples' measurement and weighing verification.
- Define if faults are within allowed error margins.
- Immediately correct faults found.

Mixtures Preparations in the Tank

- Mixing tank is clearly calibrated and supported by leveled floors.
- Measure water pH and hardness with accurate instruments.
- Verify the use of hardness and pH correctors (if necessary).
- Mixture agitator in operation.
- Correct blending order according to the products to be prepared.
- Verify the final hardness and pH of the blend.

Products' Aspersion

- Aspersion equipment without ruptures or leaks.
- Compliance with the maintenance/calibration program and change of nozzles (includes revision frequency and change parameters).
- Proper operation of control Instruments (pressure gauge).
- Ensure application pressure in the target area corresponds to the programmed pressure.
- Application rate per area is uniform among applicators, corresponding to the program and the most recent calibration of nozzles.
- Dyed water is used to indicate the beginning and end of the application.
- No mixture remains in the tank, and all beds in the area received the treatment.
- Aspersion coverage: Qualitative assessment of the drops/cm3 concentration collected in hydrosensitive cards (see the following picture on the left side).
- Aspersion coverage with Tinopal CBS-X fluorescent tracker mixed with application broth: Qualitative evaluation of coverage under black light (see the picture on the right side).

» It is necessary to make this verification with a regular frequency (at least once per week), focusing on applications over persistent phytosanitary problems or crop areas with critical pest attacks.

(Photos courtesy of Jaime Quintero).

» It is important to make a timely analysis of the findings with the purpose of identifying and correcting any faults to improve the process and guarantee effective applications for pest control.

Records of Applications and Product Consumption

The main tool for pest control products' management is to maintain an updated record of the amounts applied in the crop areas and post-harvest. This must be reflected in the adoption of an easy-to-understand indicator, useful for setting product reduction goals.

Applicable Standards

» Decree 1843 of 1991 by the Ministry of Health. *Use and Management of Pesticides.*
» Act 55 of 1993 by the Ministry of Labor. *Safety in the use of chemical products.*
» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Record the consumption indicators of pesticides, biologicals, and other chemical substances used for pest control that facilitate their management in the company.

Implementation Guidelines

Product Application Records

» To enable easier data management and traceability, it is recommended that the company keeps a record of the application of pesticides, biologicals, and other pest control chemical substances separately for each of the crop areas (blocks, sectors, greenhouses, or post-harvest, etc.). Use a format like the one in Annex 7.
» Information shall be filed during the periods demanded by competent authorities or those required by Florverde's Standard, whichever is more demanding.

Record of Consumption of Applied Products

» Maintain updated records of products' consumption per cultivated ornamental species, measured in kgs. i.a./ha/month/year.
» Identify the groups of pesticides, biologicals, and other chemical substances (soaps, disinfectants, etc.) consumed during the evaluated period
» Clearly identify the causes for increase or decrease in the consumption of the different groups of pesticides and other substances, taking as a reference the monitoring data of pests in the crop.
» Revise the monthly behavior, fluctuation, and historical trends of the consumption indicator of pesticides and other substances to set reduction goals.
» Have clearly defined goals for the consumption reduction of pesticides of toxicological categories 1a and 1b, according to WHO classification or their equivalents 1 and 2, according to the current classification of GHS.
» Report to Asocolflores the monthly consumption of pesticides, biological products, and other chemical substances by cultivated ornamental species, so that using the socio-environmental

indicators of the flower-growing sector, it is possible to have access to the referencing tools vs. the rest of the companies in the sector.

Follow-up and Measurement: IPM Indicators

The indicators are specific, observable, and measurable characteristics that can be used to show the changes and progress achieved by a process to obtain a specific result. IPM is a process that requires indicators to evaluate the performance, measure the impact of implemented strategies, and define new objectives and goals.

Applicable Standards

» Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Measure the performance of IPM to identify, adjust, and set goals to achieve a continuous improvement of the process in the company.

Implementation Guidelines

» IPM indicators must be directly managed by the person in charge of the process at the farm.

» It is recommended to have two (2) types of IPM indicators: process indicators and result indicators.

Process Indicators

» Indicators to evaluate the efficacy of executed strategies and help predict their results. Examples of these indicators are the following:

- Execution of Pest Monitoring: When the work of the day is over, the IPM Manager and his/her monitors will make a balance of the execution, identifying inconveniences found and establishing corrective actions.
  - A weekly indicator, like the following, can be kept:

    % Monitoring compliance = programmed area/ monitored area × 100

Quality of Pest Monitoring: Used to evaluate the truthfulness of information reported by monitors. This shall be evaluated at least once per week with each of the monitors, using a checklist like the one in Annex No. 6.

Result: *% of success/person/week*

- Execution of Product Applications: When the work of the day is over, the IPM Manager and the Applications Supervisor will make a balance of the execution of the programmed labor, identifying difficulties found and establishing the corrective actions. The weekly indicator could be like follows:

  % compliance = programmed area/applied area × 100

  % compliance = No. of programmed beds/No. of applied beds × 100

  % compliance = programmed volume (L)/applied volume (L) × 100

Quality of Product Applications: Evaluates the execution of activities for the application of the products. This evaluation shall be made at least every week using a checklist.

Result: *% compliance /application/week.*

» As soon as the routine monitoring results are obtained for these specific activities, they must be shown to the involved personnel to agree on improvement actions to be immediately implemented.

» Indicators must be revised by the IPM Manager on a weekly or monthly basis as needed.

» The evolution and trends of indicators must be socialized with the technical team of the farm at least once per month on the corresponding phytosanitary committee weekly meeting.

» Graphs are recommended to keep the indicators in a clear and simple manner. Make them visible and available for all stakeholders, being easy to understand by those who use them.

» The revision of indicators will be useful to identify IPM improvement opportunities, implement immediate corrective action plans, and set goals with defined limit terms.

» IPM indicators monitoring must be considered during the management revision of the IPM process, which is made periodically.
» The Management and the person responsible for the IPM Process shall agree on the objectives and goals to be achieved with each indicator for the compliance of the company's productivity, quality, and sustainability objectives.
» The agreed objectives and goals by the Management shall be included by the person responsible for the phytosanitary management with concrete action plans that include accurate and verifiable activities and execution schedules.
» IPM indicators must be used as a tool to make the annual budgets for IPM labor and materials for the farm.

