Good Plant Protection Practice- Status and future

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EPPO have since 1987 had an activity on creating guidelines for Good Plant Protection Practise with the overall aim of helping to minimze the risk from using pesticides. This has so fare lead to the creation of 18 specific guidelines on crops of major importance in the EPPO region. The wish is that these guidelines should be used to guide national authorities and advisory services on questions regarding crop protection. Each guideline addresses all major plant protection elements for a given crop this includes using cultural control measures, thresholds, best application technics, minimum necessary dose, etc. EPPO has recognized the need for Good Plant Protection Practise (GPPP) in the context of sustainable agriculture but recognize also the fact that more specific and detailed national or regional guidelines are often needed as the GPP-guidelines are to general to be used for local recommendation. An example of GPP for winter wheat production in Denmark is given in the paper.

Introduction

Pesticide risk reduction is a common goal for many countries in the EPPO region. The emphasis and focus on reduction schemes varies, however significantly between countries. Special reduction schemes have been developed by several countries (e.g. Denmark, Sweden, The Netherland) (Jørgensen, LN, 1997; Emmerman, A, 1997; van Alphen, 1997), where specific actions plans have been politically decided with the overall aim of minimizing the pesticide input as much as possible without coursing significant economical losses.

The focus on pesticide risk reduction has created a demand for scientific information and advice on pest management with emphasis on how the practical farmers can control pest, diseases or weeds by using combinations of alternative methods combined with minimum input of pesticides. This have in some cases lead to creation of Decision Support Systems including all relevant information for growers or advisors on a specific crop. The Danish system PC-Plant Protection is an example of such a system (Secher et al., 1995).

Different IPM schedules have been put foreward, some mainly organized by the growers organisations of which the Danish IPM rules can be mentioned as one example (Anon 2001; www.dansk-ip.dk) other formulated from the retails organisations of which the UK system used by Safeway can be give n as an exampel (Garbutt 2000).

EPPO has recognized the need for Good Plant Protection Practice (GPPP) in the context of sustainable agriculture. The Working Party of EPPO started from the concept of ‘Good agricultural practice’

(GAP) in the use of plant protection products, as defined by the Codex Committee on Pesticide Residues:

> *'the nationally recommended, authorized or registered safe use of pesticides under actual conditions at any stage of production, storage, transport, distribution and processing of food commodities and animal feed necessary for effective and reliable pest control. It encompasses a range of levels of pesticide application up to the highest nationally recommended, authorized or registered use. In this context, safe use takes into account public and occupational health and environmental considerations and the minimum quantities for effective pest control, applied in a manner so as to leave a residue which is the smallest amount practicable'.*

The Working Party concluded that the Codex GAP concept did not correspond with its intentions in several respects:

(1) it is based on the limits of acceptable practice as set by the registration conditions;
(2) it refers to products individually and not to their combination into a plant protection programme;
(3) it does not provide any criteria for deciding whether a given practice is good practice except the national registration conditions;
(4) it refers to residues as its principal endpoint. The Working Party of EPPO wished, in contrast:
   a) to recommend optimal practice,
   b) to consider individual product use in relation to an overall plant protection programme,
   c) to make recommendations which could serve as a practical standard for assessing a given practice,
   d) to make efficacy and environmental safety the principal endpoints, while incorporating GAP and thus covering consumer safety also.

The wish of the working party of EPPO was to create a set of guidelines for all crops in the EPPO region having a significant degree of importance. In each guideline details should be given on biology and development, appropriate control strategies should be described, and, if relevant, examples of active substances which could be used for chemical control should be mentioned.

Relation to EU directive 91/414

EU Council Directive 91/414 on the placing of plant protection products on the market allows that " proper use " of plant protection products:

> *"shall include application of the principles of good plant protection practice, as well as, whenever possible, the principle of integrated pest control".*

This implies that integrated pest control, or integrated pest management (IPM) as it is also called, sets a different standard from GPP and this is also the EPPO concept. While there are different concepts and definitions of IPM, they generally call for a complex decision-making system, and set an ideal of replacing the use of chemical products by other means. In Directive 91/414 integrated control is defined as:

> *"the rational application of a combination of biological biotechnological, chemical, cultural or plant breeding measures whereby the use of chemical plant protection*

products is limited to the strict minimum necessary to maintain the pest population at level below those causing economically unacceptable damage or loss"

Plant protection practice which respects the above definition is certainly GPP and as such is recommended by this guideline. The main purpose of the EPPO recommendations on GPP is to provide guidelines on whether and how to use products and ensure that they are used safely and effectively. GPP does not aim to reduce the use of chemical plant protection products to a strict minimum, only to avoid any unnecessary use.

