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GUIDELINES FOR INTEGRATED PRODUCTION OF CITRUS

IOBC Technical Guideline III

1st Edition, 2004

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Guidelines for Integrated Production of Citrus Fruits

IOBC TECHNICAL GUIDELINE III

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This document sets out general principles, minimum standards and guidelines for Integrated Production of Citrus Fruits. It is intended as a framework for the formulation of regional or national guidelines according to IOBC/WPRS standards and to facilitate their harmonisation. The document on IOBC principles of Integrated Production and Technical Guidelines I and II (^{3rd} edition), published in IOBC/WPRS Bulletin Vol. 27 (2), 2004, or up-dated versions thereof, are integral part of these crop specific Technical Guidelines III. The full text is available on internet (www.iobc.ch).

1. Definition of Integrated Production of Citrus Fruits

In the frame of the general IOBC definition for Integrated Production, Integrated Fruit Production (IFP) is defined as the economical production of high quality fruits, giving priority to ecologically safer methods, minimising the undesirable side effects and use of agrochemicals, to enhance the safeguards to the environment and human health.

Based on this short definition, Integrated Production of citrus fruits emphasises the following objectives:

- To promote citrus fruit production that respects the environment, is economically viable, and sustains the multiple functions of agriculture, namely its social, cultural and recreational aspects.
- To secure a sustainable high quality production of citrus fruits. Quality includes all components of total quality (IOBC Principles, chapter IV)
- To protect the farmers' health while handling agro-chemicals.
- To promote and maintain a high biological diversity in the ecosystem of the orchard and in surrounding areas.
- To give priority to the use of natural regulating mechanisms.
- To preserve and promote long-term soil fertility.
- To minimise pollution of water, soil and air.

2. Commitment of the farmer

Successful Integrated Fruit Production requires professional up-to-date training and a positive and sympathetic attitude to its aims.

Citrus fruit growers and farm managers must be professionally trained in all aspects of Integrated Fruit Production by attending locally organised training courses. They should have a thorough knowledge of the aims and principles of Integrated Fruit Production and of the IP-guidelines and standards of their organization or region. They should have a positive and sympathetic attitude to environmental conservation, human health and safety. A requirement for attendance at an introductory training course offered by the IP-organisation as well as regular updating and review meetings is mandatory.

Citrus fruit growers must be members of an officially recognised IP-association. A contract that lists the obligations of the member as defined by the IOBC/WPRS Technical Guideline I has to be signed between each member and its IP-association.

3. Conserving the Orchard Environment

An important aim and requirement of Integrated Fruit Production is the conservation of the orchard environment, its habitats and wildlife. They must not be detrimentally altered nor polluted.

As far as possible a balanced and natural orchard environment with a diverse agro-ecosystem of plants and animals must be created and conserved. According to IOBC standards, at least 5% of the entire farm surface (excluding forests) must be identified and managed as ecological infrastructures with no input of pesticides and fertilisers in order to enhance botanical and faunistic biodiversity. In areas with predominantly perennial crops and/or small farms, where a surface of 5% or more of a common and homogeneous agroclimatic unit (e.g. municipal district) has been set aside as ecological infrastructures by official and well-documented programmes, the 5% rule has not necessarily to be applied to the individual farm. Existing ecological infrastructures at the farm and community level must be preserved. Areas of linear elements (e.g. flowering border strips, hedges, ditches, stone walls) and non-linear elements (e.g. groups of trees, ponds.....) being present on the farm or planned should be combined in a manner to obtain spatial and temporal continuity as a prerequisite for the enhancement of faunistic diversity and for the maintenance of a diverse landscape.

Particular attention must be devoted to headlands and windbreaks. Diversity of composition and structure should be the aim, using or encouraging native species where possible. Species that are host plants of important citrus pathogens must be avoided. It is strongly recommended not to use host plants of important pests. IP guidelines must require implementation of at least two ecological options for active enhancement of biological diversity by each member farmer. A list of options for enhancing biological diversity must be provided. Examples are as follows: (i) refugia for predators, (ii) host plants for beneficials, (iii) provision of wildlife habitats.

Hedgerows should provide adequate screening to prevent pollution and contamination of fruit from busy roads and from other industrial pollution sources.

Development of a professionally formulated conservation assessment and plan for the farm and its implementation are recommended. See also IOBC Tool Box (www.iobc.ch)

4. Site, Rootstocks, Cultivar and Planting System for New Citrus Orchards

For new citrus orchards, site, cultivars, rootstocks and planting system must be selected and harmonised so that regular yields of quality fruit, and hence economic success, can be expected with the minimum use of agrochemicals and environmentally hazardous practices. Chemical soil sterilisation is not permitted. Sites with a favourable aspect and appropriate soils must be selected, avoiding the situations in which a continuous supply of inputs will be necessary. For instance, frost pockets, poor drainage situations, a very high calcium level or very saline soils must be avoided.

