

IOBC/WPRS  
Commission "IP-Guidelines and Endorsement"

OILB/SROP  
Commission "Directives de PI et Agrément"

# **GUIDELINES FOR INTEGRATED PRODUCTION OF FIELD GROWN VEGETABLES**

**IOBC Technical Guideline III**

1st Edition, 2004

Edited by

C. Malavolta, E.F. Boller & F.G. Wijnands

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The Publication Commission of the IOBC/WPRS:

Horst Bathon  
Federal Biological Research Center  
for Agriculture and Forestry (BBA)  
Institute for Biological Control  
Heinrichstr. 243  
D-64287 Darmstadt (Germany)  
Tel +49 6151 407-225, Fax +49 6151  
407-290  
e-mail: h.bathon.biocontrol.bba@t-  
online.de

Luc Tirry  
University of Gent  
Laboratory of Agrozoology  
Department of Crop Protection  
Coupure Links 653  
B-9000 Gent (Belgium)  
Tel +32-9-2646152, Fax +32-9-2646239  
e-mail: luc.tirry@ rug.ac.be

Address General Secretariat:

INRA – Centre de Recherches de Dijon  
Laboratoire de recherches sur la Flore Pathogène dans le Sol  
17, Rue Sully, BV 1540  
F-21034 DIJON CEDEX  
France

Web: <http://iobc-wprs.org>

## **Preface of the first edition 2004**

With this publication of the “Guidelines for the Integrated Production of Field grown Vegetables” IOBC closes an important gap in its series of crop specific guidelines. Vegetables (and fruits) are important components of a healthy diet and are connected with high expectations of the consumers with respect to nutritional quality, food safety and absence of polluting residues. Since national standards and labels for the Integrated Production of vegetables exist for a considerable period of time in various countries, the question is justified why it took so long for IOBC to establish these international standards for vegetables.

Sustainable production of vegetables has to face multiple problems such as:

- the contradicting attitude of the consumer with high expectations concerning the external cosmetic quality of the produce that should, however, contain no pesticide residues;
- a highly competitive and volatile market;
- tendency of increasing production costs and simultaneously decreasing market prices;
- continuous pressure to increase productivity by reducing labour costs;
- therefore, the producers' motivation to invest more efforts than absolutely necessary into sustainable production techniques is often low because these efforts do, in general, not generate significant monetary benefits at the farm level.

Such circumstances hampered for years the preparation of international IP standards for this important crop sector.

With the 3<sup>rd</sup> revision of its standards for Integrated Production published in 2004 (on internet [http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html)) and fully aware of the existing problems IOBC/WPRS Council has instructed the Commission for Integrated Production Guidelines and Endorsement to start the preparation of these guidelines for field vegetables. The Commission has carried out this task by collecting the available information and by describing the present state of the art by two expert panels. The first panel of experts representing Central and Northern European regions met in January 2004 at the Commission's headquarters at Wädenswil, Switzerland and consisted of: R. Baur, Switzerland; M. Hommes, Germany; B. Jönsson, Sweden; B. Parker, U.K.; W. Sukkel, Netherlands; K. Wiech, Poland, and E. Boller as Commission member. The second panel of experts representing Southern regions met in May 2004 again at Wädenswil and consisted of R. Gabarra, Spain; V. Tisselli, Italy; F. Villeneuve, France; and C. Malavolta and E. Boller as Commission members. The conclusions of both panels were combined in one single document and circulated in a wider international group of experts for consultation. The final English text was approved by the Commission on November 20, 2004 and published on internet [http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html) in December 6, 2004. Translations into other languages are in progress or have been published on internet.

We would like to extend our thanks to all persons that have assisted in the preparation of this document by their direct input and advice. Special thanks go to those colleagues who translated the English text of the original document into the respective other languages.

Wädenswil, April 9, 2005

Carlo Malavolta

Ernst. F. Boller

Frank G. Wijnands

# Guidelines for Integrated Production of Field grown Vegetables

## IOBC Technical Guideline III

Umbellifera Crops (Carrots, Fennel, Celery, Celeriac), Alliaceae (Onions, Garlic, Leek),  
Lettuce, Brassica Crops, Solanaceae (Potatoes, Tomatoes, Peppers, Eggplants), Cucurbitaceae  
(Melons, Watermelons, Squash, Zucchini, Cucumbers), Chenopodiaceae (Spinach, Silver  
Beets), Leguminosae (Beans, Peas, Green Beans)

**2004, 1st Edition  
(Original text in English)**

This document sets out general principles, minimum standards and guidelines for the Integrated Production (IP) of field-grown vegetables (including not heated protected and semi-protected production systems). It is intended as a framework for the formulation of specific national and regional IP-guidelines and standards and to promote their harmonisation throughout the geographic areas covered by IOBC/WPRS.

The requirements for Integrated Production in field grown vegetables as defined in this document are based on the IOBC Principles of Integrated Production and Technical Guidelines I and II (3rd edition) published in the IOBC/WPRS Bulletin Vol. 27 (2), 2004 and available in full text on internet [http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html). These documents are integral part of this crop specific Technical Guideline III.

## I. OBJECTIVES

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

Based on this short definition, for Integrated Production of vegetables under field conditions the following objectives are outlined:

- To promote production systems that respect the environment, are economically viable, and sustain the multiple functions of agriculture, namely its social, cultural and recreational aspects;
- To secure a sustainable production of healthy crops of high quality and with a minimum occurrence of pesticide residues;
- To protect the farmers' health while handling agro-chemicals;
- To promote and maintain a high biological diversity in the agro-ecosystems concerned 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.

## II. REQUIREMENTS

To achieve these objectives, a farmer practising Integrated Production according to IOBC standard must fulfil a certain number of requirements that apply to the entire surface of the farm.

### 1. Commitment of the farmer

The requirements for the farmer (member of the regional IP-organisation) are defined by the IOBC Technical Guideline I and are summarised as follows:

The farmer or responsible farm manager must:

- Be professionally qualified to manage the farm according to IP principles;
- Be a member of an officially recognised IP association and has to sign a contract defining clearly the duties as member;
- Undertake basic training and education in IP, and participate actively in the regular updating courses offered by his/her IP organisation;
- Make complete farm records demonstrating essential farm operations such as fertilisation, pesticide applications, soil management, irrigation, according to the rules of the IP association.

### 2. General requirements for field grown vegetable crops

The basic requirements for all crops are defined by the IOBC Technical Guideline II that must be considered in regional guidelines. The following precisions address specific requirements of individual crops not covered by Guideline II. They apply to all vegetable crops and are not repeated in the crop specific tables given in the appendix of this document.

#### 2.1 Biodiversity and ecological infrastructures

The ecological farm infrastructures (= ecological compensation areas) have to cover at least 5% of the *entire farm surface* excluding forests. In areas with predominantly small farms, with highly scattered properties, and where a surface of 5% or more of a common and homogeneous agro-climatic unit (e.g. municipal district) has been set aside as ecological compensation area by official and well documented regional programs, the 5% rule has not necessarily to be applied to the individual farm.

Existing ecological infrastructures on the farms must be preserved. Headland attractants (flowering field margins) should be established as reservoirs of pest antagonists. Regional organisations must establish lists of plants to be avoided (e.g. sources of infestations of major diseases, viruses etc). 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.

The **lateral** dimension of an individual field should not exceed 100 m. Otherwise, fields should be divided by annual or permanent vegetation strips of at least 1m width to provide ecological reservoirs and to secure connectivity with adjacent ecological infrastructures.