Result Indicators

» Records must be kept, and the monthly consumption of chemical pesticides in kgs. or liters of commercial products and reported to *Asocolflores' Floriculture Indicators System*. Those amounts are used to calculate the consumption indicator in kgs i.a./ha/month/year.
» To facilitate the register and analysis of the indicator, it is recommended to check the *Guide for Implementation of Indicators in Flower and Ornamental Crops* (Asocolflores, 2021).
» Apart from the *kgs i.a./ha/month/year,* the company must have other result indicators, such as:
  - Cost of pest chemical control measured in COP/ha or m^2/month/year.
  - Cost of biorational control measured in *COP/ha or COP/m^2/month/year.*
  - Product rejected in the classification room (national) due to pests measured by *No. of rejected stems/cause/day/week/month/year over the total number of stems entering the room.*
  - Elimination of material affected by pests in the crop (cut-off heads) measured by the *No. of stems/ cause/day/week/month/year.*
  - Product rejected by customers due to phytosanitary causes, measured by the *No. of claims or No. of stems rejected/cause/day/week/month/year/No. of exported stems.*
  - *Number of interceptions due to pests done by phytosanitary authorities in the importing country/week/month/year.*
  - Cost of labor used for the execution of IPM, including crop monitors, pesticide Applicators, and personnel to execute other pest control strategies, *measured in COP/ha/month/year.*

IV. Adjustment

Once the monitoring and verifying of the IPM activities execution is done, in the event of the results not adjusting to the pre-defined expectations and objectives, the corresponding corrections and modifications must be made to improve the performance of the process. It is expected to reach the objective by adopting the following tools:

Observations to the IPM Team

Meeting of the IPM Manager with his/her group of monitors and executors of pest control strategies to monitor the execution of programmed activities and agree on changes or adjustments to be made.

Applicable Standards

None.

Objective

Weekly monitor the group of observers and executors of pest control strategies to identify and adjust the process.

Implementation Guidelines

- Establish a weekly meeting of one (1) hour maximum of the IPM Manager with his/her work team. The meeting topics and schedule must be previously defined.
- The IPM Manager will facilitate the meeting and encourage team members' participation.
- Evaluate compliance of programmed activities.
- Weekly analyze the IPM Process assurance indicators (monitoring quality and pesticides applications' quality, among others) and establish corrective actions.
- Program IPM activities (pest control monitoring and strategies) for the following week and ensure having the necessary resources for their execution.
- Keep a record of written commitments in minutes to be followed up in the upcoming meetings.

Improvement Opportunities

After ensuring the execution of IPM activities, such as monitoring, using, and managing pest control products, it is normal to find individual and collective situations to be corrected to improve the process. The IPM Manager will be responsible for identifying and analyzing the causes of deficiencies and defining and adopting the corresponding corrective actions.

Applicable Standards

None.

Objective

Run activities to help maintain and improve the IPM Process producing true, timely, and useful data for making pest control decisions.

Implementation Guidelines

- The main source to identify improvement opportunities for the IPM process is to ensure pest monitoring activities and the best use of pest control products.
- After analyzing failure causes, the IPM Manager will define the corrective actions and concrete execution dates.
- It is also important to consider the complaints, claims, or suggestions of IPM Personnel to involve them in the process improvement.
- The monitoring and analysis of improvement opportunities must be a part of the topics discussed in the IPM team's weekly meeting.

Claims from Stakeholders

Establish the way to receive, manage, and respond to the complaints, claims, consultations, and suggestions issued by the stakeholders.

Applicable Standards

- Florverde's Standard for Sustainable Production of Flowers and Ornamental

» Plants General Regulation for the Sustainable Flowers Florverde Certification.

Objective

Respond and solve phytosanitary claims made by external customers, according to the procedure defined by the company.

Implementation Guidelines

» The IPM Manager must know the procedure to manage claims made by external customers (Florverde's Standard).
» The IPM Manager will trace the claim, investigating its origin and potential causes.
» After making the claims' root analysis, the IPM Manager will define the corrective actions and concrete execution dates.
» Claims/complaints by stakeholders are a topic to be discussed during the weekly meeting of the Phytosanitary Committee.

Phytosanitary Committee

Weekly meeting of the technical team: Production Director or Manager, IPM Manager, and Area or Crop Managers.

Applicable Standards

None.

Objective

Revise the current phytosanitary condition of the crop(s), evaluate the execution and strategies applied, and program actions for execution during the following week..

Implementation Guidelines

» A minute must be prepared after the Phytosanitary Committee meeting, including concrete actions to be executed, responsibilities, and execution terms.
» Every meeting must begin with the reading of the last meeting's minute and the follow-up of the execution of programmed and new commitments.
» After, the phytosanitary status, the follow-up of IPM strategies' execution, and the activities for the following week will be presented.

Phytosanitary Status

» It is recommended to show graphs with pests' incidence and averages per crop to analyze trends throughout time.
» Emphasize persistent and recurrent problems and critical items.
» Show results of monitoring weekly assurance.
» Show the status of customers' claims due to phytosanitary problems.

Execution of Strategies

» Show programs' results and quality of pest control products' application.
» Show compliance with other programmed pest control strategies.
» Focus on problems and critical items: what was not done and why.

IPM Activities Program

» Have at hand the product rotation programs and most recent efficacy results for each biological target to be controlled.
» Propose a program of pest control strategies per block or area submitted to the Phytosanitary Committee's approval.
» The IPM Manager will coordinate with the Area Managers to avoid pesticide applications overlapping with the rest of crop works.

New Phytosanitary Threats

IPM Programs are normally designed focused on the solution of common and routinary phytosanitary problems in crops. Nowadays, with the globalization of markets and the effects of climate change over intensive floriculture agriculture, among other factors, it is necessary to be prepared for the appearance of new pests that can cause productivity and quality losses.

Sometimes, the lack of an efficient pest control program can be caused by the incorrect diagnosis of a known problem or by not knowing a new one. The problems can be generated by their introduction in the plant material to be cultivated, climate changes, new habits of known pests, and changes in crop management practices, among many other reasons.

Therefore, the IPM Manager must be updated and prepared for these new circumstances and conditions to be able to anticipate and respond to such situations in an efficient manner.

Applicable Standards

Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Identify and efficiently solve new phytosanitary threats to minimize productivity and quality losses.

Implementation Guidelines

- Include and analyze new findings' reports delivered by the monitoring team.
- Diagnose the agents causing the new findings. Get support from official entities and private companies.
- The IPM Manager must read and learn about the biology and habits of new pests to be able to provide integrated management.
- When deemed necessary, those responsible for IPM and the production process must request support from experts who contribute to improving the management of new problems.
- These new phytosanitary threats must be analyzed in the managerial follow-up meeting.
- Establish control programs and adjust existing programs.

Managerial IPM Revision

This is the follow-up made by the Management with a defined periodicity to the IPM Process' development and execution in the company.

Applicable Standards

Florverde's Standard for Sustainable Production of Flowers and Ornamental Plants.

Objective

Ensure the implementation of the IPM Process according to the company's policies, objectives, goals, and action plans.