Aim of GPP Guidelines

The aim is to reduce risk in scientifically developed, practical manner, while still achieving optimum crop protection. However, in so far as a country maintains an official advisory and regulatory policy which encourages integrated pest management, it must be GPP to follow more local advice. National IPM guidelines can generally be must more specific than the GPP guidelines as they in many cases cover smaller regions. This generates an option of giving much more specific recommendations on crop protection problems.

EPPO guidelines on GPP are intended used by National Plant Protection Organizations, in their capacity as authorities responsible for regulation of plant protection products. The guidelines are also intended as a basis for advisory services in relation to their activities on crop protection recommendations. For the latter group the aim is to create an information tool in situations where new and unexpected problems in a given crop develops and generate a need to search for new information on how to control or handle a specific pest or disease in a crop. More general crop protection problems are expected to be handled in more local guidelines.

Over the years the aim of the guidelines has been discussed in the panel and working party as it often has been felt that the guidelines have not become sufficiently known to or used by the national authorities and advisory services. A questionnaire has been send out in winter 2001 to all EPPO countries in order to try and discover to which degree the countries are aware of GPP- guidelines and to which extend they are included as a tool in there procedures for efficacy evaluation and advice to growers.

Work of the panel of GPP

EPPO's panel on Good Plant Protection Practice has been working since 1987 to develop standards on Good Plant Protection Practice for all major crops of the EPPO region and to cover methods for controlling whole pest spectrum on the crop, including animal pests, microbial pathogens and weeds. The aim was to provide criteria which could be used in all parts of the EPPO region, allowing for local differences. The first guideline that EPPO developed was on the "Principles of GPP". It was decided that some general principles should provide sufficient clear criteria for what can, and cannot, be considered good practice. These criteria are under constant evaluation. The following listing contain major input in the criteria:

1. Crop factors and cultural control.

Crops should be well managed according to local practice. Measures applied should be cost-effective in relation to the value of the crop. For all specific quidelines, dealing with specific crops it is mentioned

which factors generally help to minimize the influence of weeds, pest and diseases. Different cultural methods can help to minimize problems. These are mentioned or discussed. Among the factors most commonly mentioned in this section is the possibilities of using variety resistance for control of diseases along with other common practices like effect of cultivation, fertilizers, crop density, etc.

2. Local pest spectrum to be controlled and thresholds for action

The specific guidelines mention all important pest and diseases in a given crop if it is known to be important in any of the EPPO countries. The importance of pests varies from season to season. If thresholds are used in some countries these are mentioned as examples of how to implement a control strategy. It is realised that thresholds are different from country to country and indeed level of importance may vary significantly. The guidelines do not recommend specific thresholds, as there are known to vary considerably between area and generalisation would be a very risky business.

3. Conditions of registered use of plant protection products

The conditions of registered use fix limits on the use of products. This ensures that maximum residue levels (MRL's) are respected and that any environmental side-effect are kept to an acceptable minimum. To go beyond these limits is, by definition, never GPP. However, it is not necessarily GPP to operate at or near these limits. The aim of GPP is to move towards a concept of adequate in relation to cost/benefit.

4. Choice of active ingredients which control specific pests, weeds and diseases.

For each pest, disease or weed mentioned in the guideline a number of pesticides registrated for use are listed. The list is not complete, but is representing active ingredients at least registrated in 2-3 countries. Old products for various reasons banded in a number of countries have been omitted in cases where alternatives are mentioned.

The first choice to be made is whether it is indeed necessary to use a plant protection product. If an effective an economically viable alternative exists in the particular plant protection situation concerned, there is no need to choose a product. If however it is necessary to use a plant protection product a choice has to be made between active substances or formulations. The substance chosen should apart from being effective on the plant pest spectrum concerned be considered in relation to possible side-effects on the environment and the risk of building up resistance to the actual pesticide.