Regional guidelines have to provide a list of possible options for the active enhancement of biological diversity. At least 2 of these ecological options have to be chosen and implemented by each member.

#### 2.2 Planting/cultivation site

Only fields suitable for a sustainable production of the respective crop must be chosen. Every field must be physically identifiable, and a unique code, name, number or colour must be used on all records that refer to that area.

Crops must not be grown on fields without adequate buffer zones adjacent to sensitive and/or problem areas (e.g. surface water and springs; highways; waste dumps; infested crops, hibernation areas of pests and diseases).

For new cultivation sites there must be a documented food safety, operator health and environment risk assessment that takes into account prior use of land, type of soil, erosion potential, quality and level of ground water, availability of sustainable water sources, and impact on and of the adjacent area. When the assessment identifies a non-controllable risk that is critical to health and/or the environment, the site must not be used for the production of vegetables. There should be a corrective action plan, setting out the measures to minimise all identified (and controllable) risks in new agricultural sites

### **2.3 Crop rotation**

Crop rotation is mandatory. Systems must be chosen to avoid problems with soil born pathogens and pests, to maintain soil fertility and structure. With respect to the specific time intervals between individual crops or crop cycles we refer to the crop specific tables.

### **2.4 Choice of cultivars and seed. Use of Genetically Modified Organisms (GMO)**

Cultivars must be selected that provide a good general health status of the produce and are - if available and commercially acceptable - resistant/tolerant against major diseases and pests. The cultivars chosen should meet the specified requirements of the market (i.e. quality standards including taste, visual appearance, shelf life, agronomic performance and minimum dependence on agrochemicals).

All propagation material must be inspected by the grower to be free of pests and diseases. Infested material must not be used. Purchased material should be accompanied by a plant health or quality certificate.

A seed record/certificate of the seed quality, variety purity, variety name, batch no. and seed vendor must be kept available.

Fields with crops for seed production can be excluded from IP programs if the specific requirements of seed production deviate significantly from IP rules. However, their crop specific characteristics must to be taken into account in the crop rotation. It is strongly recommended that plant health quality control systems be operational for private or in-house nursery propagation.

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 and the use of GMOs in IOBC endorsed IP programs may be only be permitted if the consequences of their use are not violating IP principles defined by IOBC.

### **2.5 Irrigation**

All measures must be taken to minimise water loss and to optimise product quality.

Irrigation is only justified if the available water does not satisfy the requirements of the crops concerned. The calculated water amount must not exceed field capacity. Irrigation scheduling systems should be used where available. The regional organisation has to provide to the farmers the specific information concerning the requirements of the different crops, soil types and climatic conditions, making utmost use of available information systems.

An irrigation plan has to be established individually for each plot. The amount of applied water has to be recorded in the farm records.

Irrigation water must be of adequate quality and must not contain polluting elements exceeding the official tolerance levels and pathogens

Irrigation water should be obtained from sustainable sources (i.e. sources that supply enough water under normal conditions).

The use of untreated sewage water for irrigation/fertigation is prohibited. Where treated sewage water is used, water quality must comply with the WHO-Guidelines 1989 on “Safe Use of Wastewater and Excreta in Agriculture and Aquaculture”.

## 2.6 Soil Management

Intrinsic soil fertility must be preserved and improved. Cultivation techniques must be appropriate for soil type, cropping, topography, erosion risk and climate in order to sustain and improve soil fertility. According to the IOBC Technical Guideline II soil fertility must be sustained by:

- definition of optimum organic matter content according to the characteristics of the location and its maintenance by appropriate measures;
- optimising bio-physical soil properties to avoid compaction;
- maintaining the longest possible soil protection by crop or non-crop cover;
- the lowest possible soil disturbance (physical and chemical).

In general chemical soil disinfection in vegetable production must not be applied. Exceptions can be considered for sanitation in severe cases of area-wide importance (e.g. polyphagous nematodes in sandy soils) when preventive measures are not sufficiently effective and presence is demonstrated by adequate analyses. Regional organisations have to define clearly the cases and admitted control measures including the maximum application frequency. In any case total (unselective) soil sterilisation is prohibited (e.g. methyl-bromide and steaming).

Low intensity cultivation is preferred. In regions with leaching and erosion risks, an appropriate soil cover (with adequate N-uptake capacity) must be maintained in periods of longer fallow. In very sloping areas, soil protection can be achieved also with contour cultivation and/or terraces. Where erosion damages are visible, a plan for corrective actions must be established and implemented.

Farm machinery should be chosen in order to reduce soil compaction and to preserve organic matter; to improve the efficiency and effectiveness of mechanical weed control and agrochemical applications; and to reduce fuel consumption.

## 2.7 Nutrient management

The establishment of a fertilization plan for the total farm and individual crop is mandatory to minimise nutrient loss from the system. Off-farm fertilizer input has to compensate the real exportation and unavoidable technical losses and aims at an annual rotational balance.

The regional organisation has to provide the necessary information, adequate tools and regulations. The soil analyses must be carried out at defined intervals (maximum interval of 4 years for the major elements P, K, Mg). The adequate description of the techniques applied (interpretation criteria including the target range of desirable nutrient reserves of P, K and Mg; sampling techniques; analytical procedures) is mandatory. Uptake and demand criteria for major nutrients must be established and this information made available to the members. The chemical content of at least NPK in all inorganic and organic fertilizers used on the farm within the last 12-month period must be known and documented.

Other nutrient sources such as importation through polluted air (N), animal feed and mineralisation potential of organic soil components have to be taken into account.

Nitrogen needs particular care because nitrogen leaching and evaporation have significant environmental consequences. N supply and timing must be matched to meet crop demand. The nitrogen fertilization of the specific crops must be established on the basis of soil analyses (e.g. Nmin systems) or plant analyses. Regional organisations have to define for each crop cycle the **maximum nitrogen input** (expressed in kg N/ha/crop cycle). Wherever feasible, the splitting modus should be defined for each crop. Mere references to official recommendations are not acceptable.

Phosphorus and Potassium: Exceptional excess input (up to 10%) over the amount indicated by the soil analyses must be justified.

Organic manures or compost can help to improve soil fertility by increasing organic matter content, improving nutrient and water retention, and reducing erosion. They must only contain the technically possible lowest load of heavy metals and other toxicants but have to meet at least the legal regulations. Accounting for organic N sources over a period of 3 years is requested.

Untreated Human Sewage Sludge must not be applied to farmland. Any use of **treated** Human Sewage Sludge on land destined for agricultural use must be in accordance with updated versions and internationally applied “Codes of Practice for the agricultural use of Sewage Sludge”. Existing “Codes of Practice for the Control of Microbial Hazards” give further guidance.

Organisations must establish lists of measures to reduce technically unavoidable nutrient losses (see also chapter 2.6). Manures and fertilizers must not be applied to logged or frozen soil, or steep slopes where there is a risk of run-off. Slurry must not be applied within 10 m of a watercourse or 50 m from a well, spring or borehole that supplies water for human consumption or for use in farm dairies.

Application machinery must be kept in good condition. Regular servicing and an annual verification of calibration (quantity per time and per area) must be carried out by the qualified farmer or a specialised organisation.

Storage: Storage conditions and safety precautions for fertilizers must fulfil the basic requirements of Good Agricultural Practice (GAP). Inorganic and organic fertilizers must not be stored with fresh produce and plant propagation material. Fertilizers should not be stored with pesticides.