Implementation Guidelines

- This must be a programmed period with a minimal frequency of once per year when the IPM Manager will make his accountability report.
- Follow-up the execution of each of the IPM action plans and their respective result indicators.
- Revise the execution of IPM operational budgets and investments. Make the necessary adjustments.
- Opportunity to show the needs and ensure resource availability (human, physical, economic, external consultants, etc.) for the IPM Process operation.
- Revise the IPM process results in external or internal inspections and the status of potential sanctions by related authorities.
- Prepare a minute with follow-up conclusions and recommendations.

Glossary

Acetylcholine
A substance that allows the transmission of nerve impulses during synapsis among nervous cells.

Acetylcholinesterase
An enzyme that degrades the acetylcholine, decomposing it into acetic acid and choline to interrupt the transmission of nervous impulses.

Active Ingredient
The active biological part of the pesticide present in a formulation (FAO, 2006).

Acute Intoxication by Pesticides
Characterized by a sudden appearance of symptoms within 24 hours after exposure to the pesticide. Short exposure to a high dosage occurs when the chemical agent is rapidly absorbed in one (1) or several doses in a period shorter than 24 hours.

Acute Toxicity
Refers to the adverse effects of a chemical substance manifested after oral or skin administration of one or multiple doses throughout 24 hours or as a consequence of being exposed to inhalation for four hours (ACN, 2019).

Adjuvant of Agricultural Use
A non-pesticide, adhesive chemical substance that forms an emulsifier, diluent, synergic, humidifying film to facilitate the application and action of pesticides, maintaining their characteristics. The term includes pH and hardness correctors for the adaptation of application waters (Resolution 2713 of 2006 by ICA).

Application of Pesticides
All actions by suitable personnel working in a company or not to control or eliminate pests with chemical or biological substances officially registered and authorized, using techniques, equipment, and utensils approved by the competent authorities (Decree 1843 of 1991, Ministry of Health).

Applicator
The natural or legal person dedicated to applying pesticides (Decree 1843 of 1991, by the Ministry of Health).

Aspersion
Procedure to apply diluted pesticides in high volumes of water with hydraulic application equipment that produces a cloud of drops of different sizes, which impacts the plant to be protected or the pest to be attacked (INTA, 2012).

Biological Control
Control strategy against pests in which natural enemies, antagonists, life competitors, or other organisms capable of reproduction are used.

Biological Pesticides
Product used in the integrated management of pests or to improve crop and soil productivity, using live microorganisms, viruses, macro-organisms, and natural or biochemical products. These do not include antibiotics, toxins (i.e., β-exotoxin of Bacillus thuringiensis), or organisms genetically modified (Resolution 68370 of 2020 by ICA).

Buffer Zone
The minimum distance required between the pesticide application site and the place requiring protection (ACN, 2019)

Cancelled Pesticide
A pesticide whose register has been withdrawn before the competent authorities by the holder of the register.

Carbamate Pesticides
Esters derived from n-methyl or carbamic dimethyl acids. They include compounds used as insecticides, fungicides, herbicides, and nematicides. These substances inhibit the action of acetylcholinesterase.

Certificate of Non-Compulsory Use
Certificate of whether a product's use is compulsory or not and its health registration has been obtained according to health regulations currently in effect (www.invima.gov.co).

Chemical Pesticide for Agricultural Use (PQUA for its acronym in Spanish)
Any substance or mixture of substances for the prevention, destruction, or control of any pest, plant, or non-desired animal species that can cause damage or that may interfere with the production, manufacturing, storage, transportation, or commercialization of food, agricultural products, wood, and wood products. The term includes substances to be used as plant growth regulators, defoliants, desiccants, and those applied to crops before or after harvest to protect the product against deterioration during storage and transportation. This term does not include biological agents for pest control —biochemical and microbial agents— (Andean Standard for PQUA Registration and Control, Decision 436 of 1998, ACN).

Chemical Risk
Probability of a chemical substance causing adverse health or environmental effects due to their

danger and exposure degree to the substance.

Chronic Intoxication by Pesticides

Intoxication due to repeated exposure to a pesticide at very low doses during long periods with delayed effects. Effects manifest when the toxic agent accumulates in the organism. This means that the amount eliminated is less than the amount absorbed or the effects accumulate, and there is a high frequency of complications and sequels with long-term effects, such as mutagenesis, carcinogenesis, and teratogenesis.

Chronical Toxicity

Refers to the adverse events of a pesticide after long (one to two years) or repeated periods of exposure through different paths (ACN, 2019).

Devitalization

A procedure that eliminates the plants' capacity to germinate, grow, or reproduce (FAO, 2016).

Disinfectant

A chemical agent that destroys or inhibits pathogen micro-organisms growth in non-spore or vegetative phase. Disinfectants not necessarily kill all organisms but reduce them to a level in which they do not represent a threat to the health or quality of perishable goods (WHO, 2004).

Emergency

All the situations the occurrence or imminence of an adverse event generates that requires mobilization of resources, according to the responding capacity.

Fumigation

A procedure to destroy weeds, arthropods, or rodent-pests using gaseous or gas-generating pesticides (Decree 1843 of 1991, by the Ministry of Health).

Hazard

Characteristics of a substance, agent, or situation that can cause undesired consequences. For instance, adverse effects or damage to the environment, health, or properties (FAO & WHO, 2014).

Inhibitors of Acetylcholinesterase Pesticides

Chemical substances that act over the nervous system of live organisms, impeding that in the process of synapsis, the acetylcholinesterase decomposes the acetylcholine, avoiding the interruption of the nervous impulse transmission.

Integrated Pest Management (IPM)

The careful analysis of all techniques available to attack pests and later integration of adequate measures that reduce the development of pests and maintain the use of pesticides and other interventions at economical and justifiable levels, reducing human health and environmental risks. IPM highlights the development of healthy crops, affecting agricultural ecosystems as less as possible and promoting natural mechanisms for pest control (FAO, 2006).

Intoxication

The medical symptoms caused by harmful effects of a toxic element (FAO, 2006)

Label

Set of date elements written, printed, or graphs related to a dangerous product, which are adhered or printed in the product's container or in its crate or outer packaging (GHS, 2019).

Mechanism of Action

Molecular, biochemical mode of action of the chemical pesticide, including cholinesterase inhibition, ergosterol synthesis, mitochondrial respiration, or others (ACN, 2015).

Mode of Action (MoA)

According to the mode of action of a chemical pesticide, the chemical pesticide can be systemic, translaminar, curing, protecting, of radicular absorption, by ingestion, by contact, by inhalation, or other similar ones (ACN, 2015).

Nebulization

Method using compressed air to convert a liquid substance in a cloud of very small droplets, most of them smaller than 50 microns in diameter.

