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OPENING CEREMONY

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Federal Research Centre for Agriculture and Forestry
Braunschweig, Germany

Developments towards best management practices in plant protection

G F Backhaus
BBA, Messeweg 11-12, D-38104 Braunschweig, Germany
Email: g.f.backhaus@bba.de

INTRODUCTION

After decades, during which people did not find sufficient tools or means to control plant diseases, pests and weeds, discussion within the plant protection experts during the 1950s and 1960s mainly dealt with the recently developed chemical plant protection products (PPPs), in particular with their efficacy and phytotoxicity. Over the decades, critical views about the side effects of PPPs on the environment and the health of humans were also published (e.g. Richter, 1910), but the advantages were mainly considered to be on the side of solving practical plant protection problems by chemicals. Between 1950 and the 1980s chemical plant protection made great progress, owing to its positive effects on yields and economics of crops. However, at the latest when the book '*Silent Spring*' (Carson, 1962) was published, the discussion about the effects of chemical plant protection on the health of humans and the environment became public, and ever since has never stopped. The discussions were accompanied by findings of herbicides and soil disinfectants in ground water, residues of PPPs in fruits and vegetables and other news which shocked the public or was used to shock the public. Because of ongoing controversial discussions, the evaluation of PPPs and their active ingredients was intensified, additional legal regulations were passed and new restrictions for users were introduced. However, some administrators had to realize one day that it might be impossible to control every single farmer in everything he does. Consequently, self-responsibility of farmers, horticulturists and foresters had to be addressed and guaranteed. For this purpose, in addition to the registration procedures, guidelines had to be developed about the minimum requirements for the use of PPPs and, of course, for the accompanying non-chemical measures of plant protection in the field. These guidelines were called 'good plant protection practice'. Very often they were embedded in guidelines of a broader sense, and called 'good agricultural practice', 'good horticultural practice' etc. In Germany, over the past 15 years, official authorities, extension services and grower associations developed their own guidelines (e.g. Reschke *et al.*, 1987; Brinkjans & Scholz, 2003). There was great similarity between these guidelines with respect to the major items, although they differed considerably in their details.

BEST MANAGEMENT PRACTICE

Several efforts have been made to establish generally valid guidelines, e.g. by the EPPO standard PP 2/1(1) on 'Principles of good plant protection practice' which was first approved in 1993. In Germany, in addition to the important legal regulations based on the European guideline 91/414 (EWG), the German Plant Protection Acts of 1986 and, again, 1998 defined Good Plant Protection Practice as the most important basis for every operation in chemical plant protection. Good Plant Protection Practice on the one hand serves (in addition to the registration procedures for PPPs) for the maintenance of health and quality of plants and plant products, and on the other hand for the avoidance of dangers and risks which might arise for the environment and for the health of humans and animals as a result of plant protection measures. The principles do not only concentrate on chemical plant protection but address all measures of plant protection. Good Plant Protection Practice requires the principles of Integrated Plant Protection (IPP) to be taken into consideration. These principles were described and published for the first time in 1998 (Burth & Freier, 1999) and the current version appeared in 2005 (Anon., 2005). Good Plant Protection Practice is the basic strategy and includes all measures a farmer can apply in accordance to the given rules and regulations. However, the farmer is obliged to keep in mind the principles of IPP:

- IPP requires a complex mode of action and represents a systemic approach.
- The concept of IPP includes the ecological relations of equilibrary with economic and social aspects, in order to secure sustainability.
- In IPP, preventive (prophylactic) measures should be preferred.
- IPP requires careful consideration of intending processes.
- IPP is a knowledge-based concept which places emphasis on the use of newest scientific knowledge and justifiable technological progress, and it makes high demands on the supply and transfer of location-oriented information.

This situation, however, might be merely a further mid-step on the way to finally approaching the model of future IPP. The aim for the near future is not only to define but also to internationally convert a certain minimum level of requirements for practical plant protection measures, beginning from selection, trade and transport of PPPs, all the way to the measures of application and waste management or disposal. In some discussions this development is called 'best management practice'. It is meant to deliver a standard for the behaviour of anyone who intends to use PPPs or to protect plants.

