Integration of Biological and Chemical Methods To Control Pests in Greenhouses

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Abstract

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The development of integrated control programmes that are based on the compatible use of biological and chemical methods has gained increasing attention by research scientists in many parts of the world. Studying the side effects of pesticides on natural enemies is particularly important when beneficial organisms are used as biological control agents. The present contribution discusses the development and implementation of biological and integrated control in Germany F.R. and other European countries as well as work on testing the side effects of pesticides on beneficial organisms carried out by the International Organization for Biological Control.

Development of biological control programmes

A successful biological control programme requires the cooperation between research institutions, natural enemies producers, extenstion service and growers. The production of beneficial organisms has to be based on scientific knowlege, require adequate funding and facilities. Proper housing and adequate equipments are needed for establishing of a successful mass rearing.

Effective mass rearing systems to produce the necessary quantities of the natural enemy species with defined qualities for field releases should be developed. Production techniques that insure the preservation of the genetic structure of the population and that prevent any deterioration in the natural attributes of the beneficial organism are required. Beside monitoring efficacy in the field, laboratory methods to detect any changes in the characteristics of the parasite in the rearing should be made available. Suitable location for the rearing near the area where the natural enemies is to be used and close to principal roads, public transportation, or an airport should be chosen. This will speed transportation of insects and enlarge the area of use. To increase effectiveness, natural enemies should be applied at a low pest population, at the beginning of the occurrence of the pest in the field. Adequate monitoring systems are therefore needed. Cool storage and transportation of parasites and predators should be carefully studied. Economic thresholds should be used and chemical treatments should be limited to a minimum. The advantages of using natural enemies in pest management, compared to chemical pesticides include: (1) No toxic residues on plants and soil, (2) application without complicated equipments, (3) pests do not acquire resistance, (4) effective if appropriately developed and used, (5) harmless to natural enemies of pests, (6) can be produced locally in non chemical producing countries.

Interest in the use of parasites and predators to control agricultural pests has rapidly increased world wide in the last few years. Research in this field has intensified and the number of producers has increased rapidly. Whereas no commercial producers for natural enemies were available in Germany F.R. before 1980, 11 were established since then and are operating successfully at the present time. In 1991, *Trichogramma evanescens* has been used to control the European corn borer *Ostrinia nubilalis* on an area of about 4400 ha, *Trichogramma dendrolimi* to control the Codling moth *Adoxophyes orana,* the summer fruit tortrix moth *Adoxophyes orana* on an area of ca. 15 ha. The use of natural enemies to control pests in the greenhouse has increased from 10 ha in 1980 to 200 ha in 1990.

The use of beneficial arthropods in the greenhouse

The most important pests that occur on greenhouse crops in Europe are: Spider mite *Tetranychus urticae,* Glasshouse whitefly *Trialeurodes vaporariorum,* cotton whitefly *Bemisia tabaci,* Aphids (several species), Western flower thrips *Frankliniella occidentalis,* Onion thrips *Thrips tabaci,* Leafminers *Liriomyza* spp., caterpillars (several species), Mealybugs (Pseudococcidae) and fungus diseases. Natural enemies and/ or selective pesticides to control most of these pests are available and should be used in integrated control programmes.

Today, natural enemies are being regularly used in more than 23 countries to control pests in the greenhouse. The area treated with the different beneficial organisms in 1988 were estimated to be: 5750.6 for *Phytoseiulus persimilis* (5398.2 cucumber, 213.4 tomato, 52.6 sweet pepper, 86.4 ornamentals), 3303.9 for *Encarsia formosa* (2301.7 tomato, 929.8 cucumber, 25.3 sweet pepper, 47.1 ornamentals), 268.4

for *Amblyseius* spp. (132.8 cucumber, 135.6 sweet pepper), 110 for *Aphidoletes aphidimyza* (103.2 vegetables, 7 ornamentals), 35 for *Aphidius matricaria* (vegetables) and 490.2 for leafminer parasites on tomato (17). Relevant information from Germany F.R. were published (2) and on the use of resistant *P. persimilis* (16).

Integrated control programmes that combine natural enemies and the use of pesticides were developed in many countries, the following is an example: On tomato, the whiteflies *T. vaporariorum* and *B. tabaci* are controlled by releasing *E. formosa* (mostly 2 treatments), leafminers with *Dacnusa sibirica* or *Diglyphus isaea*, spider mites *T. urticae* with *P. persimilis*, aphids with the insecticide pirimicarb, lepidopterae pests with *Bacillus thuringiensis* or *with trichogramma* spp.. The fungus diseases mildew, Botrytis, Sclerotinia are controlled by fungicides such as chlorthalonil, vinclozolin, benomyl, carbendazim, bupirimat, iprodion, procymidon, dichlofluanid (the last is toxic to *E. formosa*).

