T1988 CROP 02

# NOWADAYS TRENDS OF DRAWING UP SYSTEMS OF INTEGRATED CONTROL OF SUNFLOWER PESTS AND DISEASES

H. Iliescu, T. Baicu
Research Institute for Plant Protection, Bd. Ion Ionescu de la Brad, no. 8, Bucharest 71592, S.R. of Romania.

## SUMMARY

In view of attaining control systems of sunflower pests and diseases it is necessary to observe the following principles:
1. The unit where the integrated control system is applied is the crop agroecosystem in the frame of crop rotation.
2. Insects damaging species in sunflower crops are not removed, and the pathogens attack is not totally reduced; it is maintained at the level where yield losses are not recorded.
3. Usage of natural elements to regulate population densities must be increased as to limit the attack level.
4. The up-to-date cropping technologies can cause unexpected and negative effects, which are to be considered.
5. The integrated control systems rely on the harmonious relations between control methods.
6. The integrated control systems must have specific means to regulate treatments.
7. The integrated control systems must take into consideration the requirements of modern cropping technologies.
8. The integrated control systems must consider the toxicological, energetical, economic requirements and those referring to environment protection.
9. The integrated control systems must be part of sunflower cropping technology.
10. Drawing up integrated control systems must rely on an interdisciplinary approach, systemic and for the future it has to rely on mathematic models.

## INTRODUCTION

The development of sunflower crop leads, to the usage of some pesticides quantity per hectare, and that potentially could cause some negative side effects, The pollution phenomenon can be the effect of insecticides application for the control of soil pests (Agriotes sp., Tanymecus dilaticollis Gill, larvae of Noctuidae, etc.) or of some diseases. Application of fungicides based on benzimidazoles, thiophanates, etc. could favour the occurrence of resistant races of Botrytis cinerea Pers or resistant forms of this fungus originated in glasshouses or in viticulture, as well. The same substances can induce the development of diseases caused by fungi of Alternaria genre, if they are applied repeatedly. On the other hand, in the domain of plant protection, an ever more e ecological approach of control is requmred, These elements led to the approach of the matter of implementing integrated control systems in sunflower crop, too.(Iliescu et al. 1984, Iliescu and Baicu 1984, Baicu and Săvescu 1986).
It has to be stressed that there are no integrated control systems for sunflower pests and diseases which are quite elaborated, although some of the elements to fulfill integrated control systems are available.
Hereinafter the general principles to draw up integrated control systems (Baicu 1986) for sunflower crop, will be adapted.

Table 1

Influence of sunflower rotation and preponderance within crops structure on the seed phytosanitary aspect and yield.

Fundulea 1982

| Rotation years | Preponderance within crops structure % | Plasmopara helianthi F% | S.sclerotiorum B.cinerea F% | Other pathogens AI% | Yield q/ha |
|---|---|---|---|---|---|
| Pea, wheat, maize - pea, wheat, maize - sunflower 7 | 14 | 0.3 | 0 | 3.3 | 25.4 |
| Pea, wheat, maize, sugarbeet, maize - sunflower 6 | 17 | 1.7 | 0 | 6.3 | 25.2 |
| Pea, wheat, maize, maize - sunflower 5 | 20 | 6.3 | 3.1 | 17.3 | 23.8 |
| Pea, wheat, maize - sunflower 4 | 25 | 15.1 | 5.3 | 14.4 | 22.7 |
| Maize, sunflower 2 | 50 | 31.7 | 16.3 | 21.3 | 17.6 |
| Check 1 | 100 | 35.5 | 16.5 | 26.3 | 13.1 |
| LD 5% | | 2.7 | | 3.1 | 2.1 |
| LD 1% | | 7.9 | | 10.3 | 4.5 |

PRINCIPLES OF DRAWING UP THEIR APPLICATION IN SUNFLOWER CROPS.