In the meantime, new methods of IPP management will have to be developed, to take account of new breeding efforts, precision farming, biological measures of plant protection, and innovative new active substances. In addition, we will have to improve application techniques. Furthermore PPPs are still not always used efficiently. Their potential for efficacy might, for example, be enhanced by use of more sophisticated application systems (which provide for close contact to the target area, such as plant leaves, and avoid contamination of non-target areas) and better application timing.

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PLENARY SESSIONS

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Qualitative and quantitative loss of pesticides during waste water treatment

B Augustin
DLR R-N-H, Rüdesheimerstr. 60, D-55545 Bad Kreuznach, Germany
Email: bernd.augustin@dlr.rlp.de

I Ittel
LUWG, Kaiser-Friedrich Straße 7, D-55118 Mainz, Germany

INTRODUCTION

In the past, investigations of possible pesticide contamination have concentrated on ground water. From 1985 to 1996, 450 groundwater sampling points were investigated in Rhineland Palatinate, and about 10% of the samples contained triazines (atrazine, simazine). Furthermore, bank filtrate of the river Rhine contained bentazone and dikegulac, deriving respectively from herbicide ascorbic acid production. Since dikegulac was not used in the area, this served as a tracer for the spread of bank filtrate into the ground water zone. Improved production processes stopped further emission. Other active ingredients were rarely found (single-source entries) and pesticide contamination of groundwater was less intensive than expected. In the following years, investigations concentrated on possible contamination of surface water.

METHODS

In 2003 the outlet water of six sewage plants within Rhineland-Palatinate was analysed for 43 different active ingredients and metabolites (29 herbicides, 12 fungicides, 2 insecticides). The plants meet all requirements of maximum mechanical, chemical and biological treatment processes. Mixed 14-day water outputs were continuously sampled automatically (Endress & Hausser) or by hand. The catchment area of Sewage Plants 1–3 was characterized by a large portion of specialized crops with a sampling period from March to October. Sewage Plants 4–6 are basically connected to arable land and samples were taken during March to June.

Following collection, samples were refrigerated and, subsequently, frozen until chemical analysis, which was done by LUFA in Speyer (according to acknowledged methods for active ingredients of pesticides (DFG – the German Research Foundation)). Especially for glyphosate, the laboratory developed an approved analytical method.

Financial support was given by the Ministry of Agriculture, Rhineland-Palatinate.

RESULTS

The average water flow, combined with the measured pesticide concentration, allowed the estimation of the pesticide quantity (a.i.) leaving the individual sewage plant. The amount of pesticide loss via sewage plants varied from 1 kg to 7.7 kg per sampling period. Losses were higher in catchment areas with mainly specialized crops, which need to be treated more often

(Table 1). According to their quantitative use, herbicide residues dominated the findings. This was especially obvious in areas with mainly arable crops (Sewage Plants 4–6). When specialized crops are present, fungicide losses gain in importance (Sewage Plants 1–3).

Table 1. Specificities of six different sewage plants in Rhineland Palatinate sampled for pesticides in 2003.

		Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6
catchment area	(km²)	58	52	50	57	21	92
arable land	(km²)	3	19	36	31	11	45
specialized crop land	(km²)	26	10	10	0	2	0,1
grassland	(km²)	2	6	1	7	4	19
herbicides	(g a.i.)*	5,194	2,287	4,223	930	1,789	1,011
fungicides	(g a.i.)*	2,372	780	653	80	68	39
insecticides	(g a.i.)*	199	1	591	0	3	1
Sum	(g a.i.)*	7,765	3,068	5,467	1,010	1,860	1,051

* g a.i. ≥ limit of quantitation LOQ.