The following IPM programme has been developed for cucumber: The spider mite *T. urticae* is controlled by releasing *P. persimilis* (1 or 2 treatments), whiteflies with *E. formosa* (4 treatments), the two thrips species with *Amblyseius* spp. (every 2 weeks) and /or with dichlorvos or pyrazophos treatments, lepidopterae pests with *B. thuringiensis* or *with Trichogramma* spp., aphids with *A. aphidimyza, Aphidius matricaria, Chrysoperla carnea* or with the fungicide pirimicarb. The fungus diseases mildew, Mycosphaerella, Botrytis are controlled by fungicides such as vinclozolin, iprodion, dichlofluanid chlorthalonil, procymidon, bitertanol, fenarimol, bupirimat (dichlofluanid is toxic to *E. formosa* and bupirimat is toxic to *Amblyseius*).

Selective pesticides

Selective pesticides that control pests without adversely affecting its natural enemies can successfully be integrated with biological control methods.

Chemicals that remain in toxic form as residues on the foliage for only a short time after application can also be considered useful in many cases. The Working Group «Pesticides and Beneficial Organisms» of the Interantional Organization for Biological Control (IOBC), West Palaearctic Regional Section (WPRS), was formed in 1974 and consisting today of 67 members, has therefore steadily increased its activities to: (1) Develop standard methods (laboratory, semi-field and field) to test the side effects of pesticides on beneficial organisms according to internationally approved principles; (2) Organize joint programmes to test the side effects of pesticides on natural enemies of pests; (3) Establish a net of testing laboratories for beneficial organisms in the IOBC member countries to continuously use and update the methods; (4) Advice on the choice of selective pesticides for use in integrated control programmes. Some of the activities and collective experimental work conducted by members of the Working Group in the last few years has been summarized in a multi-author publications: (1, 9, 10, 11, 12, 13, 14) involving 7, 14, 29, 21, 20, 22, and 14 authors respectively. Information on the effect of pesticides on greenhouse natural enemies were published by Hassan & Oomen (4). Data gained by this working group are already being used by extension services in different European countries.

The use of internationally approved standard methods will not only allow the exchange of results from one country to another and make the collective presentation of results with different beneficial organisms possible, but will also save the cost of the repeated testing in different countries. Laboratory, semi-field and field test methods are therefore being developed with standard characteristics. Guide-lines for testing the side effects of pesticides on 14 beneficial arthropods in the laboratory, three tests in semi-field and two tests in the field were completed, approved by the ad-hoc Review Commintte of the working group and published (15). The publication of about 20 more standard methods is in preparation.

Study by this Working Group showed that a large number of fungicides, herbicides and insecticides are selective to important natural enemies of major pests. These should be recommended for use in integrated control programmes. Among the 102 preparations tested till now, the following compounds were found to be harmless or to have relatively low toxicity and/or limited persistence to nearly all the beneficial organisms tested and are therefore recommended for use in integrated control programmes:

(1) The insecticides/ acaricides Apollo SOSC (clofentezine), Azomate (benzoximate), Cesar S.L. (hexythiazox), Dimilin (diflubenzuron), Dipel (*Bacillus thuringiensis*), Kelthane (dicofol), Pirimor Granulat (pirimicarb), Shell Tor que (fenbutation oxide), Spruzit-Nova-flüssig (pyrethrum and piperonylbutoxide), Tedion V 18 (tetradifon);

(2) The fungicides Baycor (bitertanol), Bayleton (triadimefon), Daconil 500 (chlorothalonil), Delan flüssig (dithianon), Derosal (carbendazim), Dithane Ultra (mancozeb), Impact (flutriafol), Nimrod (bupirimate), Plondrel (ditalimfos), Pomarsol forte (thiram), Ronilan (vinclozolin), Rovral PM, Vitigran (copper-oxychlor);

(3) The herbicides Ally (metsulfuron-methyl), Betanal (phenmedipham), Illoxan(diclofop-methyl), Kerb 50 W (propyzamid), Luxan 2,4,-D amine (2,4-4 aminesalt), Semeron (desmetryn);

(5) and the plant growth regulators Cycocel Extra (chlormequat), Dirigol-M (alpha naphthyl-acetamid), Rhodofix (naphthyl acetic acid).

Chrysoperla carnea to control aphids

Experiments has shown that *C. carnea* can be effectively used to control *Myzus persicae* on several crops. An artificial diet for rearing the larvae and adults has been developed (Hassan and Hagen 1978) and is commercially used by one company since 1990 to mass produce this predator. Releases on sweet pepper and eggplant has shown that when applied at a predator/pray ratio of 1:5 a virtual total elimination of aphid population is achieved (5,6,9).