## 2.8 Integrated Crop Protection

***Preventive (indirect) measures and observations in the field on the pest, disease and weed status must have been considered before intervention with direct plant protection measures takes place.***

For further details on plant protection strategies we refer to the IOBC Technical Guideline II (2004) and its Appendices 4 and 5, respectively,

### **Prevention (= indirect plant protection)**

The prevention and/or suppression of key pests and diseases should be supported among other options especially by the

- choice of appropriate resistant/tolerant cultivars;
- use of an optimum crop rotation;
- use of adequate cultivation techniques (e.g. stale/false seedbed technique, sowing dates, sowing densities, undersowing .....);
- use of optimum fertilization (especially nitrogen) and irrigation practices;
- utilisation of ecological infrastructures inside and outside production sites to enhance a supportive conservation biological control of key pests by antagonists.

Each regional IP-organisation must establish for each crop a regularly updated list of:

- key pests, key diseases and key weeds that require regular protection measures in the region concerned;
- the most important known antagonist(s) of the key pests with supportive importance in each crop. Their protection and augmentation must be mentioned as an important objective in sustainable production systems;
- preventive and highly selective direct control measures to be used in the IP program (see “green lists” below)

### **Risk assessment and monitoring**

Pests, diseases and weeds must be monitored with adequate methods and tools to determine whether and when to apply direct control measures. Soil or plant (previous crop) analyses for the occurrence of nematodes should be carried out.

The official forecasts of pest and/or disease risks – where available - must be taken into consideration and greatest possible use must be made;

Differences in varietal susceptibility - where known - must to be taken into account;

For pests, diseases and weeds, officially established threshold levels defined for the region – where available - must be considered before treatments and respected.

### **Direct plant protection methods**

Choice of methods: Where indirect plant protection measures are not sufficient to solve the problem and the forecasting operations and threshold values indicate a necessity of intervention with direct plant protection measures, priority must be given to measures with minimum impact on human health, non-target organisms and the environment. Biological, biotechnical\* and physical methods must be preferred to chemical methods if they provide satisfactory control.

(\*Biotechnical control methods are defined in applied entomology as highly specific procedures that influence the behaviour or development of pests without direct biocidal activity, such as mating disruption, selective attractants and traps, deterrents, sterile insect technique).

All agrochemicals used must fulfil the basic requirements of GAP as detailed in the IOBC Technical Guideline II. All crop protection products applied must be officially registered or permitted by the appropriate governmental organisation in the country of application and final destination of produce. Where no official registration scheme exists reference is made to the FAO Code of Conduct on the Distribution and Use of Pesticides.

The crop protection product applied must be appropriate for the target as recommended on the product label or for officially approved off-label uses.

The choice of pesticides in sustainable production schemes and their classification into „permitted“, „permitted with restrictions“ and „not permitted“ categories must consider:

- Their toxicity to man
- Toxicity to key natural enemies
- Toxicity to other natural organisms
- Pollution potential for the environment (soil, water, air)
- Ability to stimulate pests and diseases
- Selectivity
- Persistence
- Potential to develop resistance in target
- Incomplete or missing information
- Necessity of use.

Regularly updated data on the eco-toxicological profiles of pesticides are compiled and published by IOBC and must be taken into account.

Weed management should be achieved, as far as possible, by non-chemical methods.

In general chemical soil disinfection in vegetable production must not be applied. Exceptions can be considered in severe cases of area-wide importance (see chapter 2.6).

Where the risk of resistance against a plant protection measure is known and where the level of pests, diseases or weeds requires repeated application of plant protection products in the crops, the regional organisations have to provide clear recommendations or mandatory requests for an anti-resistance strategy to maintain the effectiveness of the products.

## Establishing “green” and “yellow lists” :

Available indirect and highly selective direct plant protection measures (such as biological and biotechnical methods) must be compiled by IOBC endorsed regional organisation in a “**green list**”. These lists are established according to the IOBC Technical Guideline II (Appendix 5) and models given in the “IOBC Tool Box” of the IOBC Commission ([http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html)).

A critically selected group of plant protection measures that do not qualify for the “green list” but should be available to the grower despite certain negative aspects (especially for reasons of resistance management or earmarked for exceptionally difficult cases) must be compiled by IOBC endorsed regional organisations in a “**yellow list**”. These listed measures are only permitted to be used for precisely identified indications and with clearly defined restrictions. The specifics of “yellow” lists are explained in IOBC Technical Guideline II (Appendix 5).

### **Application and recording of pesticides**

There must be documented evidence on the application according to label instructions and that the application has been accurately calculated, prepared and recorded. Label doses are, however, maximum doses approved by the registration authorities. Reduced dosages are possible (especially in herbicides) if applied on the user's own risk (declined liability of companies) and if resistance management criteria (especially fungicides) do not impose the full dosage.

The official pre-harvest intervals must be followed and should, if possible, be extended to minimise pesticide residues. They must be recorded for all crop protection product applications made and evidence provided that they have been observed. In situations with continuous harvesting, systems must be in place in the field to ensure fail-safe compliance (e.g. warning signs).

## **2.9 Efficient and safe storage, handling and application of pesticides**

The basic requirements of Good Agricultural Practice (GAP) with respect to storage, safe handling and disposal of pesticides and to the operation and maintenance of spray equipments must be fulfilled. They are listed in IOBC Technical Guideline II and must be outlined in detail in IOBC endorsed regional IP guidelines.

The following selected list of mandatory requests include some of the general aspects and address the specific situation in vegetable production as follows:

**Storage:** The regulations on storage are numerous and contain in certain GAP standards close to 20 “must” items. Pesticides must be stored in accordance to local regulations, in a locked room and separated from other materials. Keys and access to the pesticide store must be limited to workers with formal training in the handling of pesticides. Pesticides must only be stored in their original package. Only pesticides that are approved for use on the crops must be stored in the same room; crop protection products used for purposes other than application on crops according to IOBC endorsed IP programs must be clearly identified and stored separated from “green” and “yellow list” products.

**Safety and Handling:** There must be adequate facilities for measuring, mixing and filling the products. Adequate emergency facilities must be provided to deal with potential operator contamination, such as running water, eyewash facilities, first aid box and emergency procedures. The emergency plan must include a list of emergency telephone numbers and the location of the nearest telephone. Operators must have appropriate protective clothing and equipment for all operations involving chemicals.

**Application and Training:** The use of best application techniques available to minimize drift and loss is highly recommended. All sprayer operators must have appropriate training and hold, where relevant, the appropriate certificate of competence. Operators on training for the certificate of competence must be supervised during pesticide application by a certificate holder and must be within sight and sound of the supervisor.

Maintenance of equipment: The equipment must be kept in good state of repair. The equipment has to be verified annually by a competent person for correct operation and calibration. A regular and thorough technical service of the equipment (especially manometers and nozzles) must be carried by an authorised service at least every 4 years.

Disposal of surplus mix, obsolete pesticides and empty containers: Under normal circumstances surplus spray mix should not occur. However, if surplus should occur, disposal must comply with local regulations. Surplus application mix or tank washings must be either disposed of by a registered waste contractor or sprayed onto a designated untreated part of the crop. When surplus mix or tank washings are applied onto designated fallow land, it must be demonstrated that this is legal practice and there is no risk of surface water contamination.

The safe disposal of redundant pesticides must be planned and recorded, and obsolete pesticides must only be disposed of through an approved chemical waste contractor. Empty pesticide containers must be rinsed with water three times and the rinsate returned to the spray tank. Empty containers must not be re-used and are crushed or perforated to prevent re-use.