DISCUSSION

Previous investigations pointed at sewage water as a major source for pesticides in surface water (Seel *et al.*, 1996; Augustin *et al.*, 2002). This was confirmed by these investigations. Pesticide concentrations of waste water in the course of the year indicate that they originate to a smaller scale from the actual application but more from the general handling of pesticides. Registration procedures for pesticides and enforced conditions of application aim to minimize environmental pollution. We need 'best pesticide management' to reach this aim and to prevent further environmental restrictions being placed upon pesticide use.

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Elaboration of a system for assessment of agricultural land bio-diversity in Siberia

A Babenko
Tomsk State University, Lenina Avenue, 36, Tomsk, 634050, Russia
Email: dzedzin17@hotmail.com

INTRODUCTION

System crisis in Russian agriculture has negatively affected the state of bio-diversity. In Siberia this is caused by the following: increased forest cutting and poaching, soil erosion, silting of water basins, loss of soil fertility, and degradation of pasture fields. The way out of this situation is seen in conducting agricultural activities on the basis of ecological principles. In addition to the improvement of the ecological situation in Russia this will make it possible to get maximum economic effect with low investments, which is extremely important in the present environmental crisis. In the last six years we have tried to develop a system for assessing agricultural land bio-diversity. Some groups of the most common soil and epigeous invertebrates have been selected for collecting the data concerning changes of agro-landscape bio-diversity caused by human activity.

METHODS

For the years 2000 to 2005 we have been studying the agricultural land bio-indicators in the south part of West Siberia. The territories under study are situated in the Tomsk and Kemerovo regions, which belong to a zone of so-called 'risky agriculture', especially for growing plants. The overall climate is continental, with long winters and warm, but short, summers. The frost-free period is 105–120 days a year. The standard annual precipitation level is 430–450 mm. According to some estimates only two out of every five years provide favorable weather for agriculture. The crops grown are spring wheat, winter rye, barley, oats, buckwheat and millet, as well as potatoes and other vegetables. Studied were done in fields of potato, cabbage and spring wheat. The methods of soil tests and transects of pitfall traps were used for collecting and monitoring soil and epigeous invertebrates (Vogel, 1983; Waage, 1985). The bio-diversity, density and the life form spectra of representatives of the most common group of arthropods: rove beetles (Coleoptera: Staphylinidae) have been used as indicators of agricultural land conditions.

RESULTS AND DISCUSSION

The maximal diversity of rove beetles populations (49 species) was found in cabbage fields. There were 36 species in potato fields and 34 species in wheat fields. The density of rove beetles in the studied fields (individuals/m^2) were as follows: cabbage – c. 25; potato – 18; spring wheat – 19.5 (Table 1). Some species of beetles may serve as indicators of cabbage fields (*Philonthus addendus* and *Aleochara moerens*), potato fields (*Staphylinus sibiricus*) and wheat fields (*Tachyporus solutus*).

Table 1. Bio-diversity and density of rove beetles in West Siberian agro-ecosystems.

Agro-ecosystem	Number of species	Density (individuals/m^2)
Cabbage	49	24.8 ± 2.2
Potato	36	18.0 ± 2.0
Spring wheat	34	19.5 ± 1.4

All main classes and groups of rove beetle adult life forms were found in agro-landscapes in the region of study. In all fields the most beetles were small epigeobionts (a significant number of *Philonthus*) and forest litter stratobionts (mainly forest litter Aleocharinae). The greatest variety of rove beetles life forms (4 classes and 10 groups) were found in cabbage fields. Approximately 75% of these were zoophagous, mostly 'epigeobios' and 'stratobios' (*Staphylinus*, *Ocypus*, *Quedius* and *Philonthus*). Relatively few rove beetles were mycetophous, but those that were (*Megarthrus* and *Gyrophaena*) were most numerous in the wet cabbage fields, and decreased simultaneously with increasing micro-climate severity.

Bio-diversity of rove beetles belonging to the classes 'geobios' (*Lathrobium* and *Meotica*) and (to some extent) 'psammocolymbetes' (*Astenus*) increases in the direction: wheat → cabbage → potato. Generally, an increase in the severity of micro-climatic conditions (in the direction: cabbage → potato → wheat) leads to a decrease in the diversity of adult rove beetles..