The rootstock/cultivar combination chosen must offer good prospects for economic success with minimal use of agrochemicals. Cultivars and rootstocks resistant or tolerant to pests, physiological disorders, fungal diseases, viruses and/or phytoplasmas are preferred. National/regional guidelines must set out a list of the relative susceptibilities of the commonly grown rootstocks and cultivars of citrus species to all important pests, diseases and physiological disorders and a list of the rootstock/cultivar combination recommended and forbidden. Care must be taken to ensure adequate spatial separation of cultivars to avoid cross pollination among cultivars that could produce or increase seed production in fruits. The use of different varieties in the same orchard is forbidden in order to prevent medfly and pollination problems.

Planting and grafting material must be certified as being virus- and virus-like organism free. In general, GMOs (= genetically modified organisms) must not be used. Exceptions to this rule have to be permitted by IOBC on a case-by-case basis. IOBC endorsed organisations must inform the endorsement office of IOBC about the intended use of GMOs by their members. The final decision on the appropriate application of GMOs by an IOBC endorsed organisation has to be taken by IOBC.

Planting systems must allow safer, more efficient spraying practices to be adopted. Planting distances should allow enough space for the plant throughout its expected life span. When re-planting an orchard, the soil must be deep ploughed and the re-planting should not be done before 8 months has elapsed, if the previous crop was citrus.

5. Fertilization and Tree Nutrition

The structure, depth, fertility, fauna and micro-flora of the soil must be conserved and nutrients and organic matter recycled where possible. The aim of fertilisation is the compensation of exportation and unavoidable technical losses. Based on an annual balance, a fertilisation programme which takes into account orchard characteristics, age, cultivar, rootstock, planting distances, expected yield, soil type, irrigation water quality and cropping system must be established. As a general principle the minimum quantities of fertilisers consistent with high yields of quality fruit must be used. Risks and levels of pollution of ground water with fertilisers, especially nitrates, must be minimised.

Fertilisers should be applied mainly through the soil. The use of fertigation is recommended. Foliar fertilisation is only permitted to correct the deficiencies in nutrients and when the soil characteristics limit the efficacy of soil application.

Soil must be sampled and chemically analysed prior to planting. After planting, plant, soil and water analyses must be carried out at least every 5 years to determine nutrient and fertilizer requirements. Plant, soil and water analyses must be also done when an orchard enters an IP programme. Regional/national guidelines must set out a clear method by which requirements are determined, including sampling and analytical procedures and rules for decision-making. According to soil type, regional/national guidelines must establish the total maximum N, P and K input (expressed in N kg ha⁻¹ year⁻¹, P₂O₅ kg ha⁻¹ year⁻¹ and K₂O kg ha⁻¹ year⁻¹), and the period and methods of application, to minimise leaching. Nitrogen must be applied at least at two application timings per annum, except for organic fertilisers. The quantity of P and/or K applied must not exceed the amount indicated by soil or plant analyses by more than 10%, except for organic fertilisers applied every second or third year. This maximum can be surpassed in poor soils and until the nutrient level of the soil is restored. Records of soil, plant and water analyses and of all nutrient applications must be kept and made available for inspection by the controlling officer.

Organic fertilisers must be preferred. Fertilisers or manures contaminated with toxic or environmentally hazardous substances such as heavy metals or pathogenic micro-organisms are not permitted.

Regional/national guidelines must set out the maximum content of the main nutrients in the leaves and the recommended or compulsory measures to avoid nutrient losses, related to cover crops, soil cultivation, irrigation and nutrient incorporation.

6. Soil management

The aims are to maintain soil fertility and plant species diversity in citrus orchards, to foster ecological stability, to minimise the use of herbicides (avoiding very persistent, toxic or water polluting residual herbicides completely, see Section 10) and to avoid soil erosion and compaction.

Overall bare soil management of orchards throughout the year is not permitted. Bare soil management is permitted in spring and summer to avoid competition for water and nutrients and the use of soil tillage is recommended. A vegetation cover is mandatory during the winter time. Alleyways should be of grass and/or herbs and of adequate width to easily accommodate the tractor wheelings. The use of Leguminosae as cover crops to improve soil structure, weed control and soil fertility is recommended.