## **2.10 Harvest, Post-harvest Management and Storage**

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. Some selected “must” items are listed below.

### Hygiene:

All staff must be aware of the need to harvest, transport, store and pack produce with the utmost care having received basic training in personal hygiene requirements for handling of fresh produce.

A documented and up-dated risk assessment covering hygiene aspects of the harvest process and of produce handling operations must be made and hygiene procedures be implemented.

Workers must be provided with clean fixed or mobile toilet facilities at all permanent sites and in vicinity of fieldwork.

Staff must have access to clean hand washing facilities in the vicinity of their work.

### Post-harvest washing and treatments:

The water used for final produce washing must have drinking water quality and recycled water must be filtered. In adequate intervals a water analysis must be carried out by an accredited laboratory at the point of entry into the washing machinery. The levels of the parameters analysed must be within accepted WHO thresholds or must be accepted as safe for the food industry by the competent authorities.

Chemical post-harvest treatments must not be applied to fresh produce for immediate consumption. If there is no alternative to ensure maintenance of good quality of produce destined for longer storage, a selected list of permitted treatments must be established and those eliminated that are in contradiction to the requirements of human health, sustainable production practices and consumers’ expectations on natural food. The record of each treatment must include the justification for the application.

## **2.11 Workers’ health, safety and welfare**

The aspects of the workers’ health, safety and welfare are detailed in IOBC Technical Guideline I and in the “Admission Criteria for Organisations seeking IOBC Endorsement”, respectively.

## **3. Inspection procedures and guideline structure**

National/regional IP-organisations applying for endorsement by the IOBC Commission on „IP-Guidelines and Endorsement“ have to organise and operate their inspection and certification systems according to the standards defined in the Technical IOBC Guideline I and its Appendices 2 and 3 (3rd edition 2004). With respect to the establishment of flexible national and regional guidelines, we refer to the recommendations given in Appendix 1 of the Technical Guideline I and in the “IOBC Tool Box” published by the IOBC Commission on internet [http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html).

**4. Selected literature** (available in full text on internet [http://www.iobc-wprs.org/ip\\_ipm/index.html](http://www.iobc-wprs.org/ip_ipm/index.html).)

Boller, E.F.; Avilla, J.; Gendrier, J.P.; Jörg E.; Malavolta C. 1998. Integrated Production in Europe: 20 years after the declaration of Ovrannaz. IOBC/WPRS Bulletin 21(1), 1998.

Boller, E.F.; Avilla, J.; Jörg E.; Malavolta C., Wijnands, F. & Esbjerg, P. 2004. Integrated Production: Principles and technical Guidelines. 3rd edition. IOBC/WPRS Bulletin 27 (2), 2004.

## **5. Appendices**

### **Crop specific tables for**

- Carrots, Fennel, Celery, Celeriac
- Onions, Echalottes, Garlic
- Leek
- Brassica Crops
- Lettuce, Endive, Scarola, Crisp
- Potatoes
- Tomatoes, Peppers, Eggplants
- Melons, Watermelons, Squash
- Zucchini, Cucumbers
- Spinach, Silver Beets
- Beans, Peas, Green Beans

**BRASSICA (FLOWERHEAD BRASSICAS, HEADCABBAGES, ROOT AND LEAF BRASSICAS)**

| FUNCTION  | RECOMMENDATIONS  | STRICT RULES OR PROHIBITIONS  |
|---|--|---|
| ROTATION  | 1 in 6 minimum (soil pH<7), 1 in 4 (soil pH >7).<br>Cereals could be a good previous crop.   | 1 in 3 years or 1 in 4 crops.<br>Not with sugar beet and/or cruciferous species (including catch crops) in same rotation.   |
| CULTIVARS   | Preference should be given to cultivars with good N-efficiency, tolerance/resistance for diseases (e.g. Ring Spot, <i>Alternaria</i> ) and pests.            |   |
| CULTIVATION   |  | Site restrictions: Avoid plots with <i>Plasmodiophora</i> problems as long as inoculum is detectable (or 12 years) or increase slowly pH or use tolerant varieties. Avoid vicinity of winter oil seed rape or wintercultivations of cauliflower or Brussels sprouts (overwintering sites of important <i>Brassica</i> pests). |
| NUTRIENT MANAGEMENT   | Crops or catch crops for surplus N removal (e.g. <i>Phacelia</i> , grass) should be grown after <i>Brassica</i> .  | N-content of crop residues must be taken into consideration in the following crop. Splitting of N in crops with growth periods over 12 weeks or > 60 kg applied. Crop specific validated N advice systems are mandatory when available.   |
| CROP PROTECTION<br>- PESTS<br><br><br>- DISEASES<br><br><br>- WEEDS | <u>Cabbage root fly</u> : Use of physical crop covers (nets) is recommended in small scale production. Seed coating is the preferred measure.                | No soil treatments with insecticides must be applied in the field except for placed band or spot applications.  |
|   | <u>Aphids</u> : Antagonist action should be taken into account.  | Selective insecticides must be applied according to thresholds.   |
|   | <u>Lepidopteran pests</u> : Antagonist action should be taken into account.  | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory.   |
|   | <u>Flea Beetles</u> : Use of physical crop covers (nets) is recommended in small scale production. <u>Nematodes</u> : Adequate crop rotation or catch crops. |   |
|   | Seeds should be tested for sanitary aspects.<br><u>Ring spot</u> ( <i>Mycosphaerella</i> ):  | Validated forecasting models must be used where available.<br>Disease free transplants mandatory.   |
|   | <u>Alternaria</u> :  | Disease free transplants mandatory.   |
|   | <u>Bacterial diseases</u> ( e.g. <i>Pseudomonas</i> ): hot water treatment of seeds preferred.   |   |
| HABITAT MANAGEMENT  | Undersowing experimentation is encouraged. Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).             |   |
| HYGIENE, HARVEST  | Quick incorporation of residues is recommended.  | Recycling of plant material (e.g. head cabbage) must not be done on potential <i>Brassica</i> fields.   |