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Promotion of antagonistic mymarids of the grape leafhopper by planting dog roses along vineyards

S Böll, P Schwappach, J V Herrmann
Bavarian State Institute for Viticulture & Horticulture, Herrnstr. 8, D-97209 Veitshöchheim, Germany
Email: susanne.boell@lwg.bayern.de

INTRODUCTION

Several mymarid species are known to be efficient egg parasitoids of the grape leafhopper (Empoasca vitis), a potential pest species (Böll & Herrmann 2004). However, overwintering mymarids depend on the eggs of other cicadellid species that predominantly occur in hedges. Dog roses (Rosa canina) are by far the most preferred hibernation sites of Anagrus atomus (Remund & Boller, 1996; Böll & Schwappach 2003); for two other mymarid species (Anagrus avalae and Stethynium triclavatum) the main overwintering sites are still unknown.

METHODS

As, during the past few decades, most shrubs have been cleared in intensely cultivated vineyards, it was examined in a 3-year study whether dog roses planted at the beginning and the end of vine rows established and promoted mymarid populations. With a dense net of yellow sticky traps in the vineyard and in an adjacent hedge (in the third year, also in the planted roses), the population dynamics of these mymarid species and the grape leafhopper were monitored throughout the growing season on a weekly basis. Hatching experiments with wild and planted rose shoots during the third year provided data on the number of overwintering mymarids/m shoot as well as of the number of hatching mymarids/m shoot during the vegetation period.

RESULTS AND DISCUSSION

In the third year, after most of the planted roses had reached a height of more than 2 m (similar to that of wild dog roses), results showed that:

- mymarids used the planted roses, both as overwintering sites and as a breeding habitat;
- the planted roses predominantly housed A. atomus (97%), whereas A. avalae (3%) and S. triclavatum (0%) could not be promoted;
- with few exceptions, only young rose shoots were used as egg laying sites by A. atomus and its cicadellid hosts;
- the planted dog roses were intensively used as overwintering sites, with an average of 24.4 cicadellid host eggs/m shoot and 14.6 A. atomus/m of shoot –corresponding to a winter parasitation rate of 59%;
- for the greater part of the vegetation period the planted roses were continuously used for

reproduction, with the tallest-grown roses housing similar numbers of A. atomus as wild dog roses in the adjacent hedge;

- with increasing biomass of the planted dog roses, densities of A. atomus over the study period significantly increased in adjacent wild dog roses but not in other shrub species;
- in the vineyard, grape leafhopper numbers were low, although almost equalled by the number of A. atomus over the season.

Similarly, studies in California have demonstrated that the egg parasitoid Anagrus epos of the Californian grape leafhopper (Erythroneura elegantula) can be enhanced and shows higher parasitation rates if prune (Prunus) trees are planted nearby as a refuge (Wilson et al. 1989; Murphy et al. 1996). Likewise, eggs of the host Edwardsiana prunicola serve as overwintering sites and are continuously used for reproduction over the growing season (Wilson et al. 1989). However, Rosenheim & Corbett (1996) found that the effect of prune refuges was limited to a few vine rows downwind and that A. epos exhibited a gradual decline with increasing distance from the refuge. In contrast, by planting dog roses within the vineyard along the vine rows, rather than in its vicinity, a more even distribution of the egg parasitoid was ensured in this study. Thus, establishing and promoting high-density populations of A. atomus could be an effective alternative to insecticide applications in areas with grape leafhopper problems.

In Franconia, the grape leafhopper seems to have been naturally controlled by mymarids for many years, and grape leafhopper numbers have continuously dropped. Furthermore, a close monitoring of five representative sites in the Franconian wine-growing area over the past 8 years has shown that irrespective of the number of immigrating grape leafhoppers the relationship of mymarids to grape leafhoppers at the hatching peak of the first generation stayed remarkably constant over the years, with one mymarid to 1–10 leafhoppers. In contrast to other German wine-growing areas, where two or three grape leafhopper generations per season occur, only one generation is observed in Franconia. The pattern of the population dynamics strongly indicates that mymarids effectively control the second generation of the grape leafhopper in Franconian vineyards.