1. The unit where integrated control is applied is the agroecosystem but within crop rotation.

In view of pointing out the key pests (fig.1) as well as the secondary ones means an approach of the control matters in relation first of all with the cropping plant. Sunflower is an annual hoeing crop where natural biotic factors of regulating pest populations and mainly diseases have a less important role than in other crops of perennial type. Anyhow for secondary pests and diseases, abiotic and biotic elements have an important role in maintaining a low level of attack. In case of sunflower crop, due to the existence of many polyphagous harmful organisms or with a long soil persistence, measures which are taken by means of rotation have a much bigger importance than in other crops. In Table 1 it is rendered the impact of rotation on the attack of various diseases and of yield as well.

The data render accurately the enhance of the attack of P.helianthi, S.sclerotiorum, B.cinerea and other pathogens (Iliescu et al. 1984). Similar data can be registered both with Tanymecus dillaticolis and Orobancheae if there is a lack of control measures. There are some data which certify the influence of fertilizers applied on previous crops within rotation, on the development of sunflower diseases.

All these data demonstrated that sunflower integrated control systems (ICS) must be oriented to rotation as well.

2, Insect harmful species in sunflower crop are not removed, and pathogens attack is not totally reduced but maintained at a level where yield losses are not registered.

In the frame of sunflower agroecosystem harmful species have not an equal importance. There are main and secondary ones (fig.1) as well as many other species of no economic importance which are not to be found in fig.1. Their importance and even their division in the categories enlisted in fig.1 can be different function of the cropping geographical area. Control methods and particularly the chemical ones are applied yearly for key species. For secondary species only when they developed too much and can cause great losses.

On the other hand, it is not necessary for key pests all individuals to be eradicated or to remove any trace of disease attack. Sunflower crop has a certain capability of foliage recovery which enable it to bear a low attack without economic losses. Maintaining a certain number of pests allow many entomophagi to coexist.

In case of sunflower, such an example is Brachycandus helichrysi and its entomophagi.

3. Usage of natural factors to regulate population density must increase as to limit the attack level. Among the factors which determine the level of harmful organism populations and disease attack, too, the abiotic ones have often an important role. Each species has a low and a high limit of temperature, humidity, etc. which, if they are surpassed their development is stopped. Knowledge about these elements enable us to choose corectly the type of soil, planting period, sowing depth etc.

Much more important are the biotic elements (parasites, predators, antagonists, etc.) which have a great role for secondary harmful organisms.

For the main ones, only in some periods, they can be of some importance, but they cannot reduce the attack at a level where economic

damages cannot be caused.
A much impoɛtant natural adjustability of densities can be observed with B.helichrysi, S.segetum and O.cumana. At S.sclerotiorum the sclerotia are destroyed in soil by a complex of fungi which however cannot influence too much, naturally speaking, the attack.
4. Modern cropping technologies can caused unexpected and negative effects which are to be considered.
These technologies are studied by means of rigurous experiments and they are promoted after being checked out in agricultural units. Their long lasting activity, with ecologic characteristic is evidenced under these conditions. Very long after a few or more years effects can occur which imply plant protection. In the field of sunflower cropping, for example, tendencies to reduced rotation duration lead to the increase of the attack of white rot etc. Cropping after maize, enhance the attack of Tanymecus dilaticollis etc. Extent of benzimidazole and thiophanate treatments can favour the appearance of resistant races to B.cinerea, etc. Interactions between hybrids and varieties of sunflower, fertilization, soil works, densities etc., on one hand and the development of harful organisms on the other hand, require particular research works carried out with a view to draw up the integrated control systems. In Table 2 it is rendered the impact of fertilization on the development of S.sclerotiorum attask. The excess of Na and in general its lack of balance with P and K lead to the increase of the attack frequency with influencies on the yield/ha. That means that the non-observance of some technological elements can also lead to the increase of attacks.
5. Integrated control systems rey on the harmonious link between control methods. Sunflower pests and disease control methods are different and that is the reason why they have to be examined and selected as to fit (as well as possible) the targets of integrated control. Another aspect is their harmonious link as to remove possible antagonistic effects. There are mainly to be removed the negative effects of pesticides on entomophagi of crops or, on biological means which are directly involved in control. In sunflower crops can be avoided dusting with Lindane or spraying with dimethoate pyrethroids etc., to control weevil by seed dressing with carbamic, systemic insecticides as for eg.: carbofuran, bendiocarb, furathiocarb, etc. The quantity of active ingredient per ha in that case hardly attains 50-70 g that is just a little if compared with at least 1 kg a.i. in case of dusting or spraying with organo-chlorurate or organo-phosphoric insecticides.
This selective treatment shows a weak effect on useful entomophauna mainly on Carabidae and Staphylinidae. At the same time, spiders are practically not affected.
In case of heavy densities of wire worms and weevils granulated insecticides can be applied which are less selective than dusting or spraying. For diseases, chemical control methods have been established (Iliescu et al., 1984; Acimović et al., 1982; Maric 1983, etc.) which allow the decreases of the attack of S.sclerotiorum, Phomopsis helianthi, Botrytis cinerea, etc., during vegetation period.
Table 3 renders the data of an experiment (Iliescu et al., 1984) which demonstrates quite clearly the effectiveness of treatments applied in the control of Phomopsis helianthi attack. Fungicides used in the experiment are not quoted as having negative impact on entomophagi.