### CARROTS, FENNEL, CELERY & CELERIAC

| FUNCTION                   | PREFERRED OPTIONS  | STRICT RULE OR PROHIBITION  |
|----------------------------|--|---|
| ROTATION                   | <p>1 in 6 crop cycles should be observed (depending on soil type).</p> <p>Carrots should not be grown after crops generating high N surplus (e.g. potatoes, cabbage).</p> <p>Nematodes: Previous crops should not promote nematode problems.</p>                                   | <p>1 in 4 crop cycles if no nematode problems.</p> <p>1 in 4 years where (<i>Meloidogyne</i> spp) problems exist.</p> <p>In case of black spot diseases (<i>alternaria radicina</i>, <i>phytium</i> species) at least 1 to 6.</p>   |
| CULTIVARS                  | <p>Less susceptible cultivars should be chosen for <i>Alternaria</i>, powdery mildew (carrots, celery) and <i>Septoria</i> (celery). Seed treatments against diseases are recommended.</p>   | <p>Seed quality must be certified. Use of healthy transplants is mandatory.</p>   |
| CULTIVATION                | <p>Proper site choice ( e.g. wind exposure is desirable, avoidance of lee influence of hedges and forests ). Ridge cultivation system (carrots) is recommended when proper drainage is a problem.</p>  |   |
| NUTRIENT MANAGEMENT        | <p>Avoid application of organic manures before carrots and application of N less than 1 month before harvest.</p>  | <p>Crop specific validated N advice systems are mandatory when available.</p>   |
| CROP PROTECTION<br>- PESTS | <p><u><i>Psila rosae</i></u>: Monitoring with traps is recommended during the entire growth season. Late seeding for the second crop cycle is recommended in order to prevent infestation.</p> <p>Use of physical crop covers (nets) is recommended in small scale production.</p> | <p>Existing and validated forecasting systems must be applied. Populations must be monitored in every production unit with traps and records taken at least in the first generation. The latest treatment 4 weeks before anticipated harvest must be observed.</p> <p>No soil treatments with insecticides must be applied in the field except for localised band or spot applications.</p> |
|                            | <p><u>Leaf miners</u>: Take into account presence of antagonists (especially against <i>Liriomyza</i> spp.). Treatments only in early larval stages to reduce pesticides.</p>  |   |
|                            | <p><u>Psyllids</u>:</p>  | <p>Treatments must be applied only after field inspections (after first occurrence).</p>  |
|                            | <p><u>Aphids</u>: Virus transmission should be reduced by proper site choice and avoidance of crop residues.</p>   |   |
|                            | <p><u>Cutworms and other lepidopterans</u>: Populations should be monitored (e.g. sex pheromone traps and visual inspection) and forecasting models should be taken into account.</p>  |   |
|                            | <p><u>Agriotes</u> spp. (wireworms, especially carrots, celeriac): should be monitored (e.g. sex pheromone or bait traps).</p>   |   |
|                            | <p><u>Nematodes</u>: Previous crops should not promote nematode problems<br/><u>Take population samples when problems are expected.</u></p>  |   |

|                     |   |   |
|---------------------|---|---|
| - DISEASES          | <p><u>Alternaria</u> and other leaf diseases: Dense cropping should be avoided (e.g. by wider distances in or between the rows). Existing and validated forecasting models should be applied.</p>   |   |
|                     | <p><u>Sclerotinia</u> and other soil borne diseases: Dense cropping and excessive N should be avoided (e.g. by wider distances in or between the rows). Take care of proper drainage. Good soil structure and balanced irrigation should be adopted as important elements to prevent soil born diseases (e.g. <i>Pythium</i> or <i>Sclerotinia</i>).</p> <p>Use of antagonists for control (<i>Coniothyrium minitans</i>) where available</p> |   |
|                     | <p><u>Storage diseases</u> should be managed by regulation of hygienic aspects (harvest, handling and storage condition)</p> <p><u>Bacteria</u>: Dense cropping and excessive N should be avoided (e.g. by wider distances in or between the rows). Take care of proper drainage.</p>   |   |
| -WEEDS              | <p><u>Virus</u>: see aphid control for all umbellifera crops.</p> <p>Specifically for celery: Celery Mosaic Virus (CeMV) requires the largest possible intervals (see also HABITAT MANAGEMENT).</p> <p>Preferred options are: mechanical weeding between rows, band treatments, (false/stale seed beds). Low dose system (Linuron)</p>  |   |
| HABITAT MANAGE-MENT | <p>High structure infrastructures (Hedges, trees etc) should be avoided in the vicinity (favouring populations of <i>P. rosae</i>). Avoid salix (host of <i>Cavariella aegopodii</i>). In case of presence of CeMV the elimination of spontaneous umbellifera species is necessary.</p>   |   |
| HYGIENE, HARVEST    |   | <p>No carrot dumps (residues) in the field where disease or soil-borne problems exist (inoculum risk). Destroy infected material or incorporate in field of origin.</p> |

**LEEK**

| <b>FUNCTION</b>            | <b>PREFERRED OPTIONS</b>  | <b>STRICT RULE OR PROHIBITION</b>   |
|----------------------------|---|---|
| ROTATION                   | 1 in 4 recommended. The potential risk of thrips immigration from adjacent arable rotation members (e.g. cereals, alliaceae) should be taken into account.  | 1 in 3 (or 2 leeks in 6 avoiding replanting).   |
| CULTIVARS                  | Local recommendations on choice should be established. Preference should be given to cultivars with tolerance/resistance for diseases and high N-efficiency.  |   |
| CULTIVATION                | Site history : <i>Fusarium</i> infested plots should be avoided.<br>Overlapping production cycles favouring a continuous infestation by diseases and pest should be avoided.                                      | Transplants must be inspected for health before planting.   |
| NUTRIENT MANAGEMENT        | Placed (band) applications are recommended.   | Crop specific validated N advice systems are mandatory when available.<br>Split application of N is mandatory.  |
| CROP PROTECTION<br>- PESTS | <u>Thrips</u> : Intercropping and undersowing is encouraged. Possible immigration from adjacent onion fields should be considered.  | Resistance management where resistance develops must be established by appropriate rotation of active ingredients with the same mode of action..          |
|                            | <u>Cutworms</u> : Populations should be monitored (e.g. sex pheromone traps and visual inspection) and forecasting models should be taken into account. Irrigation is recommended when early larval stages occur. |   |
|                            | <u>Leek moth</u> : Flight periods should be monitored by sex pheromone traps and sprays applied according to thresholds.  |   |
|                            | <u>Alternaria</u> : Existing and validated forecasting models should be applied.<br><u>Phytophthora</u> : Inoculum reduction by straw cover Avoid plots with known infection.                                     |   |
| - DISEASES                 |   |   |
| -WEEDS                     | With late cultivations also low dose herbicide application in combination with mechanical control is possible.  | Good mechanical weeding is possible and must receive priority.  |
| HABITAT MANAGEMENT         | Intercropping and undersowing is encouraged. Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).  | No negative influence of ecological infrastructures (e.g. hedges, flowering stripes) is to be expected.   |
| HYGIENE HARVEST            |   | Recycling of plant material must not be carried out on potential leeks fields.<br>Destroy or compost infected material or incorporate in field of origin. |

**LETTUCE, ENDIVE, SCAROLA & CRISP (excluding WITLOOF)**

| <b>FUNCTION</b>   | <b>PREFERRED OPTIONS</b>  | <b>STRICT RULE OR PROHIBITION</b>  |
|---|---|--|
| ROTATION  |   | 1 year (2 or 3 cycles) in 3 years or 1 crop cycle in 3 crop cycles.  |
| CULTIVARS   | Preference should given to cultivars with resistance/tolerance against <i>Bremia</i> and <i>Nasonovia</i> .   |  |
| CULTIVATION   | Shallow planting to avoid bottom rot is recommended. Disposable (one way) mulch materials for weed suppression and accelerating growth should be biodegradable.   |  |
| NUTRIENT MANAGEMENT   |   | Split N-application is mandatory. Stop N application 12 days preharvest (spring and summer), 20 day in winter.<br>Crop specific validated N advice systems are mandatory when available. |
| CROP PROTECTION<br>- PESTS<br><br><br><br><br>- DISEASES<br><br><br><br>- WEEDS | <u>Aphids</u> : When using resistant varieties to <i>Nasonovia</i> check presence of other aphid species. Take into account presence of antagonists.  | Selective insecticides, where available, must be applied and application only be based on presence/absence monitoring of wingless forms or available thresholds.                         |
|   | <u>Leaf-miners</u> : Take into account presence of antagonists.   | Leaf-miner-free transplants mandatory.   |
|   | <u>Lepidopterans</u> :  | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory.  |
|   | <u>Thrips</u> :   | Only treatments of summer and autumn cycles are permitted if viroses are problems in the area or if there is visible damage.   |
|   | <u>Slugs</u> : Localised treatments with baits in the border area only.   |  |
|   | <u>Downy mildew</u> : resistant varieties should be used.   | Anti-resistance strategy mandatory.  |
|   | <u>Big Veins</u> (virus transmitted by <i>Ospidium</i> ): In presence of <i>Ospidium</i> rotation intervals should be increased.  |  |
|   | <i>Sclerotinia</i> , <i>Rhizoctonia</i> and <i>Botrytis</i> : ensure good soil drainage or use bank cultivation. Mulching recommended.<br>Use of antagonists for control ( <i>Coniothyrium minitans</i> ) where available.<br>Mulching recommended (see Cultivation). | Disease free transplants mandatory.  |
| HABITAT   | Promote ecological infrastructures (e.g. grass strips, wildflower strips).  | Mechanical weeding must be preferred.  |