Organophosphate Pesticides

Esters of phosphoric acid (union of an acid and an alcohol) and a variety of alcohols, generally liposoluble. Under this denomination are chemical substances used mainly as insecticides, nematicides, fungicides, and some of them also as herbicides. These substances inhibit the action of acetylcholinesterase.

Ornamentals

All plant species cultivated for obtaining flowers or cut branches (Resolution 63625 of 2020, ICA).

Personal Protection Elements (PPE)

The clothes, materials, or instruments used by people to avoid their exposure during the handling and application of pesticides. Coveralls and hats used to minimize the physical risk of applying pesticides are excluded from this definition.

Pest

Any species, race, plant or animal biotype, or pathogenic agent that is harmful to plants or plant products (FAO, 2016).

Pesticide Waste or Residues

Includes pesticides no longer in use, which have expired or are out of technical specifications, containers or packages that have contained

pesticides, remnants, surplus, by-products of these pesticides, the resulting liquid after washing or cleaning objects, which have been in contact with pesticides. These include working clothes, application devices, and process equipment, among others (Decree 1843 of 1991, Ministry of Health).

Pesticides Management

The regulatory and technical management of all aspects of the pesticides' life cycle, including the production (manufacturing and formulation), authorization, import, distribution, sale, supply, transportation, storage, management, application, and final disposal of pesticides and their containers to guarantee the safety and efficacy and reduce as much as possible the environmental and health adverse effects, as well as the exposure of humans and animals to pesticides (FAO and WHO, 2014).

Phytosanitary Management Plan

A program duly documented that details the set of phytosanitary measures to be applied in the production site or in the post-harvest area to maintain pests at levels that make production be competitive and sustainable (Resolution 63625 of 2020, ICA).

Producer

The natural or legal person dedicated directly or who has others under his/her responsibility, who work on the production and management of flowers or cuttings of the ornamental species for export (Resolution 63625 of 2020, ICA).

Prohibited Pesticide

Pesticides whose registered uses have been totally prohibited by a firm decision of the Government or whose register has been rejected due to health or environmental hazards.

Pseudocholinesterase

Unspecific cholinesterase also denominated butyryl-cholinesterase, plasma cholinesterase, or type S (serum) cholinesterase present in soluble form in almost all tissues, mainly the liver and plasma, in low concentrations, in the central and peripheral nervous system. The measurement of its activity constitutes an important aid for the diagnosis of acute intoxications due to carbamate and phosphate pesticides.

Re-entry Period (RP)

Time elapsed between the treatment or application of a pesticide and the entrance of people to the treated area or crop without the need to wear PPEs. This time should be expressed in hours (Resolution 11768 of 2019, ICA).

Restricted Pesticide

A pesticide whose uses have been practically or totally forbidden but are authorized for certain specific uses.

Safety Data Sheet (SDS)

A document that describes the physical and chemical characteristics of a hazardous material. It also provides the information for handling, using, and storing it safely and how to act in case of an emergency (GHS, 2019).

Technical Data Sheet of a Pesticide

A commercial, non-official document that contains summarized technical data of a pesticide: chemical composition, mode of action, efficacy, pests controlled, protected crops, and general usage recommendations. It does not replace the information or usefulness of the label.

Thermo-Nebulization

Vaporization of liquid substances to produce very fine droplets using thermo-pneumatic energy (temperature and pressurized air).

Toxic

A substance with the potential capacity to cause an adverse effect on an organism, altering the vital functions of the cells through biochemical modifications, physical alterations, or both (FAO & WHO, 2014).

Toxicity

Physiological or biological property that determines the capacity of a chemical substance to cause harm or damage to a live organism through non-mechanical means (FAO & WHO, 2014).

True Cholinesterase

Also denominated specific, erythrocyte, or type E cholinesterase (erythrocytic), it is present in the neuron membranes in the ganglion synapses of the organism's neuromuscular structure and in the erythrocytes. It is a very useful biomarker in surveillance systems of chronical exposure and acute intoxication cases.

Use and Management of Pesticides

Includes all pesticide activities: the storage, measurement, weighing, transportation, preparation of mixtures, application, assurance of the different usage stages, and final disposal of waste or remnants of pesticides (Decree 1843 of 1991, Ministry of Health).

References

Adnan, M., Islam, W., Shabbir, A., Khan, A. K., Ghramh, H. A., Huang, Z., Chen, H. Y. H., & Lu, G-d. (2019). Plant defense against fungal pathogens by antagonistic fungi with *Trichoderma* in focus. *Microbial Pathogenesis, 129,* 7-18.

Agrosavia. https://repository.agrosavia.co/handle/20.500.12324/33519

—ANDI—. (2003). Guías Ambientales para el subsector de plaguisidas. Minambiente – ANDI.

Alpi, A. & Tognoni, F. (1999). *Cultivo en invernadero.* Ediciones Mundi.

Askary, H. T. (2010). Nematodes as biocontrol agents. Sociology, organic farming, climate change and soil science. In Lichtfouse E. (Eds.), *Sociology, Organic Farming, Climate Change and Soil Science* (pp.347-378). Springer. https://doi.org/10.1007/978-90-481-3333-8_13

Askary, T. H., & Ahmad, M. J. (2017). Entomopathogenic nematodes: mass production, formulation, and application. In M. M. M. Abd-Elgawad, T. H. Askary, & J. Coupland (Eds.), *Biocontrol Agents. Entomopathogenic and Slug Parasitic Nematodes* (pp. 261-286). CAB International. https://doi.org/10.1079/9781786390004.0261

Asocolflores (2005). *Plagas y enfermedades de carácter cuarentenario en flores de corte.* Booklet.

Asocolflores (2020). *Guía para la implementación de indicadores en cultivos de flores y ornamentales. Asocolflores.*

Bedding, R., & Molineaux, A. S. (1982). Penetration of insect cuticle by infective juveniles of Heterorhabditis spp. (Heterorhabditidae: Nematoda). *Nematologica, 28*(3), 354-359. https://www.researchgate.net/publication/233560381

Bogran, C.; Ludwig, S., & and Metz, B. (2006). *Using oils as pesticides.* https://oaktrust.library.tamu.edu/bitstream/handle/1969.1/86885/pdf_1192.pdf?sequence=1&isAllowed=y

Cloyd, R. (2019). What are the effects of adjuvants on biological control agents? Greenhouse product news. https://gpnmag.com/article/what-are-the-effects-of-adjuvants-on-biological-control-agents/

Colombia, Ministerio de Ambiente, Vivienda y Desarrollo Territorial —Minambiente— & Cámara de la Industria para la Protección de Cultivos —ANDI—. (2003). *Guías Ambientales para el subsector de plaguisidas.* Minambiente – ANDI.

