MANAGEMENT OF RICE INSECT PESTS

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Abstract

Rice plants are liable to attack, allover the world, of more than 100 insect species, about 20 of which result in an economic damage. These insects are categorized as : 1) root feeders, 2) stem borers, 3) leaf-and planthoppers, 4) defoliators, and 5) grain sucking insects. Managing rice insects, to minimize yield losses , depends on the integration among different tactics; host plant resistance, cultural practices, biological control and, if needed, chemical control. In Egypt, breeding materials are screened annually for rice stem borer and rice leafminer infestations. The entries showing resistance to insects are promoted in the breeding program depending on the evaluation of other traits required by the plant breeders. At IRRI, *Bt* rice (rice modified with *Bacillus thuringiensis* genes) resistant to lepidopterous insects is being developed. This type of resistance to insects can prohibit the application of insecticides to control rice stem borers. However, the hurdle is how to avoid the development of rice insect resistance to *Bt* rice. Cultural practices could be manipulated to reduce the insect populations. It was found that sowing rice as early as first half of May, and prolonging irrigation intervals can reduce the damage to rice plants resulting from the rice leafminer, *Hydrellia prosternalis.* Cutting rice stems at harvest, as close as the soil surface, removes the majority of rice stem borer larvae inside rice straw and the minority inside rice stubbles. From the point of view of borer control, it is required to get most of the larvae inside rice straw which is subject to many practices during winter that kill the harboured larvae. After rice harvest, it is recommended to eradicate the rice residues, which kills 98% of *Cillo agamemnon* larvae. The biological control component is highly emphasized at Rice Research and Training Center (RRTC), Egypt. About 12% of *H. prosternalis* larvae were killed by the parasite, *Opius hedqusti.* Eggs of leafhoppers and planthoppers are parasitized by *Oligosita spp, Paracentrobia spp, Anagrus spp, Gonatocerus spp* and *Camptoptera spp.* For the rice stem borer biological control, *Trichogramma evanescens* was released twice, each at a rate of 75,000 individuals per ha. The dead hearts and white heads resulting from *C. agamemnon* infestation were reduced by 61.48 and 77.31%, respectively due to the release of *Trichogramma.* Survey of the insect predators prevailing in rice fields revealed the occurrence of 26 species belonging to 16 families and 8 orders, mainly Coleoptera and Hemiptera. Furthermore, 12 spider species, arranged in seven families, were surveyed from rice nurseries and paddies. Most of the surveyed true spiders were found belonging to families Araneidae and Salticidae.

INTRODUCTION

Rice plants are liable to attack of more than 100 insect species; about 20 of which result in an economic damage. These pests attack rice plants from the seedling stage to maturity and feed upon all parts of the plant. Feeding pests consist of (1) root feeders, (2) stem borers, (3) leafhoppers and planthoppers; (4) defoliators, and (5) grain sucking insects. Also, rice in storage is damaged by a large variety of insect pests.

Root feeders are termites (Isoptera) and the rice water weevil, *Lissorhoptrus oryzophilus* (Coleoptera). Termites are pests in upland rice fields, as in West Africa, where they may kill the plants. The rice water weevil is a major pest in USA; the larvae of the insect severely reduce the root system, reflecting low rice yield.

Stem borers (Lepidoptera) larvae live in rice stems, resulting in two symptoms of damage. During vegetative stage, the larvae kill the central shoots resulting in "dead heart" and thus the tillering is reduced. During reproductive stage, the larvae feed inside the shoots directly under the panicle which becomes empty with no filled grains, and appear as white panicles called "white heads". The latter symptom is more responsible for yield losses than the former one, because rice plants can not compensate for white heads.

Rice hoppers (order Homoptera) are leafhoppers (Cicadellidae) that attack all aerial parts of the plant, and planthoppers (Delphacidae) which attack the stems. Both groups are sucking insects, removing the plant sap. The heavily damaged plants exhibit the symptom of "hopper burn". These insects can also transmit virus diseases.

Defoliators, e.g. rice leafminers, *Hydrellia* spp damage the rice leaves, and thus reduce the photosynthetic capacity of rice plants. However, foliage removal by most of defoliators is usually below the yield reducing level.

The stink bugs (Hemiptera) penetrate the developing grain with their sucking mouth parts and feed on the fluids of the spikelets during milky stage resulting in "pecky rice". The latter symptom reduces the values of rice grain in marketing.