5. Choice of dosage

Dosage is generally fixed by the conditions of registration which may refer to several different dosages according to circumstances. It is not GPP to use higher doses (because they are not authorized). A low-dosage treatment may be considered GPP if there is good experimental evidence to show that it is effective. In several countries appropriate or reduced dosages provide a very common practice based on intensive research on when reduced rates safely can be recommended.

6. Choice of volume

For tall-growing crops, it is extremely important to apply sprays in the correct volume. Dosage will generally be specified as a concentration in this case, and a treatment will not be GPP if the volume applied is too high or low. Thus, recommendations for such crops need to be explicit about the volume to be used according to the size of the crop and the application system used.

7. Number, timing and frequency of applications

It is GPP to achieve adequate control by making only as many treatments as are needed for effective control. This number may vary considerably between seasons or localities. Monitoring and forecasting systems are important elements providing the necessary information for the decision whether and when chemical control measures should be applied.

The timing of the first application so that it is neither, wastefully, too early, nor too late (allowing populations to build up) is a key element in GPP. Numerous warning systems exist which allow one to forecast when individual pests will become active (meteorological, temperature sums, direct monitoring, pheromone traps, etc.). In any case, account should be taken of the local experience of advisory services and farmers and of direct visual observations in the field.

It may be possible to continue to use warning systems to time subsequent applications (against successive generations of an insect pest, or by detecting infection periods for fungi). It is GPP to do this as far as is practicable. It should, however, be noted that generations may come to overlap, or overall weather conditions may favour a disease over a long period.

There are also situations when the only possible GPP is to treat regularly. It is not GPP to use a warning system which is impracticably complicated, especially if it does not succeed in reducing the number of applications below those of a reasonable calendar programme. Treatment according to a fixed programme, of dates or of phenological stages of the crop, is GPP, unless it has clearly been shown that it is possible and practical to use a warning system to reduce the number of applications in most years.

Some treatment regimes allow for an interaction of dosage and frequency (higher dose less often, lower dose more often, but only within the permitted dose range). Good experimental evidence of the efficacy of such regimes is needed. There is no particular GPP preference in this respect.

The timing of the last application will be determined by what is needed for effective control, subject to the over-riding condition that the pre-harvest interval should be respected. In many cases, it may be GPP to make the last application long before the pre-harvest interval.

8. Equipment and methods of application

It is GPP to select equipment and application conditions which ensure that a high proportion of product applied reaches its target, with, for sprays in particular, the minimum wasted as aerial drift or onto the ground. Many factors should be taken into consideration (nozzle type, pressure, spray volume, droplet size, speed, etc.). However, it should be shown, for each product, that efficacy is maintained. The equipment should be adequately calibrated according to the purpose of the treatments in order to ensure that the correct dosage is applied and should be regularly checked.

9. Biological means of control

The concept of GPP relates to plant protection products in general, and includes formulated microbiological products and natural enemies which one decide to introduce into a crop (e.g. *Encarsia formosa* in glasshouses). GPP is concerned with the proper use of such products, and with the

interaction between chemical products and natural enemies introduced into a crop. There should be good experimental evidence that such biological means of control have acceptable efficacy.

GPP also seeks to derive benefit from the management of natural enemies which pre-exist in a crop. In particular GPP has to respect the conditions of registered use which seek to protect natural enemies. If reliance on a biological agent (e.g. typhlodromid mites in orchards) has become a regular component of the control scheme within a crop, then it is GPP to avoid products which would destroy the agent and thus lead to a need to use more of other products.

10. Identified side-effects

Side-effects on bees, or on wildlife, are covered by the conditions of registered use, so GPP will automatically take account of them. Local populations of natural enemies should be specifically considered. Side-effects on natural enemies, which interact with the efficacy of plant protection, have been considered under 'Biological means of control'. It is GPP to seek and consider all up-to-date information on such side-effects.