Table 2

Influence of fertilization level on the attack level of white rot in sunflower (natural infection).

Fundulea, 1981-1982

| Fertilization level | Fundulea 59 Frequency % S.sclerotiorum | Yield q/ha | Sorem 80 Frequency % S.sclerotiorum | Yield q/ha |
|---|---|---|---|---|
| $N_oP_o$ | 5.8 | 29.5 | 5.6 | 40.6 |
| $N_oP_{4o}$ | 7.0 | 26.7 | 4.2 | 39.4 |
| $N_{4o}P_{4o}$ | 15.3 | 28.9 | 9.9 | 40.1 |
| $N_{4o}P_{4o}K_{4o}$ | 14.4 | 27.5 | 10.4 | 38.0 |
| $N_{8o}P_{4o}$ | 18.1 | 25.9 | 19.4 | 33.8 |
| $N_oP_{8o}$ | 2.2 | 28.6 | 1.1 | 38.9 |
| $N_{4o}P_{8o}$ | 9.7 | 26.6 | 6.6 | 38.5 |
| $N_{8o}P_{8o}$ | 25.2 | 23.2 | 17.3 | 35.7 |
| $N_{8o}P_{8o}K_{4o}$ | 29.1 | 22.6 | 11.1 | 37.0 |
| $N_{8o}P_{8o}K_{8o}$ | 20.0 | 26.5 | 9.3 | 36.1 |

Among the biological means meant to control harmful organisms in sunflower crops there are to be found: Phytomyza orobanchia to control white rot.
P.orobanchia has limited usage due to the new hybrids and varieties with increased resistence to Orobanchae.

Table 3

Effectiveness of some fungicides applied during vegetation against brown spot and stem lodging of sunflower (Phomopsis helianthi).

Oradea 1982 (Sorem 82)

| Product | 2 treatments F% | 2 treatments % broken plants | Yield q/ha |
|---|---|---|---|
| Benomil 0.75 kg/ha | 42.7 | 5.0 | 20.3 |
| Vinclozolin 0.375 kg/ha + Carbendazim 0.25 kg/ha | 79.7 | 7.5 | 19.1 |
| Iprodion 0.75 kg/ha | 80.7 | 15.0 | 15.3 |
| Untreated check | 88.3 | 25.0 | 8.3 |
| LD 5% | | | 3.5 |
| LD 1% | | | 5.1 |

T.viride, in our experiments showed a better activity applied for seed dressing mainly when soil temperature is higher.
Table 4 renders an experiment (Iliescu et al. 1984) where strains of Trichoderma viride ($TD_{23}$ and $TD_{50}$) gave satisfactory results used alone or as a mixture with some fungicides.
That demonstrates that it is possible to integrate this biological

means with fungicides for seed dressing.