In Egypt, rice plants are liable to attack by several insects, but fortunately, only three cause yield losses; the rice stem borer, *Chilo agamemnon* Bles. rice leafminer, *Hydrellia prosternalis* Deem. and bloodworms, *Chironomus* spp. Field losses due to stem borer are estimated as 5-8% depending on rice cultivar (Sherif 1996). Rice leafminer can result in considerable yield losses when rice is planted later than mid-May which is the recommended date for sowing. The bloodworms are serious insects in saline soils, particularly in rice nurseries and direct-seeded fields. The severely damaged areas may need resowing.

Managing rice insects, to minimize yield losses, depends on the integration among different tactics of insect pest control; host plant resistance, cultural practices, biological control, and eventually, if needed, chemical control. The combination among these tactics is crucial to avoid the excessive application of insecticides that are commonly misused among rice farmers (Heong *et al.* 1994).

COMMON FIELD PESTS OF RICE IN EGYPT

Rice plants, in Egypt, are liable to attack by several animal pests. Sherif *et al.* (1999) reviewed the recorded pests damaging rice plants during the growing season (Table 1). Other than the conventional insects, thrips has been recently recorded to infest rice nurseries (Sherif and Hendawy 2004). Also, the crayfish, *Procambrus clarkii* (Girard) and *Orconectes virilis* (Hagen) burrow in the levees and destroy the irrigation system. These two species have become a threat to rice production, because the water source is a very limiting factor in rice production in Egypt.

INSECT DAMAGE AND YIELD LOSSES

In some areas of rice cultivation, the insects result in a considerable damage, reducing the rice yield economically, but in some other areas, these insects are of low significance. Cramer (1967) estimated the rice yield losses caused by insects, reviewing the literature, and found that the loss levels ranged between 2.0% in Europe and 31.5% in tropical Asia (Table 2).

Stem borers

Losses in rice yield due to stem borers depend on pest population density, time of damage and growing conditions. According to Israel and Abraham (1967), 1% increase in stem borer infestation reduced grain yield by 0.28% in young plants, and by 0.62% in plants of reproductive stage. Pathak (1968) reported that 1% white heads caused 1 to 3% yield loss. However, Rubia & Penning (1990), in their model, found that up to 20% dead hearts at the vegetative stage had insignificantly reduced the grain yield, while white head had caused an almost proportionate yield reduction. They suggested that spraying against stem borers at the early vegetative stage is often unnecessary since young rice plants can tolerate considerable damage.

In Egypt, Abdallah *et al* (1989) simulated the damage of *C. agamemnon* by detillering. At 40 days after transplanting, 10% simulated dead hearts resulted in 6-8% yield losses by the progress of the season, 2% damage occurring 75 days after transplanting, resulted in about 5% yield reduction. Isa (1989) estimated losses due to the borer as 5-6%. Khadr *et al.* (1991) indicated that late detillering reflects more yield reduction than does early detillering, compensation for injury was greater in IR28 (indica) than in Giza 172 (japonica). Sherif *et al.* (1991) reported that for every 1% increase in dead hearts, rice yield was reduced by 0.4%, while 1% increase in white heads resulted in about 1% yield loss.

Leafminers

Rice leafminers damage rice plants, but it is uncertain whether they result in losses in rice yield or not. Some authors (Singh *et al* 1990 and Manandhar and Grigarick 1983) found no correlation between the presence of rice leafminers and rice yield, indicating that these insects are probably of little economic importance in rice cultivation. Others suggest that they lead to considerable losses. Results of the International Rice Research Institute (IRRI 1975) indicated that almost all of the substantial and significant yield differences were caused by rice leafminers during early crop growth, but the tiller number of damaged hills may be similar to that of undamaged ones. Manandhar & Grigarick (1983) concluded that *H. griseola* feeding was more negatively affecting on younger leaves than on older ones. They also found that mining in leaves restrained on the water surface showed a greater damage on the plant growth than infestation in upright leaves.

Experiments conducted at Rice Research and Training Center in Egypt (1999) revealed that rice sown during May did not suffer any yield losses since the plants were capable of compensating the insect damage. In late sowings (during June), the protected plots significantly yielded more than unprotected ones. El-Habashy (2003) recorded the highest loss in rice yield (18.22%) when sowing rice one month later than recommended, while the least loss (0.45%) was induced from plots sown on 5 May (within the recommended duration of sowing).