Soil management should be carried out mainly by mechanical measures, reducing soil tillage to a minimum. The use of machinery that causes deterioration of the soil structure and favours the creation of hard pans is forbidden. Herbicides can be used locally during spring and summer.

7. Irrigation

Trees must be supplied with adequate soil moisture to ensure balanced growth and high internal and external fruit quality. Irrigation is only permitted when the available water

does not satisfy crop requirements. Excessive use of irrigation water is wasteful, as it may result in poor fruit quality, leaching of nutrients and increased risk of root rots.

Irrigation techniques that guarantee maximum efficiency of water use should be used. Regional/national guidelines must set out the irrigation techniques to be used, according to the characteristics of the area, and must set out the maximum amount of water per year that can be used in every case.

All measures necessary to avoid water losses must be taken. Regular inspections of water distribution systems must be carried out to check whether they are in good state. The use of drip irrigation in new irrigated areas is preferred.

An irrigation programme must be set out for each plot, according to soil type, the density of the plantation, the techniques used and crop physiology. The amount and the distribution of the irrigation water must be supplied according to the requirements of the tree, the soil moisture balance and the soil water storage capacity. Therefore, it is necessary to collect or measure the daily rainfall, the amount of irrigation water supplied and the evapotranspiration data from local meteo stations. The amount of applied water must be recorded.

Irrigation water must be of adequate quality and its salinity and content of polluting elements must be, at most, the official tolerant levels. Chemical analyses must be carried out prior to planting, before entering an IP programme and every five years, as a maximum, after planting. Regional/national guidelines must set out the maximum content of the main nutrients in irrigation water.

8. Tree Training and Management

Trees must be trained and pruned to achieve a manageable uniform size, a balance between growth and regular yields, and to allow good penetration of light and spray to the tree centre.

Pruning must be reduced to a minimum according to cultivar and to the physiological status of the plant. Heavy pruning must be avoided, as it interferes with the plant equilibrium.

Suckers, shoots growing from the trunk and the main branches, dead and weak branches and branches that grow vertically in the centre of the tree must be pruned.

The use of non-naturally occurring synthetic plant growth regulators is not permitted.

9. Fruit Management

Regular yields of quality fruit with the preferential use of cultural practices and the minimal use of agrochemicals are a central aim of Integrated Fruit Production.

The use of non-naturally occurring chemicals for fruit management is not permitted in general. Their use can only be permitted when absolutely necessary. Regional/National guidelines must set out which chemicals are permitted, clearly specifying the aim and the restrictions of their use.

Branch girdling to increase fruit set in varieties with problems is recommended.

10. Integrated Plant Protection

The modern approach to Integrated Plant Protection in sustainable production systems has been described in Technical Guideline II. Basically, all available preventive (indirect) plant protection measures must be applied before direct control measures are used. The decision for the application of direct control methods is based on economic thresholds, risk assessments and forecasts, including those provided by official forecasting services. Each IP-organisation, working according to IOBC standards, must establish a restricted list of the key pests, diseases and weeds that require regular attention.

Priority must be given to natural, cultural, biological, genetic (GMOs excluded) and biotechnical methods of pest, disease and weed control, and the use of agrochemicals must be minimized. Permission to use GMO's can be given on a case-by-case basis.

Populations of key natural enemies (e.g. *Cales noacki*, *Rodolia cardinalis*, *Euseius stipulatus*) must be preserved and incremented. At least three key natural enemies in each crop must be identified in national/regional guidelines. This means that the use of plant protection products toxic to them must be reduced to a minimum and always in periods of low activity of the natural enemies or of low risk for them.

The establishment and maintenance of untreated areas as refugia for natural enemies is strongly recommended.

Populations of pests, diseases and weeds must be regularly monitored and recorded. Scientifically established assessment methods appropriate to the region or locality must be used. For each pest or disease the approximate level of infestation or the risk of damage must be estimated and a decision as to whether or not a control measure is required, based on scientifically established threshold levels wherever possible, taken and recorded. Problem weed species present, their growth stage, distribution and density should also be recorded.

Wherever a control measure is deemed necessary, a biological, genetic (cultivar choice) or biotechnical control method (e.g. releases of *Cryptolaemus montrouzieri* and *Leptomastix dactylopii*) must be used if available and effective.

Where the use of plant protection products is necessary, the product selected must be the least hazardous to human beings, livestock and the environment whilst providing effective control of the pest, disease or weed problem (see Appendix 5 of Principles and Technical Guidelines).

IP-Organisation guidelines must set out a strategy of mandatory measures for minimising the risk of the development of resistance of pests and diseases to pesticides. The strategy must require the alternation of the use of pesticides with different modes of action. National/regional guidelines must set out the maximum yearly number of applications per chemical or group of chemicals, in order to minimise the risk of resistance. The maximum number of applications of any acaricide group must be set to one per crop per year.