Table 4

Effectiveness of biological treatments with Trichoderma viride in the control of Sclerotinia sclerotiorum and Botrytis cinerea attacks on sunflower during dgermination-emergence-seedling stages (artificial infection in soil, 1982).

| Variant | S.sclerotiorum Healthy plants % | | B.cinerea Healthy plants % | |
|---|---|---|---|---|
| | 7 days | 14 days | 7 days | 14 days |
| Rovral TS 0.2% (seed treatment) | 76.0 | 78.0 | 93.3 | 90.6 |
| TD 23 (seed treatment) | 78.6 | 73.3 | 90.6 | 92.0 |
| $TD_{50}$ (seed treatment) | 72.6 | 70.6 | 94.6 | 92.6 |
| Rovral TS 0.1 kg/q + $TD_{23}$ (soil treatment) | 73.3 | 70.0 | 90.6 | 93.3 |
| Rovral TS 0.1 kg/q + $TD_{40}$ (soil treatment) | 72.6 | 70.0 | 96.6 | 98.6 |
| Rovral TS 0.1 kg/q + $TD_{50}$ (soil treatment) | 70.6 | 62.6 | 96.6 | 96.6 |
| Untreatment check | 47.3 | 39.3 | 69.3 | 60.0 |
| LD 5% | 4.9 | 7.9 | 6.2 | 5.3 |
| LD 1% | 6.7 | 10.8 | 8.4 | 7.2 |
| LD 0.1% | 9.1 | 14.7 | 11.4 | 9.7 |

In the frame of methods relationships, the interactions, hybrids and cvars resistence - pesticides, hybrids and cvars resistence - biological means, hybrids and cvars - agrotechnical means, pesticides - agrotechnical means, pesticides- biological means, and so on and so forth are to be thoroughly studied.
The interactions between hybrids resistence, densities and various levels of pesticides have been studied by Iliescu et al. (1987) in the frame of large trials with many elements.
Data of Table 5 explain one aspect of the manyfold relations under observation, by which it is explained the idea of the necessity to study the interactions between various agrotechnical elements and the occurrence of disease attack.
6. Systems of integrated control must have specific means to regulate treatments.
Proper application of both chemical and biological treatments is another important aspect for the success of ICS.
In the frame of ICS for sunflower crop, seed dressing although have a preventive characteristic has a particular role to play in limiting the attacks of S.sclerotiorum, B.cinerea, Plasmopara helianthi, etc., as well as of some pests as Elateridae and T.dilaticollis. An important part in introducing ICS have the forecasting and warning methods. Nowadays there are such methods for T.dilaticollis, wire worms (Elateridae), downy mildew (Plasmopara helianthi)

Table 5

Genotype uinfluence on the pathogen attack frequency (%).

Sclerotinia sclerotiorum

| Hybrid | HDF | | HDSt | | HSFt | |
|---|---|---|---|---|---|---|
| Romsun 53 | 13.8 | a | 12.4 | a | 10.9 | a |
| Select | 9.5 | b | 9.7 | b | 8.8 | b |
| | LD 5% | = 0.52 | | = 1.0 | | = 1.5 |

Phomopsis helianthi

| Hybrid | HDF | | HDSt | | HSFt | |
|---|---|---|---|---|---|---|
| Romsun 53 | 20.9 | a | 17.9 | a | 14.28 | a |
| Select | 6.8 | b | 5.3 | b | 3.6 | b |
| | LD 5% | = 1.2 | | = 1.2 | | = 1.44 |

HDF - interactions between hybrids-densities-fertilization
HDSt - interactions between hybrids-densities-seed treatment
HSFt - interactions between hybrids-sowing-foliage treatments

Methologies for white rot (S.sclerotiorum) and grey rot (B.cinerea) have to be improved (Forecast methods, 1980, Săvescu and Rafailă, 1978).