## ONIONS , ECHALOTTES & GARLIC

| FUNCTION  | PREFERRED OPTIONS  | STRICT RULE OR PROHIBITION   |
|---|--|--|
| ROTATION  | Immigration of thrips from adjacent alliacea fields to be considered   | 1 in 3 years (onions), 1 in 4 years (garlic and echalottes) to be observed in general, 1 in 8 in case of White Rot problems. |
| CULTIVARS   |  |  |
| CULTIVATION   | Site selection: wind exposed fields are recommended. Regional organisations should establish a concept to avoid overlap at the regional level ( summer and winter crops, overwintering hosts).   |  |
| NUTRIENT MANAGEMENT   | Placed (band) applications of N are recommended where inter-rows permit.   | Split application of N is mandatory. Crop specific validated N advice systems are mandatory when available.                  |
| CROP PROTECTION<br>- PESTS<br><br>- DISEASES<br><br>- WEEDS               | <u>Onion fly</u> : use of sterile male technique where possible otherwise seed treatments.   | No soil treatments with insecticides must be applied in the field.   |
|   | <u>Thrips</u> : Treatments should only be made in the first half of the growing period and after field inspections. Immigration of thrips from adjacent alliacea fields to be considered.  | Resistance management by appropriate rotation of active ingredients must be established.                                     |
|   | <u>Nematodes</u> : Good soil structure and healthy bulbs should be used..  | Use only certified bulbs (nematode and virus free) in garlic and echalottes production.                                      |
|   | <u>Downy mildew</u> : Minimum distances between set and seed onions should be defined. The use of validated forecasting models should be taken into consideration.<br>Warm water treatment of (infected) planting material (bulbs) might be considered.<br><u>Sclerotium spp.</u> (White Rot) and <u>Fusarium spp</u> : Plant material should be inspected for absence of infestation (see also crop rotation). Bulbs in garlic and echalottes should be dry-treated with specific fungicides before planting. Soil drainage recommended where necessary.<br><u>Storage diseases</u> (e.g. <u>Botrytis spp</u> ): prompt and appropriate drying after harvest and avoid excessive humidity during storage. |  |
| Stale seed beds should be used. Low dose band treatments are recommended. |  |  |
| HABITAT MANAGEMENT  | Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wild-flower strips).   |  |
| HYGIENE HARVEST   | Reduce dumps in the field where disease or soil-borne problems exist (inoculum risk). Dry crop after harvest in field or shelter before storage. Destroy infected material.  |  |

**POTATOES (excluding seed production)**

| <b>FUNCTION</b>            | <b>PREFERRED OPTIONS</b>   | <b>STRICT RULE OR PROHIBITION</b>   |
|----------------------------|--|---|
| ROTATION                   | 1 in 4 years. Winter cereals are suitable previous crops. Avoid alfalfa as previous crop ( <i>Rhizoctonia</i> risk).   | Potatoes must not to be grown more than 1 in 3 years without nematode problems (avoidance of other Solanaceous crops). In nematode infested fields and in absence of cyst nematode resistant cultivars potatoes must not be grown in less than 1 in 7 years.                  |
| CULTIVARS                  | Cultivar diversity within the farm should be considered. Cultivars with a broad spectrum of resistance to major virus diseases and "field resistance" to late blight should be used.<br><br>In nematode-infested fields, only cultivars with high tolerance to one or more of the nematode species or their dominating pathotypes should be grown. |   |
| CULTIVATION                | Ploughing is the recommended technique of soil cultivation, for "optimal" seed-bed preparation, and weed control.  |   |
| NUTRIENT MANAGEMENT        | Plant analysis for nitrogen input (in addition to Nmin-analysis) is recommended.   | Crop specific validated N advice systems are mandatory when available Nitrogen supply pre-planting must not exceed 75% of the total supply in northern conditions, 50% in southern conditions, respectively. In sub-arctic regions, all nitrogen can be applied pre-planting. |
| CROP PROTECTION<br>- PESTS | <u>Aphids</u> : Straw mulch to reduce aphid infestation is recommended.  | Available selective aphicides must be used and applied according to national/regional recommendations.  |
|                            | <u>Colorado Beetle</u> : Selective methods (e.g. <i>B. thuringiensis tenebrionis</i> or IGRs) should be preferred. Use of forecasting models where available.  | Insecticides against Colorado Beetle (where established) must be used only according to threshold levels.   |
|                            | <u>Agriotes</u> spp. (wireworms): should be monitored (e.g. sex pheromone or bait traps).  | Soil insecticides applied as placed (band) treatments.  |
|                            | <u>Cutworms</u> : Irrigation in years with early droughts is recommended.  |   |
|                            | <u>Nematodes</u> : In nematode-infested fields, only cultivars with high tolerance to one or more of the nematode species or their dominating pathotypes should be grown.  | No nematicides are allowed.   |
|                            | <u>Slug</u> baits should only be used in exceptional cases.  |   |

|                                  |  |  |
|----------------------------------|--|--|
| <p>- DISEASES</p> <p>- WEEDS</p> | <p>For Late Blight the use of resistant/tolerant cultivars with low susceptibility is the most appropriate preventive measure. Highly susceptible cultivars should not be grown.</p> <p>Copper should not be used.</p> | <p>Fungicide treatments must be based on forecasting models if available. Copper input must be minimised.</p> <p>For <i>Rhizoctonia</i>, seed treatment is permitted only if threshold levels for tubers with sclerotia are exceeded.</p> <p>Priority must be given to mechanical weed control. Pre-emergence herbicides are not permitted. Post-emergence herbicides are only permitted in exceptional and clearly defined circumstances.</p> |
| <p>Destruction of foliage</p>    | <p>Preference for mechanical canopy removal.</p>   |  |
| <p>HABITAT MANAGEMENT</p>        | <p>Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).</p>   |  |
| <p>HYGIENE HARVEST</p>           |  | <p>Potato dumps must be destroyed.</p>   |