Pesticides available locally or nationally identified as meeting these criteria, as well as being as safe as possible to key natural enemies, must be identified in regional guidelines and included in the list of permitted control measures (green list) or included in the list of control measures permitted with restrictions where appropriate (yellow list) (see Appendix 5 of Principles and Technical Guidelines)

The following criteria must be taken into account in the classification of pesticides into 'permitted' and 'permitted with restrictions' categories:

- Toxicity to man
- Toxicity to key natural enemies
- Toxicity to other natural organisms
- Pollution of ground and surface water
- Ability to stimulate pests
- Selectivity
- Persistence
- Incomplete information
- Necessity of use

Based on these criteria, the following categorisation of certain pesticides and pesticide groups is established. It may require up-dating with the development of new products.

Not Permitted

- Pyrethroid insecticides and acaricides
- Non-naturally occurring plant growth regulators¹
- Organochlorine insecticides and acaricides
- Toxic, water polluting or very persistent herbicides

Permitted with Restrictions

- Dithiocarbamate fungicides (normally a maximum of 3 applications per season and not in succession so that predatory phytoseiid mites are not affected).
- Fosetil-Al and Phosphonate Potassium, maximum of 2 applications per year.
- Metalaxyl, maximum of 2 g / m².
- Residual (soil) herbicides (except toxic, water polluting or very persistent products) in the first three years after planting, maximum of one dose-equivalent per annum.

The occurrence of pesticide residues on fruits at harvest must be further minimised by maximising safe-to-harvest intervals and by minimising post-harvest chemical treatments.

Where available, officially-recognised dose adjustment protocols must be used to adjust dose rates to suit the size and density of the target tress being sprayed. The use of localised application of pesticides is recommended. National / regional guidelines must set out the maximum volume of application per ha, according to the tree volume. The growers / applicators must be trained in the use and the application of pesticides.

11. Efficient and Safe Application Methods

¹ Their use can only be permitted when absolutely necessary. Regional/National guidelines must set out which chemicals are permitted, clearly specifying the aim and the restrictions of their use

An important requirement of Integrated Fruit Production is that the sprayers are used as safely and efficiently as possible and that new designs of sprayers that are safer and more efficient are gradually adopted. The use of static fans is forbidden. Aerial treatments are forbidden, except in the case of compulsory regional treatments against *Ceratitidis capitata*. It is recommended that non-cropping areas be protected from contamination by spray drift by planting windbreaks as barriers. Statutory buffer zones specified on pesticide labels must, in any event, be observed.

Sprayers must be regularly serviced and calibrated annually by the grower. A recognised agent must service them at least every four years and must comply with officially recognised sprayer testing requirements. The size and shape of the spray plume generated by the sprayer should be set to match the tree target. Spraying in windy conditions is not permitted. Statutory buffer zones must be observed to protect watercourses from pollution by spray drift. When planting systems for new orchards are chosen, their compatibility with safe and efficient spraying methods must be taken into account. Wherever possible, tractors must be fitted with a cab.

12. Harvesting, Storage and Fruit Quality

Harvest, post-harvest handling and storage practices have to fulfil the general requirements for product quality, food safety and traceability established by national or international standards and are outlined in the IOBC Technical Guideline II.

Internal quality parameters should be at least as important as the external ones. National / regional guidelines must set the minimum quality parameters for each variety. The harvest of fruits for fresh consumption must be done by hand and from the tree.

Short-term fruit storage must be based on the exclusive use of environmental conditions (temperature and humidity). In storage, the employment of active ingredients or of beneficial organisms for the control of pathogenic fungi can be done only at one point in the entire chain and only for fruits that are for long term storage. The storage facilities must be cleaned at least once per year.

13. Post-harvest treatments

Methods of de-greening fruit must be strictly regulated by national/regional guidelines, taking into account fruit quality. The use of waxes must strictly comply with the rules and conditions set by the code of elaboration of alimentary products. The use of waxes of natural origin is recommended.

14. Inspection Procedures and Guideline Structures

National/regional IP-organisations applying for endorsement by the IOBC commission 'IP-Guidelines and Endorsement' have to organise and operate their inspection and certification systems according to the standards defined by Appendix 2 of the Principles and Technical Guidelines (3rd edition 2004). With respect to the establishment of flexible national and regional guidelines, we refer to the recommendation in Appendix 1 of Principles and Technical Guidelines (3rd edition

2004).

Selected literature

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