Recently there have been established the necessary warning elements for Phomopsis helianthi (Iliescu et al., 1985).

Much more important are the economic threshold (ET), an ICS element which allow treatments to be applied only when yield losses are equal with treatment cost. There are so removed some treatments which are preventive only. By establishing the ET on each plot, field, etc. some treatments can be done with when ET is not achieved.

The literature in this domain is very poor in such kind of data for sunflower crop. That is why one of priority aims in the field of drawing up ICS for sunflower crop is to establish ET for the main pests and diseases. The numeric relation between entomophagi and pests where the entomophagi maintain at a low level pest population and therefore treatments are no longer required, is another useful elememt. For B.helichrysi it is necessary and possible to establish this index, too.

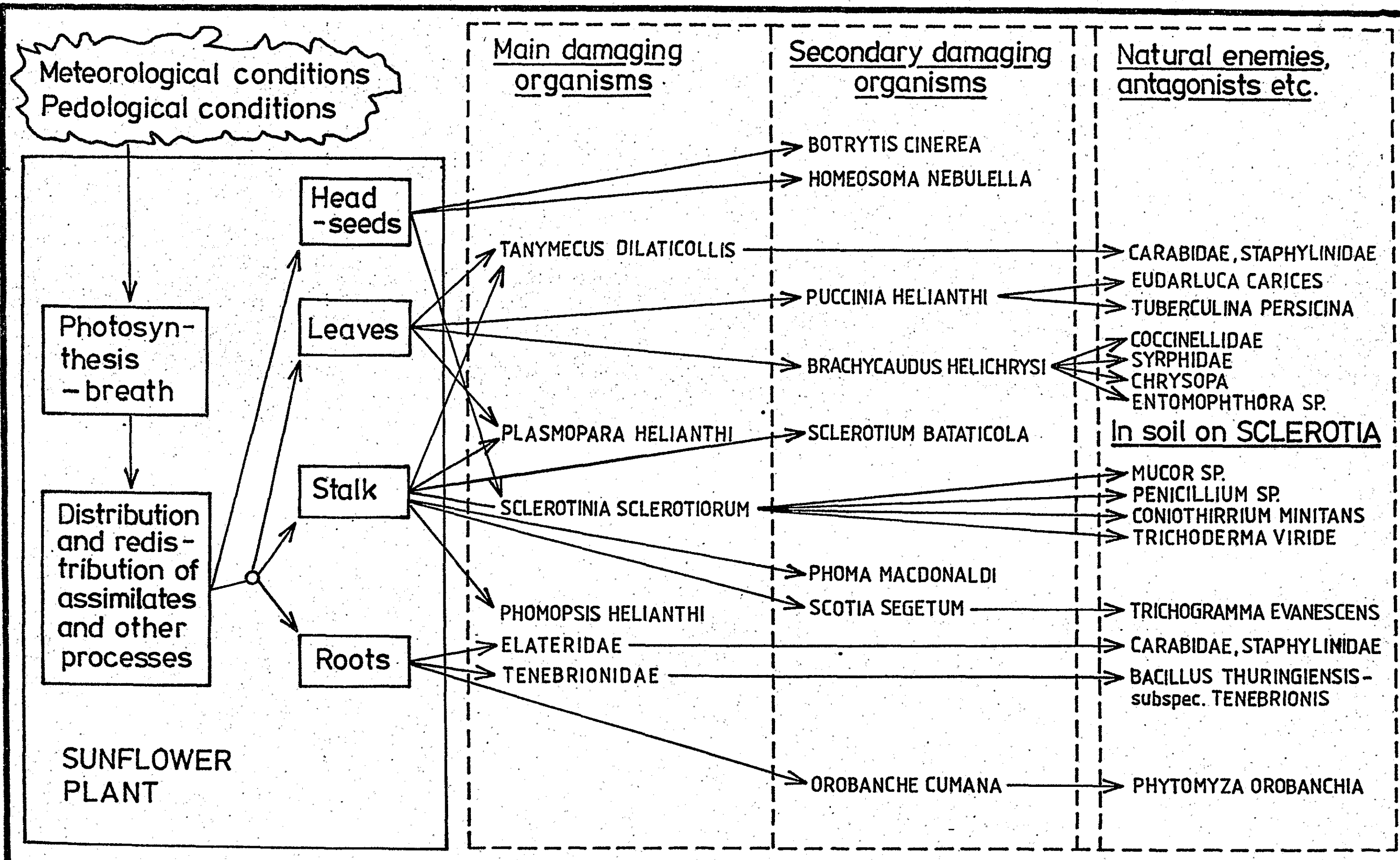
Usage of sexual pheromones for some Agrotinae which occur in sunflower crops is another working idea which can lead to treatment adjustment. Taking into account sunflower crop susceptibility, tow main phases to concentrate control works: the emergence stage and after flowering-setting of head stage are to be established. During the first stage, soil pests, white rot, grey rot, downy mildew have a particular role in establishing the density. The control matters in this stage are adequately solved by seed dressing with a complex of fungicides and insecticides.