**TOMATO (processing)**

| <b>FUNCTION</b>   | <b>RECOMMENDATIONS</b>  | <b>STRICT RULES OR PROHIBITIONS</b>  |
|---|---|--|
| ROTATION  | 1 in 3 years; avoid solanaceous crops in the interval.  | 2 in 4 without replanting , 2 in 5 with replanting .   |
| CULTIVARS   | High tolerance to nematodes, viruses, bacteria, fungi.  |  |
| CULTIVATION   | Drip irrigation is recommended. Mulching materials for weed suppression should be biodegradable.        | Use of healthy transplants is mandatory.   |
| NUTRIENT MANAGEMENT   | Fertigation is recommend to reduce nutrient input.  | Splitting of N applications if > 60 kg applied. Crop specific validated N advice systems are mandatory when available.   |
| CROP PROTECTION<br>- PESTS<br><br><br><br>- DISEASES<br><br><br>- WEEDS | <u>Aphids</u> : Monitoring and thresholds should be applied. Antagonists should be enhanced.            |  |
|   | <u>Agriotes</u> spp. (wireworms): should be monitored (e.g. sex pheromone or bait traps).               | Soil insecticides only applied as placed (band) treatments.  |
|   | <u>Lepidopterans</u> : Monitoring for eggs and first larval stages is recommended.                      | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory.  |
|   | <u>Spider mites</u> : Treatments should only be carried out against early infestations.                 |  |
|   | <u>Thrips</u> :<br><u>Downy mildew</u> : Forecasting models where existing                              | Treatments are permitted only if viroses are problems in the area.   |
|   | <u>Bacteria</u> : Removal and destruction of infested plants. Localised drip irrigation is recommended. | Certified bacteria-free seeds are mandatory.   |
|   | <u>Viroses</u> :<br>False/stale bed technique is recommended.   | Certified virus-free seeds or transplants are mandatory.<br><br>Priority must be given to mechanical weed control. Pre-emergence herbicides are only permitted as band applications. |
| HABITAT MANAGEMENT  | Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).   |  |
| HYGIENE, HARVEST  | Short time lapse between harvest and processing. Adequate transportation procedures.                    | Growth regulators only permitted in early crops to concentrate harvesting time.  |

**TOMATO, PEPPER & EGG PLANTS (fresh)**

| <b>FUNCTION</b>  | <b>RECOMMENDATIONS</b>   | <b>STRICT RULES OR PROHIBITIONS</b>   |
|--|--|---|
| ROTATION   | 1 in 4 crop cycles ; avoid solanaceous crops in the interval.  | 1 in 3 crop cycles. 1 in 2 if grafted material is used.   |
| CULTIVARS  | High tolerance or resistance to nematodes, viruses, bacteria and fungal diseases., specific for the region.  |   |
| CULTIVATION  | Mulch is recommended. Mulching materials for weed suppression should be biodegradable. Drip irrigation is recommended.                                       | Use of healthy transplants.   |
| NUTRIENT MANAGEMENT  | Fertigation is recommend to reduce nutrient input.   | Splitting of N applications if amount applied > 60 kg. Crop specific validated N advice systems are mandatory when available. |
| CROP PROTECTION<br>- PESTS<br><br><br><br><br><br>- DISEASES | <u>Aphids</u> : use of biological control is recommended e.g. antagonists, banker plants.  |   |
|  | <u>Cutworms</u> : Populations should be monitored (e.g. sex pheromone traps and visual inspection) and forecasting models should be taken into account.      | If soil insecticides are necessary then spot applications are mandatory.  |
|  | <u>Other lepidopterans</u> : Monitoring for eggs and first larval stages.  | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory.                                 |
|  | <u>Spider mites</u> : Biological control recommended.  |   |
|  | <u>Leptinotarsa</u> : Selective methods (e.g. <i>B. thuringiensis tenebrionis</i> or IGRs) should be preferred.  |   |
|  | <u>White flies and leaf-miners</u> : Biological control is recommended.  | Treatments are permitted only if virosis transmitted by <i>B. tabaci</i> is a problem in the area.                            |
|  | <u>Thrips</u> : Biological control is recommended.   | Treatments are permitted only if virosis transmitted by <i>F. occidentalis</i> is a problem in the area.                      |
|  | <u>Downy mildew and Botrytis</u> : Improve ventilation in protected cultivation systems.   |   |
|  | <u>Bacteria</u> : removal and destruction of infested plants. Localised drip irrigation is recommended. Improve ventilation in protected cultivation systems | Certified bacteria-free seeds are mandatory.  |
|  | <u>Soil borne diseases</u> : Grafting on resistant rootstock (egg-plant and tomato).   |   |
| - WEEDS  | <u>Viroses</u> : removal and destruction of infested plants Certified virus-free transplants.  | Certified virus-free seeds are mandatory.   |
|  | Mulch  | Priority must be given to mechanical weed control.  |
| HABITAT MANAGEMENT   | Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).  |   |

## MELON, WATERMELON & SQUASH

| FUNCTION  | RECOMMENDATIONS   | STRICT RULES OR PROHIBITIONS   |
|---|---|--|
| ROTATION  | 1 in 4 years; avoid cucurbitaceous crops in the interval.   | 1 in 3 years.<br>In protected melon 2 in 4 if grafted resistant material is used.                                      |
| CULTIVARS   | High tolerance to aphids, viruses, bacteria, fungi.   |  |
| CULTIVATION   | Mulch is recommended. Mulching materials for weed suppression should be biodegradable.<br>Drip irrigation recommended.  | Use of healthy transplants (melon, watermelon).  |
| NUTRIENT MANAGEMENT   | Fertigation recommend to reduce nutrient input.   | Splitting of N applications if > 60 kg applied. Crop specific validated N advice systems are mandatory when available. |
| CROP PROTECTION<br>- PESTS<br><br><br><br><br><br><br>- DISEASES<br><br><br><br><br><br><br>- WEEDS | <u>Aphids</u> : <i>Aphis gossypii</i> . use of biological control is recommended e.g. antagonists, banker plants in protected crops.                          |  |
|   | <u>Agriotes</u> spp. (wireworms): should be monitored (e.g. sex pheromone or bait traps)(squash excluded).  | Soil insecticides only applied as placed (band) treatments.  |
|   | <u>Spider mites</u> : Biological control recommended.   |  |
|   | <u>White flies</u> : Biological control is recommended.   | Treatments are permitted only if virosis transmitted by <i>B. tabaci</i> is a problem in the area.                     |
|   | <u>Thrips</u> : Biological control is recommended.  |  |
|   | <u>Downy mildew</u> : Improve ventilation in protected cultivation systems.   |  |
|   | <u>Powdery mildew</u> : Tolerant and resistant varieties. Take into account the development of new resistant mildew strains.                                  |  |
|   | <u>Bacteria</u> : removal and destruction of infested plants. Localised drip irrigation is recommended. Improve ventilation in protected cultivation systems. | Certified bacteria-free seeds for <i>Pseudomonas</i> spp. and <i>Erwinia</i> spp. are mandatory.                       |
|   | <u>Soil borne diseases</u> : Grafting on resistant rootstock (melon, watermelon).   |  |
|   | <u>Viroses</u> : removal and destruction of infested plants. Certified virus-free transplants.  |  |
| Mulch. Priority should be given to mechanical weed control.   |   |  |
| HABITAT MANAGEMENT  | Ecological infrastructures enhancing pest antagonists (e.g. leguminosae, grass strips, wildflower strips) should be promoted.                                 |  |