Trichogramma to control lepidopterous pests

The release of mass produced egg parasites of the genus *Trichogramma* to control lepidopterous pests has gained increasing attention in the last few years. Over 18 million ha are annually treated with *Trichogramma* species in 16 countries. About 18 different species of this egg parasite are being used to control pests on corn, sugar-cane, rice, soybean, cotton, sugar-beet, vegetables and pine. A survey on the global use of *Trichogramma* was recently summarized in «Trichogramma News» (8).

It is generally known that most *Trichogramma* species show strong preference to certain host(s), crop(s) and climatic conditions. Before field releases be undertaken a suitable *Trichogramma* strain of known qualities should be chosen. The effectiveness of *Trichogramma* in the field largely depends on its searching behavior (habitat location, host location), host preference (recognition, acceptance) and tolerance of environmental conditions. While searching behavior ought to be tested in the presence of plants, in semi-field or field experiments, host preference as well as host suitability may successfully be tested in the laboratory. Efforts are being made to select suibable *Trichogramma* strains and increase the use of this parasite to control pests of greehouse crops.

الملخص

حسن شريف. 1992. تكامل المكافحة الاحيائية مع الطرائق الكيميائية لمكافحة الآفات في الدفيئات البلاستيكية. مجلة وقاية النبات العربية 10 (1): **57-54**.

لقي تطوير برامج مكافحة متكاملة ترتكز على الإستخدام المتوافق للطرائق الكيميائية والطرائق الاحيائية اهتماماً متزايداً من الباحثين في أجزاء عديدة من العالم. وتعتبر دراسة الآثار الجانبية لمبيدات الآفات في الأعداء الطبيعية على غاية من الأهمية عند استخدام هذه الأعداد كعوامل مكافحة احيائية.

وتناقش المقالة الحالية واستخدام المكافحة الاحيائية والمكافحة المتكاملة في المانيا ودول أوروبية اخرى بالإضافة إلى البحوث المتعلقة باختبار الآثار الجانبية لمبيدات الآفات في الكائنات النافعة والتي نفذتها المنظمة الدولية للمكافحة الاحيائية.

References

المراجع

1. Franz, J.M. Bogenschotz, H. Hassan, S. A.; Huang, P.; Naton, E.; Suter, H.; Viggiani, G., Results of a joint pesticide test programmes by the Working Group «Pesticides and Beneficial Arthropods». Entomophaga 25: 231-236.
2. Hassan S.A. & Neuffer G., Praktische Erfahrungen bei der Anwendung der Schlupfwespe *Encarsia formosa* zur Bekämpfung der Weiben Fliege *Trialeurodes vaporariorum* an Tomaten im Gewächshaus. - Mitt. d. Deutsch. Ges. f. allg. u. angew. Entomol., 1: 282-287.
3. Hassan, S.A, & Hagen, K.S., A new Artificial Diet for rearing *Chrysoperla carnea* larvae (Neuroptera, Chrysopidae). - Z. angew. Entomol., 86: 315-320.
4. Hassan, S.A., & Oomen, P.A., Testing the side effects of pesticides on beneficial organisms by IOLB Working Party, 145-152. In: Hussey, N.W., & n: Scopes (eds.): **Biological Pest Control - the glasshouse experience.** Blandford Press, Poole, Dorset, 240 pp..
5. Hassan, S.A. Untersuchungen zur Verwendung des Prädators *Chrysoperla carnea* Steph. (Neuroptera, Chrysopidae) zur Bekämpfung der Grünen Pfirsichblattlaus *Myzus persicae* (Sulzer) an Paprika im Gewächshaus. - Z. angew. Entomol., 82: 234-239.
6. HASSAN, S.A., Releases of *Chrysoperla carnea* Steph. to control *Myzus persicae* (Sulzer) on eggplant in small greenhouse plots. - Z. Pflanzenkrankh., Pflanzensch., 85: 118-123.
7. Hassan, S.A., 1988. Selection of suitable *Trichogramma* strains to control the codling moth *Cydia pomonella* and the summer fruit tortrix moth *Adoxophyes orana, Pandemis heparana*(Lep.:Tortricidae).Entomophaga 34:19-27.
8. Hassan, S.A., 1990. Trichogramma News Nr. 5. Edited by S.A. Hassan, published and printed by Federal Biological Research Centre for Agriculture and Forestry Braunschweig, 45 pp.
9. Hassan, S.A., Klingauf, F, & Shahin, F., 1985: Role of *Chrysoperla carnea* as an aphid predator on sugar beet and the effect of pesticides. - Z. angew. Entomol., 100: 163-174.
10. Hassan, S.A.; Albert, R.; Bigler, F.; Blaisinger, P.; Bogenschutz, H.; Boller, E.; Brun, J.; Chiverton, P.; Edwards, P.; Englert, W.D.; Huang, P.; Inglesfield, C.; Naton, E.; Oomen, P.A., Overmeer, W.P.J.; Rieckmann, W.; Samsoe-Petersen, L.; Staubuli, A.; Tuset, J.J.; Viggiani, G. and Vanwetswinkel, G., Results of the third joint pesticide testing programme by the IOBC/WPRS Worting Group «Pesticides and Beneficial Organisms». Z. angew. Entomol. 103: 92-107.
11. Hassan, S.A.; Bigler, F.; Blaisinger, P.; Bogenschotz, H.; Brun, J. Chiverton, P.; Dickler, E., Easterbrook, M.A., Edwards,P.J.; Englert,W.D.; Firth, S.I.; Huang, P.; Inglesfield, C.; Klingauf, F.; Kühner, C.; Ledieu, M.S.; Naton, E.; Oomen, P.A.; Overmeer, W.P.J.; Plevoets. P.; Reboulet, J.N.; Rickmann, W.; Samsoe-Petersen, L.; Shires, S.W.; Stäubli, A.; Stevenson, J.; Tuset, J.J.; Vanwetswinkel, G. and Zon, A.Q. van, Standard methods to test the side-effects of pesticides on natural enemies of insects and mites developed by the