Control, in the second stage, depends a great deal of hybrids resistance and at the same time by chemical treatments during vegetation. These are to be applied after warning ET.

7. ICS must observe the requirements of up-to-date cropping technologies.

ICS as a complex of control methods, with interdependent elements which rely on natural factors of densities regulation with a view not to surpass ET can be looked upon from modern cropping technologies and systemic analysis stand point, as well.

From systemic stand point 4 subsystems can be observed:
a) Subsystem of technological processes which means in fact all protection works, resistent hybrids and varieties, chemical and biological means, etc.
b) Subsystem of the control of seed treatment quality (biologic and colourimetric) of treatments during vegetation (% of coverage, number of drops/sq.cm, etc).
c) Handling subsystem which includes transportation, preservation of chemical products mainly of biological ones. In this subsystem there could be included the process of obtaining some biological products in agricultural units. This subsystem is common to more agricultural crops.
d) Management subsystem which ensures carrying out the works in due time and space provided the level of planned yields, biological cycle of sunflower crop and harmful organisms, density of pests population, level of disease attack, relation entomophagi: pests, etc. This subsystem includes warning methods, methods to establish ET, automatic equipment for meteorological data processing, microcomputers, etc.
8. Integrated control systems must observe the toxicological, energetical, economical requirements and those of environmental protection as well.
Study of registered fungicide and insecticide range to be applied in sunflower crop from toxicological stand point demonstrates that fungicides based on benzimidazoles (benomyle, carbendazim, thiabendazole), thiophanate-methyl, methalaxyl, oxadixyl, etc. do not arise such kind of problems. Dicarboximidae (vinclozoline, iprodion, procimidon, etc.) are also very good. Although some international medical organisms ask for a thorough research of their activity.
Insecticides recommended for seed treatment (heptachlor, carbofuran, furathiocarb, etc.) are very toxic, but their application in very low rates per hectare only by seed treatment limits the risks. Anyhow, research works are to be carried out as to introduce new less toxic products instead of the existing ones.
From energetical stand point, the least calory consuming measure is to crop resistent hybrids and varieties. At the same time, usage of compatible mixtures of fungicides and insecticides for seed dressing or during vegetation period, allow the decrease of energetic consumption if compared with their separate application.
From economical point of view, the cheapest treatment is that of seed dressing. Those applied during the vegetation period are very economical in crops for seed purposes. In ordinary crops usage of ET also ensures treatment economy. Nowadays chemical technologies have a consumption rate of 2-3 kg a.i./ha; in the frame of some measure complexes with integration elements this consumption can decrease to 1.2 kg a.i./ha, thus reducing the amount of pesticides per hectare and contributing to a better environmental protection.
9. ICS must be included in sunflower cropping technologies. It can be defined a sumum of agrophyto-technical methods and other methods as well and their interaction in space and time on modern hybrids and varieties and various soil types, thus leading to obtaining seed yield.
In the frame of sunflower cropping technology ICS must be organically included without any of its elements coming into contradiction with the basical requirements of the technology. Intensive agricultural technologies of industrial type for sunflower crop




