Integrated Plant Production and Protection

Recent Developments in Integrated Production and Protection Management for Greenhouse Crops Cultivation

Wilfried.O. Baudoin
Plant Production and Protection Division, FAO, Rome, Italy

Abstract

The paper gives an overview of the expansion of the greenhouse sector, with specific reference to the Mediterranean region, where greenhouse cultivation has witnessed spectacular development during the last 15 years. Reference is made to the particular interest of greenhouse crop technology in the context of FAO's special program for food security. The intensification of crop rotation under protected agriculture is posing a threat to the environment, through the increased use of pesticides and the disposal of drainage water and waste products. Integrated production and protection management (IPP), is proposed as a strategy to develop an economically viable and sustainable production system which should lead to a substantial reduction in the use of pesticides and the preservation of the environment. Adequate cultivation practices in conjunction with coordinated climate control and use of improved cultivars are essential components of IPP, which includes integrated pest management (IPM). Experiences gained and activities undertaken by the FAO Regional Working Group for Greenhouse Crop Production in the Mediterranean Region are used as an illustration.

Integrated Foliar Disease Management for Greenhouses in Arid, Hot Climates

Mohamed Abdel-Latif Nofal
Plant Pathology Department, National Research Center, Giza, Egypt

Abstract

Integrated foliar disease management (IFDM) is the utilization of all suitable techniques to prevent leaf-disease outbreaks or to reduce leaf-disease spread below economic threshold. In protected agriculture, IFDM comprises: greenhouse sanitation (weed control outside the greenhouse, removal of crop debris, soil sterilization, and washing greenhouse walls with sterilant); physical control (insect-proof screens, sticky traps, environmental regulation—plant nutrition, temperature, irrigation levels, free water, humidity and air circulation—, and location of greenhouse); cultural practices (host-plant resistance/tolerance, crop-rotation, disease-free seed and transplants, sterile growing media, and worker behavior in handling diseased and healthy plants); biological control (antagonists of disease-causing organisms); and, chemical control (limited use of fungicides). The aim is to reduce pesticide use (which contaminates the environment), although fungicide will remain an essential component of IFDM for the foreseeable future. [The full paper reviews 26 diseases affecting four groups of greenhouse crops.]

Integrated Management of Soilborne Pests for Greenhouses in Arid, Hot Climates

James J. Stapleton
Kearney Agricultural Center, University of California, Parlier, USA

Abstract

Soilborne pests (fungi, bacteria, nematodes and weeds) may severely limit production in protected agriculture. Pests may be naturally present in the soil, or may be introduced through air, water, cultural practices, or infected seed or transplants. Integrated pest management (IPM) is being developed to reduce dependency on pesticides. The focus of IPM for protected agriculture should be plant root health. Components of IPM include cultural practices, biological control and physical methods. For arid, hot environments, the use of soil solarization is recommended. It is passive soil-heating, providing effective, low-cost soil disinfestation. Solar energy is captured using clear plastic or glass sheets (permitting 90–98% light transmission) and may raise soil-surface temperature to 75°C (sufficient to kill many fungi, bacteria, nematodes and weeds). The activity combines physical effects (heating) with chemical (hydrothermal breakdown of organic matter) and biological shifts (recolonization of disinfested soil by fast-growing micro-organisms). In hot, arid environments, soil solarization alone should adequately control soilborne pests; however, cool weather, heat-resistant or deeply buried pests may necessitate the use of low doses of pesticide or bioactive organic matter incorporated into the soil, combined with solarization. The use of bioactive organic matter (or biofumigation) requires field-testing to determine appropriate doses. Soil solarization is most useful in greenhouses or containerized soil—in which effective control can be achieved in 1–7 days. Excessive heating must be avoided, otherwise soil organic matter may be decomposed.