**CHENOPODIA (SPINACH, SILVER BEET)**

| <b>FUNCTION</b>   | <b>PREFERRED OPTIONS</b>  | <b>STRICT RULE OR PROHIBITION</b>   |
|---|---|---|
| ROTATION  | 1 year (1 or 2 cycles) in 4 years or 1 crop cycle in 4 crop cycles.   | 1 year (1 or 2 cycles) in 3 years or 1 crop cycle in 3 crop cycles. (Admitted alternative only for processing produce: 1 crop cycle with 1 winter cereal as interval maximum 2 years). No chenopodia in the interval. |
| CULTIVARS   | Preference should given to cultivars with resistance/tolerance against <i>Peronospora</i> .   | Certified and treated seeds against major diseases.   |
| CULTIVATION   |   |   |
| NUTRIENT MANAGEMENT   |   | Split N-application is mandatory if input is >60 kg. Stop N application 20 days preharvest  |
| CROP PROTECTION<br>- PESTS<br><br><br><br><br><br>- DISEASES<br><br><br>-WEEDS  | <u>Aphids</u> : Take into account presence of antagonists.  | Selective insecticides, where available, must be applied and application only be based on presence/absence monitoring of wingless forms or available thresholds.  |
|   | <u>Leaf-miners and <i>Pegomyia</i> spp.</u> : Take into account presence of antagonists. Treatments only in early larval stages to reduce pesticides.                         |   |
|   | <i>Clonorrhynchus</i> beetle: Localised treatments in the border area only.   |   |
|   | <u>Cutworms and other lepidoptera</u> : Populations should be monitored (e.g. sex pheromone traps and visual inspection) and forecasting models should be taken into account. |   |
|   | <u>Slugs</u> : Localised treatments with baits  |   |
|   | <u>Nematodes</u> : Where nematodes are a problem use catch crops (e.g. <i>Raphanus</i> ) in previous intervals.   |   |
|   | <u>Downy mildew (<i>Peronospora farinosa</i>)</u> : Use resistant varieties.  | Anti-resistance strategy mandatory.   |
|   | <u>Powdery mildew and <i>Cercospora</i></u> : Early monitoring recommended .  |   |
| <u><i>Phoma</i> and <i>Rhizoctonia</i></u> : ensure good soil drainage. Avoid beans as previous crops ( <i>Rhizoctonia</i> ). |   |   |
| HABITAT MANAGEMENT  | Promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).   |   |
| HYGIENE   | Quick incorporation of residues is recommended (especially mildew).   |   |

**BEANS, PEAS & GREEN BEANS (fresh and processing)**

| <b>FUNCTION</b>  | <b>PREFERRED OPTIONS</b>  | <b>STRICT RULE OR PROHIBITION</b>  |
|--|---|--|
| ROTATION   | 1 year (1 or 2 cycles) in 4 years or 1 crop cycle in 4 crop cycles.   | 1 year (1 or 2 cycles) in 3 years or 1 crop cycle in 3 crop cycles. (Admitted alternative only for green beans for processing: 1 crop cycle with 1 winter cereal as interval maximum 2 years). No leguminosae in the interval. |
| CULTIVARS  | Preference should be given to cultivars with resistance/tolerance against Antracnose (for peas <i>Peronospora vicia f. sp. pisi</i> ) and viroses when available.   |  |
| CULTIVATION  |   |  |
| NUTRIENT MANAGEMENT  | Use only low N-input in starters and in situations of compacted soils.<br>Fertirrigation in protected crops is recommended.   |  |
| CROP PROTECTION<br>- PESTS<br><br><br><br><br><br><br><br>- DISEASES | <u>Aphids</u> : Take into account presence of antagonists.  | Selective insecticides, where available, must be applied and application only be based on presence/absence monitoring of wingless forms or available thresholds.   |
|  | <u>Lepidoptera</u> : Populations should be monitored (e.g. sex pheromone traps and visual inspection) and forecasting models should be taken into account.<br>European corn borer (processing beans and green beans): Special attention in autumn crop cycle. | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory.  |
|  | <u>Spider mites</u> : Biological control is recommended in protected crops. Chemical treatments should be permitted only in early crop stage if natural populations of predators are not present.   |  |
|  | <u>White flies</u> : Biological control in protected crops is recommended.  |  |
|  | <u>Downy mildew</u> ( <i>Peronospora pisi</i> ): Early monitoring recommended.  |  |
|  | <u>Powdery mildew</u> (peas): Early monitoring recommended. Treatment only in case of generalised infection.  |  |
|  | <u>Rhizoctonia and Sclerotinia</u> : ensure good soil drainage. Use of treated seeds.   |  |
|  | <u>Antracnose</u> : Use of treated seeds (see CULTIVARS and HYGIENE)  |  |
|  | <u>Bacterial diseases</u> ( <i>Pseudomonas</i> ): removal of infected plants advisable.   | Certified seeds are mandatory.   |
|  | <u>Viroses</u> : BCMV-resistant cultivars.  | Virus-free seeds (BCMV and PSBMV) are mandatory.   |
| -WEEDS   | False/stale seedbed technique recommended.  |  |
| HABITAT MANAGEMENT   | Especially for products for fresh consumption: promote ecological infrastructures enhancing pest antagonists (e.g. grass strips, wildflower strips).  |  |
| HYGIENE HARVEST  | Quick incorporation of residues is recommended (especially antracnose).   |  |

## ZUCCHINI & CUCUMBER

| FUNCTION                   | RECOMMENDATIONS   | STRICT RULES OR PROHIBITIONS   |
|----------------------------|---|--|
| ROTATION                   | 1 in 4 years.<br>Avoid cucurbitaceous crops in the interval.  | 1 in 3 years or 1 in 3 crops.<br>In protected cucumbers 2 in 4 if grafted resistant material is used.          |
| CULTIVARS                  | High tolerance to aphids, viruses, bacteria, fungi.   |  |
| CULTIVATION                | Mulch is recommended. Mulching materials for weed suppression should be biodegradable. Drip irrigation recommended.   | Use of healthy transplants.  |
| NUTRIENT MANAGEMENT        | Fertigation recommend to reduce nutrient input.   | Splitting of N applications if > 60 kg. Crop specific validated N advice systems are mandatory when available. |
| CROP PROTECTION<br>- PESTS | <u>Aphids</u> : Biological control is recommended e.g. antagonists, banker plants.  |  |
|                            | <u>Spider mites</u> : Biological control recommended.   |  |
|                            | <u>White flies</u> : Biological control recommended.  | Treatments are permitted only if virosis transmitted by <i>B. tabaci</i> is a problem in the area.             |
|                            | <u>Thrips</u> : Biological control is recommended)  |  |
|                            | <u>Lepidopterans</u> : Monitoring for eggs and first larval stages.   | Application of selective products (e.g. Bt, IGR) where available and effective, is mandatory                   |
|                            | <u>Nematodes</u> : Avoid susceptible tomato cultivars as previous crops.  |  |
|                            | <u>Downy mildew</u> : Improve ventilation in protected cultivation systems  |  |
|                            | <u>Powdery mildew</u> : Tolerant and resistant varieties. Take into account the development of new resistant mildew strains.                                  |  |
|                            | <u>Bacteria</u> : removal and destruction of infested plants. Localised drip irrigation is recommended. Improve ventilation in protected cultivation systems. | Certified bacteria-free seeds for <i>Pseudomonas</i> spp. and <i>Erwinia</i> spp.                              |
|                            | <u>Soil borne diseases</u> (e.g. <i>Fusarium</i> spp.): Grafting on resistant rootstock (cucumber).   |  |
| - DISEASES                 | <u>Viroses</u> : removal and destruction of infested plants. Certified virus-free transplants.  |  |
|                            | <u>WEEDS</u><br>Mulch.  | Priority must be given to mechanical weed control in open fields.  |
| HABITAT MANAGEMENT         | Ecological infrastructures enhancing pest antagonists (e.g. leguminosae, grass strips, wildflower strips) should be promoted.                                 |  |
| HYGIENE, HARVEST           | Quick removal or incorporation of residues.   |  |