—CONCEPT PATERN OF THE SYSTEM OF SUNFLOWER PLANT — HARMFUL ORGANISMS — NATURAL ENEMIES, ANTAGONISTS foresee increased quantities of chemical products which are to be applied mainly preventive. Under these circumstances ICS can be attained. Including ICS in cropping technologies must observe such modern requirements as: fiability, flexibility, modular structure and typification.

10. Establishing integrated control systems must rely on an interdisciplinary, systemic, in prospect approach, on mathematic models. The interdisciplinary approach in case of sunflower crop ICS is governed by the complexity of harmful organisms agroecosystem and by various control methods, too. It is necessary to use results of the researches carried out in the field of breeding, agronomy, physiology, ecology, chemistry, systematics, entomology, phytopathology, weed science.

The systemic approach is required as to solve the implementation of ICS in the frame of sunflower agroecosystem. This is in fact a biological system formed by different elements which can influence both the level of harmful populations density and the level of losses. Some of these elements depend on man, but most of them cannot be directly controlled. The systemic approach requires models, particularly mathematical models.

Starting from Gutieerf's (1986) work, in fig. 1 it is rendered a conceptual model adapted to sunflower crop - harmful organisms and of those useful for integrated control.

For the future, the relations as shown by this scheme must be quantitatively expressed and mathematical formula meant for models are to be elaborated.

## CONCLUSIONS

In the present there is a lot of data necessary for the elaboration of a complex of control measures with many elements of ICS for sunflower crop. But it is necessary to develop the reseasrches concerning sunflower agroecosystem as well as the methods of treatment adjustment, biological control means, mathematical modelling.

## BIBLIOGRAPHY

1. Acimovic M., Strasser N., Drazic S., 1982, Moguénost suzbijanja Phomopsis sp. i ostalih prouzrokovaca bolesti suncokreta zastita bilja br. 161: 293-299.
2. Baicu T., 1986, Les principes d'élaboration de systemes de lutte intégrée. Bull. ASAS Nr. 16: 179-190.
3. Baicu T., Săvescu A., 1986, Sisteme de combatere integrată a bolilor şi dăunătorilor pe culturi, 265 p., Ed. Ceres, Bucureşti.
4. Gutierref A.P., 1987, L'analyses des systèmes en protection intégrée, p.71-84, Protection intégrée Ed. Delucehi, Parasitis 86, Genève.
5. Iliescu H., Baicu T., 1984, Mesures de lutte intégrée contre les agents pathogènes du tournesol, Helia no. 7: 39-44.
6. Iliescu H., Csep N., Ioniţă Alina, Jinga V., Bobeanu A., 1987, Résultats concernant la lutte intégrée contre les maladies du tournesol, Helia no.10 (in press).
7. Iliescu H., Jinga V., Ciurea Alexandra, Ioniţă Alina, 1985, Investigations related to the prognosis of sunflower stem canker, Helia no.8, 51-56.
8. Iliescu H., Sin Gh., Toncea I., Pîrvu N., Csep N., Ivancia Valeria, Sesan Tatiana, Păcureanu Maria, Voinescu I., 1984, Posibilităţi de combatere integrată a principalelor boli şi dăunători ai florii soarelui, Analele ICCPT vol. 52, p. 213-221.
9. Maric A., 1984, Proceedings of reports on chemical control of

sunflower diseases during 1983 in Voivodina (Yugoslavia). Szudentski centar UK SSO Beograda.
10. Săvescu A., Rafailă C., 1978, Prognoza în protecţia plantelor, 354 p., Ed. Ceres Bucureşti.
11. x x x, 1980, Metodici de prognoză şi avrtizare, 538 p., CMDPA-Bucureşti.