Colombia, Ministerio de la Protección Social. (2008). GATISO (Guías de atención integral en salud ocupacional).

Colombia, Ministerio de Salud. (1991). Decreto 1843. Uso y manejo de plaguicidas.

Comunidad Andina de Naciones —CAN. (2015). *Decisión 804. Modificación de la Decisión 436 de 1998 (Norma Andina para el registro y control de plaguicidas químicos de uso agrícola).* https://www.mincit.gov.co/ministerio/normograma-sig/procesos-misionales/administracion-profundizacion-y-aprovechamiento-de/decisiones/decision-804.aspx

Comunidad Andina de Naciones —CAN—. (2019). *Manual Técnico Andino para el Registro y Control de Plaguicidas Químicos de Uso Agrícola.* https://www.comunidadandina.org/DocOficialesFiles/resoluciones/RESOLUCION2075.pdf

Córdoba, P.D. (2000). *Toxicología.* Editorial Manual Moderno.

Cotes, A. M. (2018a). *The concept of biological control and Its fundamental premises.* Corporación colombiana de investigación agropecuaria – Agrosavia. https://repository.agrosavia.co/handle/20.500.12324/34057

Cotes, A. M. (Ed.). (2018b). *Biological control of Phytopathogens, insects and mites: Applications and perspectives.* Volumen 2. Corporación colombiana de investigación agropecuaria – Agrosavia. https://repository.agrosavia.co/handle/20.500.12324/33519

Cowles, R. S., Cowles, E. A., McDermontt, A. M., & Ramoutar, D. (2000). "Inert" formulation ingredients with activity: Toxicity of trisiloxane surfactant solutions to two-spotted spider mites (Acari: Tetranychidae). Journal of Economic Entomology, 93(2), 180-188. https://doi.org/10.1603/0022-0493-93.2.180

Denyer, S. P., Hodges, N. A., & Gorman, S. P. (2004). *Hugo and Russell's Pharmaceutical Microbiology.* Blackwell Publishing. https://doi.org/10.1002/9780470988329

Diomedi, A., Chacón, E., Delpiano, L., Hervé, B., Jemenao, M.I., Quintanilla, M., Riedel, G., Tinoco, J., & Cifuentes, M. (2017). Antiséptico y desinfectantes: apuntando a su uso racional. Recomendaciones del comité consultivo de infecciones asociadas a la salud. Sociedad Chilena de Infectología. *Revista Chilena de Infectología, 34*(2), 156-174. http://dx.doi.org/10.4067/S0716-10182017000200010

Dowds, B. C., & Peters. A. (2002). Virulence mechanisms. In R. Gaugler (Ed.), *Entomopathogenic Nematology* (pp. 79-98). CAB International.

Dreves, A., & Lee, J. (2019). Entomopathogenic nematodes. *In Pacific Northwest Insect Management Handbook* (pp. 1-5). https://pnwhandbooks.org/node/263/print

Durling, J. C. (Ed.). (1999). *SARE in Michigan: Highlights of projects funded by the North Central Region Sustainable Agriculture Research & Education Program, 1989-1998.* https://archive.lib.msu.edu/DMC/extension_publications/e2692/E2692-1999.PDF

Earl, A. M., Losick, R., & Kolter, R. (2008). Ecology and genomics of bacillus subtilis. Trends Microbiology, 16(6), 269-275. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2819312/

Ehlers, R. U. (2005). Forum on safety and regulation. In P. Grewal, R. Ehlers, & D. Shapiro-Illan (Eds.), Nematodes as Biocontrol Agents (pp. 117-114). CAB International.

Ehlers, R. U., & Hokkanen, H. T. M. (1996). Insect biocontrol with non-endemic entomopathogenic nematodes (Steinernema and Heterorhabditis spp.): conclusions and recommendations of a combined OECD and COST workshop on scientific and regulatory policy issues. Biocontrol, 43, 77-86. https://doi.org/10.1023/A:1009965922794

EPA (Environmental Protection Agency). U.S. Environmental Protection Agency. https://www.epa.gov

Etiennot, A., & Piazza, A. (2010). Buenas prácticas de aplicación en cultivos extensivos. Acta Toxicológica Argentina, 18(2): 40-42. http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1851-37432010000200002

FAO (2002). Guías sobre buenas prácticas para la aplicación terrestre de plaguicidas. https://www.fao.org/3/Y2767S/Y2767S00.htm

FAO (2003). Código Internacional de conducta para la distribución y utilización de plaguicidas. https://www.fao.org/publications/card/en/c/9ccb64f4-de27-549f-ab4b-7c29f96948a2/

FAO (2016). Glosario de términos fitosanitarios. https://www.fao.org/3/mc891s/mc891s.pdf

FAO y OMS (2014). Código internacional de conducta para la gestión de plaguicidas. https://www.fao.org/publications/card/en/c/I3604S/

Ferron, P., & Deguine, J. P. (2005). Crop protection, biological control, habitat management and integrated farming. A review. Agronomy for Sustainable Development, 25(1), 17-24. https://hal.archives-ouvertes.fr/hal-00886278/document

Florverde (2018). Estándar Florverde para la producción sostenible de flores y ornamentales, Version 7.1.

Florverde (2020). Consumo de plaguicidas en empresas Florverde 1998-2019. Sistema de registro.

FRAC (2020). Fungicide Resistance Action Committee. https://www.frac.info

fuente importante de controladores naturales. Asocolflores Magazine, 56, 4-12.

Ghazanfar, M. U., Raza, M., Raza, W., & Qamar, M.I. (2018). Trichoderma as a potential biocontrol agent, its exploitation in agriculture: A review. Plant Protection, 2(3), 109-135. https://esciencepress.net/journals/index.php/PP/article/view/3142/1571

González, B. Laura (2003). Antisépticos y desinfectantes. Educación Sanitaria. Offarm: farmacia y sociedad, 22(3), 64-70. https://www.elsevier.es/es-revistaoffarm-4-articulo-antisepticosdesinfectantes-13044452

Greene S. A., & Pohanish, R. (2005). Sittigs handbook of pesticide and agricultural chemicals. William Andrew Publishing.

Grewal, P.S., Ehlers, R.U., & Shapiro-Ilan, D. I. (2005). Nematodes as biological control agents. CAB Iinternational.

Guleria, S., Tiku, A. K., Koul, A., Gupta, S., Singh, G., & Razdan, V. K. (2013). Antioxidant and antimicrobial properties of essential oil extracts of zanthoxylum alatum grown in North-

Henao, H. S., & Corey, O. G. (1991). Plaguicidas inhibidores de la colinesterasa. OPS – OMS.

Ilan (Eds.), Nematodes as Biological Control Agents (pp. 363-381). CAB International.