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The Standardized Treatment Index as an indicator for pesticide use intensity on farms in North-East Germany

J Bürger, B Gerowitt
University of Rostock, Crop Health, D-18051 Rostock, Germany
Email: jana.buerger@uni-rostock.de

S Goltermann
LLALF, Department of Plant Protection, D-18059 Rostock, Germany

H Heilmann
State Research on Agriculture and Fisheries Mecklenburg-Vorpommern, D-18276 Guelzow, Germany

INTRODUCTION

In 2004, the German Government issued a National Reduction Programme for the Use of Chemical Plant Protection Products, with the aim to reduce risks associated with their use. In order to monitor the progress of the programme a number of indicators were developed. Here, the pesticide use intensity will be analysed using the Standardized Treatment Index (STI). The STI counts the number of pesticide applications to a crop over one season. One application of a fungicide, herbicide, insecticide or growth regulator at the full permitted dosage over the whole area accounts for an index of 1. Reduced dosages and non-spraying of field parts decrease the index value. For monitoring or studying pesticide intensity, the index can be seen as a more accurate indicator than the amount of active ingredient(s) or amount of money spent. Owing to the standardized calculation procedure, it is possible to compare STI values for different crops and farms or even regions.

MATERIAL AND METHODS

In a study in Mecklenburg-Vorpommern (North-East Germany), on-farm data of pesticide use were collected to calculate the STI under practical field conditions. Two data-sets of pesticide use are analysed for a five-year period (2000 to 2004). The major focus was on crop rotations with oilseed rape and cereals. One data-set was collected by the State Plant Protection Service through a survey (data-set LPS). This comprised information on 36 single fields of different farms in the region and, over the five years, amounted to 80 records of winter wheat and 52 records of winter oilseed rape. The second data-set was acquired from the State Research Centre for Agriculture (data-set LFA), and originally collected for economic research. This data-set included information from all fields of seven farms in the region, 447 records of winter wheat and 227 records of oilseed rape. Together with the pesticide data, information was collected on cultivation practices such as cultivar choice, seeding time and tillage. Thus, analysis was possible on how far intensity of pesticide use is influenced by cropping practices. The effect of cultivation practices on STIs in winter wheat was examined by univariate or a multivariate ANOVA.

RESULTS

The variability of index values was high between years, but also between farms or individual fields. The yearly mean STI in winter wheat ranged from 4.3 to 5.6 in data-set LPS, and from 5.2 to 6.8 in data-set LFA. Comparable values for oilseed rape were 4.4–5.9 (LPS) and 4.4–6.9 (LFA). The means increased from year 2000 to 2004, due mainly to higher fungicide and herbicide intensity in wheat, and to greater insecticide use in oilseed rape.

The results of the univariate ANOVA show significant effects on fungicide and herbicide STI values by the following factors ($P < 0.05$): cropping region and year, cultivar susceptibility, amount of cereal crops in the rotation, tillage and seeding time. Cultivar susceptibility had the highest value of explained variability (eta^2) for fungicide STI in data-set LPS. All fields of the data-set LPS were grown with cultivars of medium to low susceptibility; therefore, no ANOVA could be run on this factor. No effect appeared for winter wheat following winter wheat, for integration of a summer crop in the rotation or for the amount of nitrogen fertilization.

In the multivariate ANOVA, region and year were combined into one factor that represented the non-manipulable conditions of cropping. All cropping practices were combined into another factor, representing the susceptibility of the crop through management. The categories were developed with expert knowledge, particularly in relation to disease and weed pressure. The results indicate that the use of pesticides in the analysed data-sets is influenced mainly by environmental conditions (with about one third of variability explained by this factor). Only herbicides in data-set LFA seem to be less influenced by this factor. Moreover, data-set LFA shows that the combination of cultivation practices has a significant relationship to the intensity of fungicide and herbicide use. The factor ‘crop susceptibility through management’ could explain around 5 to 10% of STI variability. The effect could not be seen in data-set LPS, presumably owing to the smaller number of record sets.