11. Risk of resistance

One of the most critical side-effects of product use is to impose a selective pressure for the development of resistant pest populations. It is GPP to take full account of all reports on appearance of practical resistance and to consider the general behaviour in this respect of other substances of the same chemical type. For particular crops recommendations may be made on a resistance-avoiding strategy, e.g. to use a 'sensitive' product not more than once a season, to use mixed formulations with a multisite active substances. Guidelines for different groups of plant protection products have been developed by resistance action committees of ECPA; FRAC (for fungicides); IRAC (for insecticides) and HRAC (for herbicides). EPPO has also provide the guideline "Resistance Risk Assessment". Where strategies have been defined, it is GPP to follow them.

12. Safety

GPP requires that relevant official regulations and codes of practice for the safety of the operator, consumer and environment should have been respected.

13. Training and documentation

It is GPP to ensure that all applications of plant protection products are made by trained operators. Regulations for adequate training of operators should be respected. It is GPP to document all applications of plant protection products (acccording to national requirements if they exist.)

Number of GPP

EPPO standards on GPP have been published for 18 individual crops, three more are to be published in 2001, 4 are going for a final approval in 2001, while 5 more are at different stages of development (Table1). The guidelines have been published in EPPO Bulletins (24,25,26,27,28).

Table 1: List of GPP guidelines published or under preparation.

Guidelines on GPP approved and published	Guidelienes under preparation by the panel
Principles of GPP	Grapevine
Potatoes	Citrus
Lectures under protection	Tomatoes, peppers, and aubergines (outdoors and protected).
Allium crops	
Rodent control	Curcurbitaceae (outdoors and protected)
Hops	Ribes and Rubes
Vegetable Brassica	Forage crops
Rape	Oat
Strawberries	Cotton
Wheat	Prunus fruits
Barley	Olives
Beet	Rice
Pea	
Tobacco	
Ornamentals under protection cultivation	
Farm grassland	
Maize	
Pome fruits	
Rye	
Umbelliferous crops	
Mushroom	
Sunflower	

Future of GPP-guidelines.

The future activity regarding creating and use of GPP guidelines should be based on the demand from EPPO-countries. The response from the ongoing questionnaire should hopefully give some responses regarding the need for future activities.

The panel of GPP has at their last meeting in Rome (Sept. 2000) been considering that the work of creating guidelines is getting towards the end. The need for the future will have to be decided on and several elements could be for consideration.

a) Need to finish guidelines under preparation. Most of those are involving subtropical crops and therefore have a need for a substantial input from countries from the south of Europe.
b) General need to update and revise the guidelines with some years interval.
c) Creation of an internet based version which link up to different relevant more specific guidelines of local origin. The decision of whether or not such an internet version should be made is for consideration.
d) Creation of a workshop forum where members from national institutions can discuss and exchange knowledge of GPP, based on the broader EPPO guidelines as well as the more specific national guidelines which exist in many countries.

Table 2. An example of GPP in winter wheat with local input from Denmark

Good cultural practices

Grow winter wheat on well drained soils with good nutrition balance.
Prepare a good seed bed before drilling to ensure good and even establishment of the crop.

The plant density should be adjusted depending of the time of drilling to minimize the risk of lodging. When sowing early in September the seed number should aim at 150-250 plants/m^2. At later sowing dates the seed rate should increase to aim at 250-350 plants/m^2.

Choose a high yielding variety with good resistance genes towards important diseases, in order to minimize disease attack. Other important variety factors are straw length, lodging risk and winter hardness.

If winter wheat is grown as a 2^{nd} year wheat the sowing date should be delayed to reduce the risk of the diseases take-all (*Gaeumannomyces graminis*) and eyespot (Pseudocercosporella herpotrichoides).

It is recommended to apply nitrogen as a split treatment. This minimize the risk of lodging and of encouraging disease development. In Denmark an upper limit has been fixed for input on nitrogen (150-180 kg/ha), this ensures that excessive levels are used which could encourage to epidemic development of diseases.

Weed control

Delaying sowing can reduce the population of weed in the field. Although the level can be reduced it is often not cost effective to do so, as weed control still may be needed and yields will be reduced significantly from late sowing.

Weed harrowing has in some situations been used successfully, but generally the methods are too uncertain in autumn sown crops.

It is recommended to make a weed map of the fields in order to know which weed problems are likely to appear. Before application monitoring of the weed species and numbers/m^2 in the field should create background for assessing the need for control as well as recommending and effective herbicide and dose. Various handbooks or decision support systems can be used as support.