Instituto Colombiano Agropecuario (ICA). https://www.ica.gov.co/

Instituto Nacional de Tecnología Agropecuaria —INTA—. (2012). Guía para el uso adecuado de plaguicidas y la correcta disposición de sus envases.

Instituto Nacional de Vigilancia de Medicamentos y Alimentos (INVIMA). https://www.invima.gov.co/

IRAC. (2020). https://irac-online.org/

Johnson, M. P., Easter, E. P., & Horstman, S. W. (1999). Personal protective equipment for pesticide applicators. http://www2.ca.uky.edu/agcomm/pubs/pat/pat6/pat6.pdf

Koppenhofer, A. M., & Grewal, P. S. (2005). Compatibility and interactions with agrochemicals and other biocontrol agents. In P. S. Grewal, R.U. Ehlers, & D. I. Shapiro-

Ladou, J. (1990). Occupational medicine. Editorial Appleton & Lange.

Lee, R., Pérez, M. M., & Cure, J. R. (1999). Tan cercas y tan vivas: Cercas vivas, una

Lewis, E. E., & Clarke, D. J. (2012). Nematode parasites and entomopathogens. In F. Vega & H. K. Kaya (Eds.), Insect Pathology. Elsevier.

Maroni, M., & Fait, A. (1998). Risk assessment and health surveillance of pesticide workers. La Medicina del Lavoro, 89(Suppl 2), S81-90. https://pubmed.ncbi.nlm.nih.gov/10217928/

Mathews, G. A. (2000). Pesticide application methods. Blackwell Science Ltd

McDonnell, G., & Russell, D. (1999). Antiseptics and disinfectants: activity,

Merck Sharp and Dhome Corp. Kenilworth. (2000). Merck and The Merck Veterinarian Manual. Antiseptics and disinfectans https://www.merckmanuals.com/

Mesnage, R., & Antoniou, M. (2018). Ignoring adjuvant toxicity falsifies the safety profile of commercial pesticides. Frontiers in Public Health, 5(Article 361), 1-8. https://www.frontiersin.org/articles/10.3389/fpubh. 2017.00361/full

Moreno, G. M. (2003). Toxicología ambiental. Evaluación de riesgo para la salud humana. McGraw Hill.

Mullin, C. A., Fine, J. D., Reynolds, R. D., & Frazier, M. T. (2016). Toxicological risk of agrochemical spray adjuvants: organosilicon surfactants may not be safe. Frontiers in Public Health, 4(Article 92), 1-8. https://www.frontiersin.org/articles/10.3389/fpubh.2016.00092/full

NTC-ISO 9001. (2015). Sistemas de gestión de la calidad. ICONTEC.

Pohanish, R .P. (2015). Sittigs Handbook of pesticides and agricultural chemicals. William Andrew Publishing. https://www.elsevier.com/books/sittigs-handbook-of-pesticides-andagriculturalandagricultural-chemicals/pohanish/978-1-4557-3148-0

Qiuzhi, C., Wang, W., Regev-Yochay, G., Lipsitch, M., & Hanage, W. P. (2014). Antibiotics in agriculture and the risk to human health: how worried should we be? Evolutionary Applications, 8(3), 240-247. https://doi.org/10.1111/eva.12185

Quintero, J. (2002). Búsqueda de alternativas para el cumplimiento de intervalos de reentrada en áreas tratadas con plaguicidas. Revista Asocolflores, 60, 53-61.

Quintero, J. (2009). Guías para el uso y manejo seguro de plaguicidas en cultivos ornamentales y poscosecha. Asocolflores, programa finca Florverde.

Reigart, R. J., & Roberts, R. J. (1999). Reconocimiento y manejo de los envenenamientos por pesticidas. U.S. Environmental Protection Agency.

Rosas-García N. M. (2009). Bipesticides production from bacillus thuringiensis: an environmentally friendly alternative. Recent. Pat. Biotechnology 3, 28-36. https://dx.doi.org/10.2174/187220809787172632

SGA (GHS). (2019). Sistema globalmente harmonizado de clasificación y etiquetado de productos químicos. United Nations. https://www.unece.org/fileadmin/DAM/transdanger/publi/ghs/ghs_rev08/ST-SG-AC10-30-Rev8s.pdf

Shapiro-Ilan, D. I., Gouge, D. H., Piggott, S. J., & Patterson Fife, J. (2006). Application technology and environmental considerations for use of entomopathogenic nematodes in biological control. Biological Control, 38, 124-133.

Shapiro-Ilan, D.I., & Gaugler, R. (2002). Production technology for entomopathogenic nematodes and their bacterial symbionts. Journal of Industrial Microbiology and Biotechnology, 28, 137–146.

Shapiro, D. I., & Glazer, I. (1996). Comparison of entomopathogenic nematode dispersal from infected hosts versus aqueous suspension. Environmental Entomology, 25, 1455-1461.

Stoytcheva, M. (2011). Pesticides in the modern world risk and benefits. https://www.intechopen.com/books/pesticides-in-the-modern-world-risksand-benefits

Syngenta. (2004). Aplicaciones técnicas. Principios y fundamentos. https://www.syngenta.com.co/tecnicas-de-aplicacion

Teulon, D., Casta, C., Nielsen, M.-C., El-

Sayed, A., Davidson, M., Gardner-Gee, R., Poulton, J., Kean, A., Hall, C., Butler, R., Sansom, C., Suckling, D., & Perry, N. (2014). Evaluation of new volatile compounds as lures for western flower thrips and onion thrips in New Zealand and Spain. New Zealand Plant Protection, 67, 175–183. https://doi.org/10.30843/nzpp.2014.67.5749

Thomson, S. (May 2, 2019). UV light may be ripe to replace chemicals in fungus fight. https://news.cornell.edu/stories/2019/05/uv-light-may-be-ripe-replace-chemicals-fungus-fight

U.S. Global Resources. (s. d.) Soil Treating Temperatures. https://www.usgr.com/soilsterilization/soil-temperaturesterilizing-table/

Villalobos. R., & Montoya, E. (2010). Nomogramas para ensamble y uso de la inyectora Unidrench® de dispositivo venturi. Agronomía colombiana, 28(2), 303-318. https://revistas.unal.edu.co/index.php/agrocol/article/view/18075/18991

Wang, X. Q., Zhao, D. L., Shen, L. L., Jing, C. L., & Zhang, C. S. (2018). Application and mechanisms of Bacillus subtilis in biological control of plant diseases. In V. Meena (Eds.), Role of Rizospheric Microbes in Soil (pp. 225-250). https://link.springer.com/chapter/10.1007/978-981-10-8402-7_9

Western Himalaya. The Scientific World Journal, 1-9. http://downloads.hindawi.com/journals/tswj/2013/790580.pdf

WHO. (2007). International Commission on Non-Ionizing Radiation Protection: Protecting Workers from ultraviolet radiation. www.who.int/uv/publications/protect_workers/en/

WHO. (2009). The WHO Recommended classification of pesticides by Hazard.