CONCLUSIONS

Cultivation practices are a good means to significantly influence and reduce the intensity of pesticide use, as these measures of precautionary plant protection reduce the necessity for pesticide treatments.

ACKNOWLEDGEMENTS

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Reference farms for pesticide use and state of IPM implementation in arable farming

B Freier, B Pallutt, M Jahn, A Günther
BBA, Stahnsdorfer Damm 81, D-14532 Kleinmachnow, Germany
Email: b.freier@bba.de

INTRODUCTION

The German Action Plan for Reduction of Pesticide Use, starting in 2007, includes the establishment of a network of reference farms. These farms will provide reference data on the behaviour of farmers in relation to plant protection, and will deliver data on the intensity of pesticide use (as defined using the treatment frequency index (TFI)) and on the minimum need for pesticides in defined regions.

Two main aims of the action plan are described below.

- **Annual collection of data on the intensity of pesticide use in major crops**

  The available TFI data demonstrate variable behaviour of farmers in different crops, years and regions. The statistical analysis of TFI data will be linked with data from the NEPTUN survey, which is conducted in a large number of farms every 3 or 4 years. Because of the large sample size, NEPTUN yields useful information on mean values, frequency distributions and corridors of the standard deviation of TFIs in the target regions. Because only a few reference farms can be established in each region, they provide typical examples but are not a statistically representative sample. However, the advantage of reference farms is that they permit data to be collected annually.

- **Analysis of TFI data in connection with background information, especially on infestation per crop and year**

  The collected TFI data are analyzed by specialists from the advisory service in regard to minimum pesticide requirements. Reduction of pesticide use to the necessary minimum, in favour of cultural, natural and biological control methods, is a central demand of integrated pest management.

METHODS

The reference farm network is a collaborative project between the BBA and the plant protection services of German Länder. The BBA developed a concept that was discussed, together with the Länder, at a meeting in February 2007. This concept includes the following methodological approach:

- nomination of contact persons at the state and BBA level (Länder, BBA);
- annual collection of data on pesticide use in major crops (3 fields of each) of the reference farms and collection of other farm-related data;
- TFI calculation (BBA);
- monitoring and evaluation of field-specific infestations in the major crops (Länder);
- farm-specific evaluation of pesticide use in regard to minimum need requirements and reduction potentials (Länder);
- publication of crop-specific information summaries on pesticide use and background data for each reference farm (Länder, BBA), and public communication of results (BBA, Länder).

The number of reference farms selected, and criteria for their selection, will be based on the defined regions used in the NEPTUN surveys (Rossberg, 2002).

RESULTS AND DISCUSION

To date, 19 arable farming regions have been defined, covering all Länder except for the city states. Also, c. 60 reference farms have been earmarked, 41 of which have already been notified by the Länder. Most of these farms grow winter wheat, winter barley and winter rape, which are important crops for the analyses.

Vegetable (cabbage, carrot), fruit (apple), wine and hop-growing regions were identified, and the following numbers of reference farms were selected: 12 for each vegetable crop, 26 for apple, 14 for wine and 7 for hop.

The comments of specialists will show how objective factors, particularly occurrence of weeds, diseases and pests as well cost-benefit assessments by the users, modify the TFI. We also expect to gain information on subjective influences, such as user skills and risk behaviour. The findings from reference farms will help us to identify shortcomings in IPM, in terms of best practice. The information will contribute to the identification of pesticide reduction potentials, and will be very important for transparency and for communication of plant protection matters in Germany.