Summary of Major Issues Arising and Discussion

The Need for an Integrated Plant Production and Protection Strategy

The increased use of pesticides and the disposal of drainage water and waste products calls for the development of an integrated production and protection management (IPP) program for vegetable production in protected agriculture suitable for the Arabian Peninsula.

The essential components of IPP are similar to those of integrated pest management (IPM) with more emphasis on the production techniques and activities and the management of the greenhouse. These essential components are: (i) coordinated climate control in the greenhouse, (ii) adequate cultivation practices, (iii) the use of improved adapted cultivars, which together will reduce dependency on use of pesticides and provide adequate control of insect pests and diseases which seriously limit crop production in protected environments.

Pesticides and Health Hazards

Public awareness about health hazards which accompany the extensive use of pesticides in many countries around the world is pushing growers to use less and less of these chemicals in vegetable production in general, and in protected agriculture in particular. Growers are everywhere profit driven. In the Arabian Peninsula, at least at present, consumers are not prepared to pay higher prices for 'organic' or 'bio-products.' However, this could change in the near future, and consumers might shift to buying products with labels indicating that ecologically friendly approaches were used in their production. Growers need to be prepared for this market evolution. Encouragingly enough, some markets in the region (e.g. Egypt) are responding positively to organic farming.

It is obvious that there is a public demand to reduce the use of pesticides as much as possible. In the short term, it is unlikely that we can produce crops economically in protected agriculture without using pesticides. A better approach is minimal use of pesticides, with emphasis on those that are selective. Other control strategies need to be used, such as resistant varieties, biological control, and appropriate cultural practices—components of IPM. However, to succeed in adapting IPP approaches, research under local environments is essential to permit the development of IPM packages which will be acceptable to the growers.

In the long term, however, and with heavy investment in research on biological control, biotechnology, soil solarization, etc., we might be able to achieve zero or close to zero pesticide use. Some countries (e.g.

Switzerland) are already producing grapes without spraying the crop. A few years ago, nobody would have imagined this to be possible. We need to be optimistic.

Solarization and Soilborne pests

Plant root health is essential to produce a good crop and an IPP approach to control soilborne diseases and insect pests should include cultural practices, biological and physical control methods.

Since an arid, hot climate is prevalent in the Arabian Peninsula (AP), the use of soil solarization is highly recommended. Soil solarization under AP conditions may raise soil surface temperature to 75ºC, sufficient to kill many soilborne fungi, bacteria, nematodes, insects and weeds.

The use of bioactive organic matter (biofumigation) enhances heating efficiency by soil solarization, but this requires field-testing under AP conditions. When applying solarization, however, it is essential not to excessively heat the soil to avoid soil organic-matter decomposition.

Concern was expressed that solarization could be harmful to beneficial organisms in the soil, such as mycorhizae, which have a positive role in reducing stresses and improving nutrient up-take. Even though there is little research in the region to properly address this issue, the general feeling is that temperatures below 45ºC will cause little damage. When temperatures exceed that level, it is expected that the mycorhizae population decreases, but returns to original levels in 2–3 weeks.

The addition of chicken manure or crop residues (e.g. of cabbage), at the rate of 5 tonnes per hectare, greatly enhanced the efficiency of solarization in controlling soilborne pathogens. There was no difference between incorporating a fresh crop residue or letting it dry on the soil surface before incorporating it into the soil. It is essential not to use too much residue, as this could have negative effects.

Integrated Pest Management

It is essential to apply IPM approaches to control diseases and insect pests which attack the above-ground parts of the plant. Growers often choose to use pesticides excessively for control. There is some progress in the AP in this direction, but experimentation should be increased to make full use of the available technology at the growers level. The main components of such an IPM strategy are: (i) greenhouse sanitation, (ii) physical control (insect proof, sticky traps, etc.), (iii) cultural practices, including host resistance and healthy seeds or seedlings, and (iv) biological control.

Biological control of insect pests and diseases, in the short term, should be the subject of research, using biological-control agents indigenous to the AP. It is also essential to define the optimal conditions under which such indigenous biological-control agents will achieve their full potential. Agricultural research stations and universities in the AP can collectively contribute significantly to such an effort.