World Health Organization —WHO—. (2003). Pulverización de insecticidas. Guía práctica.

Annex 1: Classification and Properties of Disinfectants

	Ghemical group	Mechanism of action	NAF*	Characteristics
Inorganic	**1. IODINE**			
	Free iodine, hypoiodous acid	Penetrates cell walls modifying functional protein groups and nucleic acids. Inactivate proteins and enzymes by oxidation of sulphur-based chemical groups.	±	Unstable in dilution. Compatible with hard water. Plastic can absorb it. Poor efficiency at low temperatures and sensitive to Ph changes. Microbial activity is reduced in the presence of organic material. Requires prolonged contact to act over pathogens.
	2. CHLORINE			
	Hipoclorito de sodio, hipoclorito de calcio, dióxido de cloro	Inactivation of nucleic acids. Denaturalization of cellular proteins. Inhibition of enzymatic reactions.	±	Metal corrosive. They activate in the presence of organic matter. Unstable against the light. Not affected by water hardness. Low toxicity. They cause eye and mucosal irritation.
	3. OXIDANTS			
	Peracetic acid (= peroxyacetic)	Protein denaturalization. Disruption of permeability of the cell wall and oxidation of enzymes, proteins, and other metabolites.	+	Do not activate in the presence of organic matter. Sensitive to concentrations higher than 20%. Has oxidizing properties, so may ignite if in contact with combustible material.
	Ácido peracético (= peroxiacético)	Desnaturalización de proteínas. Disrupción de la permeabilidad de la pared celular y oxidación de enzimas, proteínas y otros metabolitos.	+	May corrode some metals. Unstable in dilution.
Organic	**4. PHENOLS**			
	Phenols, cresols, Triphenyl carbinol, Parabens (derived from p-hydroxybenzoic acid)	Produce wall rupture, membrane permeability, and precipitation of cellular proteins. Can cause inactivation of the essential enzymatic system.	±	Plastic absorbs them. They ause skin and eye irritation.

*NAF Fungicide level of action. + High, + Intermediate, - Low
Source: Based on *McDonnell G & Russel, D. Antiseptics and Disinfectants, 1999*

	Ghemical group	Mechanism of action	NAF*	Characteristics
Organic	**5. ALDEHYDES**			
	Formaldehyde	Alkylation of amino and sulfhydryl groups of cellular proteins.	+	Not used due to its ocular and respiratory irritating action and for being a skin allergen. Classified by the International Agency for Research on Cancer in Group 1, as “Carcinogenic for Humans.”
	Glutaraldehyde	Alkylation of amino carboxyl, hydroxyl, and sulfhydryl groups of microorganisms, altering the DNA, RNA, and protein synthesis.	+	Must always be activated with an alkaline solution. Verify occupational exposure levels (maximum 0.5 ppm on an 8-hour journey).
	Orto-ftalaldehyde (OPA)	Like the glutaraldehyde but strengthened by the time of contact with microorganisms.	+	Skin, eyes, and mucosa irritation.
	6. AMMONIUMS QUATERNARY			
	Ammoniums Benzalkonium Chloride	They act over the peptidoglycans of the cell wall and break the cytoplasm membrane. Protein and nucleic acids degradation. Produce cell lysis.	-	They deactivate in the presence of organic matter. Incompatible with hard water, soaps, and anionic detergents. Low corrosivity.
	7. DYES			
	Gentian violet (= crystal violet, methyl violet)	Interferes with the synthesis of peptidoglycan, making the cellular wall permeable and causing dehydration.	-	Sunlight causes degradation. Not affected by the presence of organic matter. Causes eye irritation.
	8. BIGUANIDES			
	PHMB (Poly hexamethyl biguanide)	They bind to anionic components of the cell membrane and block its operation.	-	Deactivation in contact with anionic materials and chlorine. Week fungicide action. Low toxicity for humans.

*NAF Fungicide level of action. + High, + Intermediate, - Low

Source: Based on *McDonnell G & Russel, D. Antiseptics and Disinfectants, 1999*

Annex 2: Medical fitness test parameters

1. Health Condition

The occupational health medical test has the purpose of certifying a persons' fitness to handle or apply chemical pesticides, biologicals for agricultural use, and other pest control chemical substances in a company, as well as managing machines used in the IPM process, which may generate physical and ergonomic risks for the person..

The protocol is presented as a tool to be used by the professional who issues a medical concept of labor capability. The protocol includes the following:

- Medical interview
- Clinical evaluation
- Work History
- Mental Health Evaluation
- Clinical Lab Tests

2. Medical Interview

This activity considers a general summary of information that includes basic demographic data, previous illnesses—paying special attention to the history of allergies, skin or respiratory problems, and sequels from the liver, the kidneys, or the central or peripheral nervous system diseases, endocrine or reproductive disorders, etc.—, family history, and regular medications prescription.

3. Clinical Evaluation by a Physician

General clinical and systems exploration by the physician to check the condition of the skin, teguments, and conjunctives and digestive apparatus with emphasis on liver function, cardiovascular apparatus, respiratory track, and central and peripheral nervous system, among others.

- Identify pathologies that absolutely impede the management or application of chemical pesticides, biological products for agricultural use, and other chemical substances for pest control, as well as the manipulation of equipment used to apply the pesticides.
- Identify pathologies that relatively impede working on the application of pesticides.

4. Work History

With special emphasis on previous exposures to pesticides at work. Information from the current working site, if any, will be collected, as well as the exposure profile to pesticides or other chemical products and the protection measures used.

5. Mental Health Evaluation

This evaluation serves to identify workers with pathologies that could put at risk their or other people's health, given the hazardous materials being handled. It is made through a medical interview and answers to a survey to evaluate depression symptoms.

6. Clinical Lab Tests

Lab tests are biological indicators associated with the use and management of pest control products to assess the exposure, effects, and detoxification processes of individuals.

6.1 Acetylcholinesterase Test

This test must be taken if the person is going to be or has been exposed to organophosphate and carbamate insecticides. The result of the initial test must be available at the time of the medical exam to enter the pesticide application shift. The result of the final test must be available at the time of the medical exam to exit the application shift.

6.2 Evaluation of hepatic and renal function

This evaluation is recommended because both functions determine the detoxification capacity of the human organism. The clinical evaluation will be supported by lab tests, such as transaminases, creatinine, or others, given there is a clinical justification for requesting them.