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Interaction between weed management, faunal diversity and plant growth of apple stands in the dry region of central Germany

W Heyer, O Christen
Martin-Luther-Universität Halle, Ludwig-Wucherer Str. 2, D-06108 Halle/Saale, Germany
Email: wolfgang.heyer@landw.uni-halle.de

INTRODUCTION

A main objective of agri-environmantal schemes is a reduction in the risk of environmental contamination resulting from plant protection measures. This includes the banning of herbicide use in perennial crops, especially apple orchards and vineyards. In line with this, investigations were done to clarify the effects and interactions that occur within the agri-ecosystem under the dry conditions of central Germany. This deals especially with different methods of weed control or management, and their effects on arthropod populations within an apple stand.

MATERIALS AND METHOD

Investigations were done over three years, to specify the agri-environmental effects of different weed management procedures. The following variants were established: (1) control – without weed management; (2) weed management by herbicide use (glufosinate @ 5 litres/ha); (3) weed management by mechanical soil tillage. Within the treated areas, data were collected as follows: (1) characterization of apple tree development by measuring shoot growth; pitfall trapping to verify the population dynamics of epigeous arthropods (six traps per unit); (3) abundance assessment by leaf counts (30 leaves/tree, 10 trees per unit); (4) observations of aphid colony development and presence of antagonists (beneficials) (50 marked colonies with and without ant visitation).

RESULTS

The type of weed management influenced considerably both the growth of trees and the appearance of various arthropods (Table1). Growth was very different, when comparing the result of variant 1 with those of variants 2 and 3. This underlines the significant reduction of growth in variant 1 by water stress, resulting from higher transpiration by the dense weed cover on the soil. Differences in ther presence of arthropods were also evident; Table 1 shows selected examples. The number of recorded ants, aphids, mites (winter eggs) increased significantly as an effect of the intensity of weed management. On the other hand, the spider abundance dropped with increasing weed management. These findings confirm clearly the interactions between the type of weed management and the presence of arthropods in the apple stand. Using contingency table analysis (Dammer & Heyer, 1997), these findings could be quantified in selected arthropod communities (see Table 2). The calculation quantify the influence of the complete factor complex on the appearance of selected insect groups. The abundance of aphids, ants and beneficials is influenced most strongly by weather conditions and by vegetative growth stage. Nevertheless, other parameters also had significant impact on arthropod abundance. Concerning aphids, there is a clear dependence on weed managment. On the other hand, the appearance of beneficials in aphid colonies is considerably influenced by the presence or otherwise of ants.

Table 1. Shoot growth and arthropod presence (selected data, Manuel, 1999)

	Control	Herbicide	Tillage
Mean length of 50 shoots (cm)	17.7	21.1	22.0
Total no. of ants (6 pitfall traps, 350 days)	4,850	6,990	6,800
Total no. of aphid colonies (300 branches)	155	300	370
Total no. of mites (winter eggs, 10 × 10 cm fruiting branches)	169	229	311
Total no. of spiders (300 leaf clusters)	57	28	6

Table 2. Interaction of selected parameters, quantified by contingency table analysis.

Arthropods and impact parameters	Interaction selected	Coefficient of contingency
Aphids, period of vegetation (date), habitat (type of weed regulation)	total impact (dependency)	0.478
	date × aphids	0.338
	habitat × aphids	0.278
Ants, beneficials*; year	total impact (dependency)	0.431
	year × ants	0.201
	year × beneficials	0.368
	ants × beneficials	0.255

* Ladybirds (adults and larvae), hover flies (larvae), spiders and gall midges (larvae)

DISCUSSION

Various structural parameters determine the presence or absence of organisms in an ecosystem. Due to the water scarcity (c. 490 mm precipitation/year) the alternative to banning herbicide use does not lie in leaving the sub-vegetation but in the mechanical elimination of weeds by soil tillage. The structure of the apple stand is modified considerably with this and noticeably affects arthropod communities. In particular, aphid abundance is increased and the mutualism between ants and aphids will be enhanced. Therefore, under the specific conditions within the dry region of central Germany, the agri-environmental scheme of 'banning of herbicides' is inappropriate and does not make sense to apply.