Training in Integrated Plant Production and Protection

Training needs should be identified at the regional and country levels. Based on such an assessment, the most appropriate training material will be designed to fulfill the needs and serve the country where it will be used. Such training material will, as much as possible, be based on available experience in the region.

There are some technologies available, which can be adopted in several regions, e.g. the production of healthy, high-quality seedlings.

There are also some publications available, produced over the last decade by different institutions and international organizations, which can serve as a good starting point with some up-dating of the details. Nevertheless, the basic principles are available.

Implementation of IPP at the Research Station in Bahrain. This illustrates the use of plastic mulch, yellow sticky traps, insect-proof nets on vent openings and use of a double door with insect-proof nets.

Future Activities and Research Priorities

The identified activities needed to enhance IPP in the Arabian Peninsula cover: (i) surveys, (ii) research and demonstrations, (iii) training, (iv)

networking, (v) database development, and (vi) policy recommendations. Activities were put in three categories: short term—activities that can be initiated immediately; medium term—activities that can be conducted during the coming 2–5 years, and long term—activities for the coming 5–10 years.

Short Term

S.1. Surveys—to permit prioritization of different activities related to IPP of crops in protected agriculture, it is essential to conduct the following surveys:

S.1.1. To identify production constraints specific to different countries of the Arabian Peninsula.

S.1.2. To determine the economic importance of different pests affecting protected agriculture in each of the Arabian Peninsula countries.

S.2. Research and Demonstration Activities

S.2.1. To permit rapid impact in protected agriculture, it is essential to make use of the available technologies and demonstrate their usefulness in growers' greenhouses. These technologies, however, could be modified at a later stage based on research conducted in the Arabian Peninsula countries.

S.2.2. There are many simple technologies available for immediate use by farmers, which are effective in many regions around the world and can be easily adopted by growers in the Arabian Peninsula. These technologies are:

- proper ventilation
- water application techniques
- cooling techniques
- supplementary heating
- appropriate cover materials for the greenhouse
- use of screens for greenhouse openings to protect from insect vectors of viruses
- use of soil mulches
- control of soilborne pests by soil solarization
- use of healthy seeds and transplants
- pollination
- fertigation
- application of general hygiene principles.

S.3. Training—training growers, producers (owners), workers (technicians) and extension staff in IPP approaches.

S.4. Networking on IPP—it is essential to exchange experience and information related to IPP among all workers in the Arabian Peninsula.

Development of databases to include all existing information on IPP and to make it available to research and extension staff.

S.5. Policy Recommendations—even though there was a general consensus that policy issues are the responsibility of officials in the respective countries of the AP, there was agreement among participants that scientific staff involved in IPP can provide technical recommendations to policy-makers in AP countries.

Medium Term

M.1. Research

M.1.1. Continue all immediate activities mentioned above under Short Term.

M.1.2. Develop economic thresholds for the most economically important pests. Such thresholds are important as guides for the development of IPP packages.

M.1.3. Encourage the private sector to develop central nurseries.

M.1.4. Identify indigenous biological-control agents for the economically important pests in AP.

M.2. Database Development

M.3. Policy Recommendations

M.3.1. Develop recommendations related to pesticide application regulations, residue levels and the 'safe period' before harvest.

M.4. Training

M.4.1. Continue training as indicated for the Short Term.

M.4.2. Develop simple color manuals for pest identification, identification of bio-control agents, application of solarization and integrated pest management.

M.4.3 Individual training on specific areas.

Long Term

L.1. Policy Recommendations.

L.2. Research on economic viability of production and governmental actions required to assure viability.

L.3. Research on optimization of using inputs for IPP.

L.4. Research on application of biological control based on the use of indigenous bio-control agents.

L.5. Training of scientific staff at MSc and PhD level.

80