Annex 3: Criteria for the selection, care, and maintenance of PPEs

1. Personal Protection Elements Program

Before delivering the Personal Protection Elements, the company must have developed strategies for the prevention and control of the use and management of pesticides and other pest control chemical substances, achieving the commitment and self-care by the worker.

The following activities must be considered when developing a PPE Program:

- Identify hazards and assess risks according to the activity being developed.
- Determine the PPEs, specifying the label recommendations and SDS of products in use.
- Establish PPE delivery registers that describe the characteristic, life cycle, delivery date, and maintenance.
- Within the workers' training program, highlight the importance of the proper use, cleaning, and maintenance of PPEs.
- Establish a program for the inspection of the status and use of provided PPEs.

2. Selection of PPE

PPEs shall be used when specific risk factors are present, so they allow the prevention of accidents and contribute to work wellbeing.

It is mandatory that employers provide adequate PPEs to their workers, which follow good quality in their manufacturing, endurance, and duration. Selecting the PPEs might be done checking at the suppliers who follow the national legislation on protection equipment and elements.

Training and Delivery of PPEs

People in charge of delivering the PPEs must be trained for the proper provision, according to risk factors in the work area.

Monitoring of the Use of Personal Protection Equipmen

The IPM Manager and the Occupational Safety and Health Joint Commission (COPASST) will oversee the process, ensuring the proper use of PPEs.

Replacement of Personal Protection Equipment

Employers must guarantee the timely replacement of personal protection equipment. A person responsible for SG-SST shall inspect the PPEs and notify the replacements required.

Registers

Maintain up to date the register with a detailed list of the training, supply, time of use, and replacement of the PPEs of each person.

Annex 4: Emergency plan in case of intoxication with a chemical product

START

1. State the emergency: Give notice to the Emergency Committee, then, it will inform the Brigade
2. Risk identification: Know the name of the product which caused the intoxication (revision of the product label).
3. Select PPEs for personnel taking care of an intoxicated person (use the product's SDS).
4. Remove the intoxicated person from the area of danger. Remove the person's clothes if it is impregnated with the product.
5. If the product has caused dermal contamination, wash the person's skin with abundant clean water and soap for at least 15 minutes.
6. If intoxication is caused by inhalation, hyperextend the head, maintaining it in a position that facilitates breathing.
7. If the intoxication is caused by ingestion, revise the mouth with a finger covered with a clean cloth. Remove remains or residues of product or vomit.
8. If the product has caused eye contamination, wash the eyes with abundant clean water for at least 15 minutes. Cover eyes with a clean cloth.
9. After the emergency, this shall be evaluated, a report shall be made and the corrective and preventive measures shall be taken.

END

Annex 5: Emergency plan in case of chemical product spills

START

1. State the emergency: Give notice to the Emergency Committee, then, it will inform the Brigade.
2. Risk Identification: Know the name and approximate amount of spilled substance.
3. Select PPEs for personnel who will control the spill (use the product's SDS).
4. Stop the origin of the spill: Straighten or rotate the container, Close the leaking site, Pass on to another container, etc.
5. Contain the spill: Use absorbent material, deviate the spill, do not was the spill with water, avoid the spill from reaching water sources, and delimit and put a sign in the area.
6. Clean the contaminated site, do not wash it with water. Materials contaminated with the product should be managed as special waste. Collect with shovels, deposit in containers, and identify the spilled product with its name, as well as the date of the event.
7. Wash with water the tools used to collect spillages and the contaminated PPEs. Personnel participating in collecting the spills must shower using clean water and soap.
8. Emergency must be assessed, making a report and taking the necessary corrective and preventive measures.

END

Annex 6: Check list for application inssurance

COMPANY*: _____

CROP: _____ BLOCK:_____

BIOLOGICAL TARGET TO BE TREATED: _____ DATE: _____

APPLIED PRODUCT(S): _____ VOL/BED (L): _____

Control sites	In compliance		Observations
	Yes	NO	
BEFORE THE APPLICATION			
1. The amount of product delivered by the warehouse corresponds to the amounts requested according to the program.			
2. Products are delivered in properly closed and labeled containers..			
3. Product from the warehouse to the mix preparation sites is transported in closed and safe vehicles.			
4. Equipment shall be in good operating conditions without product leaks or clogs (pressure gauge, filter, mixing agitator, pump, calibrated tank, hydrants, hoses, tips, nozzles).			
5. Nozzles' capacity is used to calculate the travel time per bed.			
6. Water conditions were measured with accurate instruments to justify the use of pH and hardness correctors.			
7. The mixing products order was done correctly.			
8. On stationary equipment, dyes are used to indicate the beginning and end of the application to be sure there are no remnants of the mixture.			
9. Personnel who supervise and apply the products have complete PPEs in good condition.			
10. Signs are used for restricting the access of personnel not using PPEs in all entrances to areas being fumigated or already treated.			
DURING AND AFTER THE APPLICATION			
11. Workers' speed application is uniform and corresponds to the application volumes by bed or area.			
12. The position and orientation of the application implements are uniform and correspond to the biological target to be treated.			
13. The prepared product was completely applied. There are no pesticide blends left, and no beds were left without pesticide application.			
14. The evaluation with hydrosensitive paper of the plant's coverage (number of drops/cm^2) was adequate (attach cards on the lower boxes).			

	WORKER: _____		WORKER: _____		WORKER: _____	
UPPER THIRD						
	TOP	**BOTTOM**	**TOP**	**BOTTOM**	**TOP**	**BOTTOM**
MEDIUM THIRD						
	TOP	**BOTTOM**	**TOP**	**BOTTOM**	**TOP**	**BOTTOM**
LOWER THIRD						
	TOP	**BOTTOM**	**TOP**	**BOTTOM**	**TOP**	**BOTTOM**

Annex 7: Pest control products application record

NAME OF THE FARM: _____

AREA, BLOCK, OR SITE: _____ TREATED ORNAMENTAL SPECIES: _____

Date (dd-mm-aa)	Biological Target	Products to be applied (NC)*	Dose/l (gr. or cc)	Bed No.	Vol/bed or area (l)	Application Method	Aimed at (third)	Application Equipment	RP** (hrs)

*NC = Commercial name of the product **RP = Re-entry Period

Person responsible for making the recommendation:

Name: _____ Signature: _____
__

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Dear reader:

Florverde Sustainable Flowes offers you a valuable document that, undoubtfully, will change your way of managing the Pest Integral Management (PIM) in Colombian floriculture.

This is an updated and comprehensive collection of all practices known in the sector to this date, to technically develop an inteligent phytosanitary management, framed within respect for the health of humans, the environment, and the applicable legislation.

This guide delivers a series of tools and implementation guidelines for each of the described PIM practices. It will become an instrument for your daily work, which will help to improve the management of those in charge of the phytosanitary management of flower and ornamental plants. We are convinced it will be.