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Survey on pesticide use in vegetable crops in Germany

M Hommes
BBA, Messeweg 11-12, D-38104 Braunschweig, Germany
Email: m.hommes@bba.de

D Roßberg
BBA, Stahnsdorfer Damm 81, D-14532 Kleinmachnow, Germany

INTRODUCTION

Publicly available information on the real use of chemical plant protection agents in agricultural practice is urgently needed to address a series of scientific questions as well as for political argumentation. Therefore, in Germany, a survey on the application of chemical plant protection products on the most important crops has been carried out on a regular basis since the year 2000 (NEPTUN-Project). This project aims to increase the transparency regarding the intensity of chemical plant protection and to provide solid data for individual crops.

METHODS

An extensive survey on the use of plant protection products for a range of important vegetable crops was carried out for the first time in Germany in 2005. The grower organization 'Fachgruppe Gemüsebau im Bundesausssschuss Obst und Gemüse (BOG)' acted as the coordinator for data collection. Data were collected for the year 2005, and included all chemical and biological plant protection measures. The survey was based on a voluntary cooperation of selected farms in the main vegetable-growing regions and was, except for greenhouse crops, region specific. To obtain a realistic situation, all collected data were stored anonymously. For data analysis the application frequency and the application index were calculated. Application frequency denotes only the number of treatments, without considering the number and the amount of pesticides used at the same time. The application index specifies the number and amount of pesticides, used as well as the proportion of area treated. Besides these factors, index rankings of active substances of different product groups (fungicides, herbicides, insecticides) were calculated.

RESULTS

For the vegetable survey in 2005, a total of 11,788 plant protection measures in 1,103 datasets were documented and analysed (Roßberg, 2006). Table 1 provides an overview on the application index of the different groups of plant protection products for selected vegetable crops. As expected, great differences between crops existed in the total number of plant protection measures, as well as in the range of the different groups of plant protection products. Salads and cucumbers were the crops with the highest intensity of pesticide use in outdoor and indoor production, respectively. The lowest use of pesticides occurred in spinach and basil production.

Table 1. Application index for selected vegetable crops in 2005.

Crop	No. of data sets	All measures	Fungicide	Herbicide	Insecticide + acaricide
Field					
Salads	137	12.17	5.56	0.63	5.98
Carrot	160	6.91	2.67	2.30	1.93
Asparagus	258	6.66	4.29	1.40	0.97
Onion	147	9.52	5.53	2.73	1.27
Spinach	69	2.34	–	2.30	0.04
White cabbage	163	9.70	1.75	0.89	7.05
Greenhouse					
Basil	47	1.15	0.58	–	0.57
Cucumber	65	9.46	7.67	–	1.79
Tomato	57	4.36	2.72	–	1.24

In the field the most used active ingredients of the fungicides were mancozeb (salads and onions) and difenoconazol (carrots, asparagus and white cabbage). In spinach no fungicides were applied. In the greenhouse propamocarb (basil), difenoconazol (cucumber) and fenhexamid (tomato) were most important. Concerning insecticides, cypermethrin (salads), lambda-cyhalothrin (carrot and asparagus), dimethoate (onions), *Bacillus thuringiensis* (spinach and tomato), methamidophos (white cabbage), soap (basil) and abamectin (cucumber) were the most frequently applied active ingredients. In only a few cases were significant differences observed regarding the intensity of plant protection in the different growing regions of Germany. In greenhouse cultivation, on average, 85–90 % of the measures against insects and mites were releases of beneficials.

DISCUSSION AND CONCLUSIONS

The data collected by the NEPTUN-Project are very important for stakeholders. One of the major benefits is transparency for the public regarding the use of plant protection measures. Growers and consulting services will get valuable information about the status quo. The survey should be done on a regularly basis, to obtain information on the development of plant protection measures in practice. Politicians can use these data for the implementation and observation of special programmes concerning the use of pesticides and the introduction of new techniques.

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