It is generally recommended to aim at weed control in the autumn as this give good possibilities of using reduced dosages of herbicides. Only if specific weed problems develop in spring is it recommended to repeat the herbicide application. It is obligatory to control wild oat if this appear either by herbicide or hand weeding.

If perennial grasses (*Elymus repens*) are found at significant levels treatments can be recommended as pre-harvest treatment. This is not an option in wheat grown for bread quality.

Disease control

Autumn control of leaf diseases or snow mould is never recommended.
From GS 29 it is recommended to carry out monitoring in the field to follow the development of eyespot, mildew and rust diseases. This information should create background for assessing the need for control as well as recommending and effective fungicide and dose. Various handbooks or the decision support system PC-Plant Protection can be used as support.
Control of septoria (*Septoria tritici, Stagonospora nodorum*) diseases are based on information on precipitation or visible assessments.
The following thresholds are examples from some of the growth stages :
Eyespot : Control of more than 35% of the plants have attack at GS 30-32. On attacked plants symptoms should be visible on the white leaf sheath beneath the outer leaf.
Mildew : susceptible varieties – more than 10 % plants attacked at GS 29-31,
resistant varieties – more than 25% of plants attacked at GS 29-31
Yellow rust: susceptible varieties – more than 1 % plants attacked at GS 29-31, after 1st application treatments are repeated with 3 weeks interval.
resistant varieties – more than 1 % of plants attacked at GS 29-31. Should not be followed by routine treatments.
Septoria : susceptible varieties – Count days with precipitation from GS 33. Apply an effective fungicide after 4 days with precipitation (more than 1 mm per day) or if more than 10 % of plants are attacked at 3rd leaf at GS 45-59.
less susceptible varieties – Count days with precipitation from GS 37. Apply an effective fungicide after 5 days with precipitation (more than 1 mm per day). Do not apply before GS 39.

Choice of fungicide: It is recommended to use mixtures with different mode of action to avoid fungicide resistance. A maximum of two applications with strobilurins per season is recommended. Although reduced dosages are recommended this are only on low disease levels in order to avoid a big selection pressure.

Insect control

It is not GPP to add an insecticide to a fungicide treatment if the threshold is not exceeded.
The fields should be monitored for Ahpids from earing and on to GS 75.
The following thresholds are used:
GS 41-50: More than 40% tillers attacked
GS 51-60: More than 50% tillers attacked
GS 61-75: More than 60% tillers attacked

0,5-1,0 larvae of Oulema melanopus per ear bearing tiller

Growth regulation

It is generally not recommended to apply a growth regulator. This strategy has been confirmed in field trials. These have rarely shown that use of growth regulators are cost effective.
To minimize the risk of lodging it is recommended to grow short varieties with low risk of lodging. By adjusting sowing rate according to sowing date and using split nitrogen strategies very dense crops can be avoided which again minimize the risk of lodging.

References

Anon. 2001. Håndbog for frugt og bæravlere 2001. Rådgivningsudvalget for frugt og bær.

EPPO Bulletin 24 (2)1994

EPPO Bulletin 25 (4)1995

EPPO Bulletin 26 (2)1996

EPPO Bulletin 27 (2/3) 1997

EPPO Bulletin 28 (3) 1998

EPPO Bulletin 29 (3)1999

EPPO Bulletin 30 () 2000

Van Alphen, C.A.M. 1997 A strategy for reduced use of plant protection products in The Netherlands. EPPO Bulletin vol 27 no 2/3. 210-211

Emmerman, A. 1997. Programm to reduce the risks connected with the use of plant protection products in Sweden. EPPO Bulletin vol 27 no 2/3. 212-213.

Garbutt N. 2000. Meeting consumers demands for food safety: European retailer protocols for crop protection programmes. BCPC Conference, Pest and diseases. 129-132

Jørgensen, L.N.1997 The Danish Pesticide Plan - Facts and reality. EPPO Bulletin vol. 27, no. 2/3. 206-209.

Secher, B.J., Jørgensen, L.N.,.Murali N.S. & Boll P.S. (1995). Field Validation of a Decision Support System for Control of Pests and Diseases in Cereals in Denmark. Pesticide Science, 45, 195-199.