IOBC/WPRS Working Group «Pesticides and Beneficial Organisms». Bulletin OEPP/EPPO Bulletin 15: 214-255.

12. Hassan, S.A.; Bigler, F.; Bogenschütz, H.; Boller, E.; Brun, J.; Chiverton, P.; Edwards, P.; Mansour, F.; Naton, E.; Oomen, P. A.; Overmeer, W.P.J.; Polgar, L.; Rieckmann, W.; Samsoe-Petersen, L.; Stäubli, A.; Sterk, G.; Tavares, K.; Tuset, J.J.; Viggiani, G. and Vivas, A.G., Results of the fourth joint pesticides testing programme carried out by the IOBC/WPRS-Working Group «Pesticides and Beneficial Organisms». Z. angew. Entomol. 105: 321-329.
13. Hassan, S.A.; Bigler, F.; Bogenschütz, H.; Boller, E.; Brun, J.; Calis, J.N.M.; Chiverton, P.; Coremas-Pelseneer, J.; Duso, C.; Lewis, G.B.; Mansour, F.; Moreth, L.; Oomen, P.A.; Overmeer, W.P.J.; Polgar, L.; Rieckmann, W.; Samsoe-Petersen, L.; Stäubli, A.; Sterk, G.; Tavares, K.; Tuset, J.J. and Viggiani. G., Results of the fifth joint pesticide testing programme carried out by the IOBC/WPRS - Working Group «Pesticides and Beneficial Ogranisms». Entomophaga. 36: 55-67.
14. Hassan, S.A.; Bigler, F.; Bogenschütz, H.; Brown, J.U.; Firth; S.I.; Huang, P.; Ledieu, M.S.; Naton, E.; Oomen, P.A.; Overmeer, W.P.J.; Rieckmann, W.; Samsoe-Petersen, L.; Viggiani, G.; Zon, A.Q. Van, Results of the second joint pesticide testing programme by the IOBC/WPRS Working Group «Pesticides and Beneficial Arthropods». Z. angew. Entomol. 95: 151-158.
15. IOBC/WPRS Bulletin, XI/4, 1988: Working Group «Pesticides and Beneficial Organisms», Gluide-lines for testing the effects of pesticides on beneficial: short description of test methods, 143 pp.
16. König, K.&Hassasn S.A.. Resistnenz und Kreuzresistenz der Raubmilbe *Phytoseilus persimilis* (Athias-Henriott) gegenüber organischen Phosphorsäureestern. - Z. angew. Entomol., 101: 206-215.
17. Lenteren Van, J.C., Sting- Newsletter on Biological Control in greenhouses, Department of Entomology, University of Wageningen, 45 pp.
18. Samsoe-Petersen, L.; Bigler, F.; Bogenschütz, H.; Boller, E.; Brun, J.; Hassan, S.A.; Kühner, C.; Mansour, F.; Naton, E.; Oomen, P.A.; Overmeer, W.P.J.; Polgar; L.; Rieckmann, W. and Stäubli, A., 1989: Laboratory rearing techniques for 16 beneficial arthropod species and their prey/hosts. Z. Pflanzenkrankh., Pflanzensch. 96: 289-316.