Leafhoppers and planthoppers

Leafhoppers and planthoppers become serious pests in the disturbed rice ecosystems. In such disturbance, the natural enemies populations are seriously destroyed, mainly due to excessive applications of insecticides. However, these hoppers result in two types of damage; 1) direct damage, when they occur in dense numbers and feed upon rice plants by sucking plant saps turning the severely affected plants dry. In this case, the rice field has the symptom of "hopper burns", which reflects few tillers, small panicles and reduced yield. 2) indirect damage, because several species of leafhoppers and planthoppers transmit virus diseases. The green leafhoppers, *Nephotettix* spp. (Homoptera: Cicadellidae) can transmit virus diseases such as dwarf, transitory yellowing, tungro, yellow dwarf and yellow-orange leaf. The brown planthopper, *Nilaparvata lugens* is a vector of grassy stunt virus.

Rice bugs

Rice bugs are found in all rice environments, but are mainly causing considerable damage in upland ecosystems. Nymphs and adults feed upon rice panicles during the milky stage. The grains are becoming partially filled which reflects loss in panicle weight. Furthermore, the insect mouth parts may be contaminated with bacteria or fungi which invade the spikelets during the process of insect feeding. The pathogens stain the infected tissues resulting in the symptom of "pecky rice". These discoloured grains may result in refusing the whole rice lot in some countries, and also increase the percentage of breakage during milling process. Factors that favor high populations are adjacent woodlands, extensive weedy areas near rice fields and staggered rice planting (Reissig *et al.* 1985). The most common species resulting in yield losses are *Leptocorisa chinensis* (Dallas), *Nezara viridula* (L.) and *Oebalus pugnax* (F.).

MANAGEMENT STRATEGIES

1. Plant resistance:

1.1 Rice variety screening

That rice varieties showing differences in their susceptibilities to stem borers have been known for over 80 years (Pathak 1964). Examples of resistance have been documented among the three types given by Painter (1951); tolerance, antibiosis, and non-preference. For example, some varieties are non-preferred for oviposition and thus they receive few egg masses while others are preferred because of long, wide leaves, tall plants and large stems. Some varieties have antibiosis which causes high larval mortalities or retarded growth rates due to more layers of lignified tissues in the cell wall, large silica deposits, or thick layers of sclerenchymatous tissues (Pathak 1977).

In Egypt, Isa (1989) concluded that the rice stem borer, *C. agamemnon* infestation was positively correlated with rice stem diameter, and width of rice leaves, but negatively correlated with stem hardness, tillering capacity and tightness of leaf sheath around the stem. Sherif *et al* (1996) obtained lighter borer larvae from resistant rice lines compared to heavier ones when bred on susceptible lines.

In 2004 rice season, breeding materials of Rice Research and Training Center (Egypt) were screened for rice stem borer and rice leafminer infestation (Table 3). Rice entries showing resistance or moderate resistance to the considered insects were promoted in the breeding program depending on the evaluation of other traits required by the plant breeders. Several promising liens were resistant to rice stem borer, but most of the new plant type (super rice) materials were highly susceptible. All hybrid rice entries exhibited moderate susceptibility to the pest. None of the tested promising lines were resistant to the rice leafminer, *H. prosternalis* which is similar to most of rice entries all over the world. However, the rice leafminer, as it will be explained later in this article, is mainly managed through manipulating of cultural practices.

That low levels of resistance of rice varieties to rice leafminers have been reported by several authors (e.g. Heinrichs *et al.* 1985, Foda *et al* 1997). Evaluation of 20,000 rice entries to *Hydrellia philippina* revealed that none was distinctly resistant (IRRI 1975). However, wild rices have high levels of resistance, but they are useless as sources of resistance because they are difficult to cross with *Oryza sativa* (IRRI 1977). Viajante and Rizal (1976) studied the mechanism of resistance of rice varieties against *H. philippina*, and found that resistance is mostly due to antibiosis and thus, few and smaller insects survived on the resistant variety compared to the susceptible one.

Heinrichs (1994) reported that all of the major rice producing countries in South and Southeast Asia have breeding programs to control the brown planthopper. Rice cultivars resistant to this pest were first identified at IRRI in 1963. Since 1963, about 50,000 accessions have been tested and more than 400 resistant accessions have been identified.

1.2. Engineering rice for resistance to stem borers

Programs for developing *Bt* rice (generically modified with *Bacillus thuringiensis* genes) resistant to rice stem borers were initiated at IRRI. European Union countries, and others. *Bt* rice is resistant to stem borers by the action of toxin proteins generated in transgenic rice. The research project "Erri" was funded by European union (1998-2000) and participated by researchers from Spain, Italy and France. The project aimed to develop resistance of rice to striped stem borer (*Chilo supprssalis*) through transfer of *Bacillus thuringiensis* (*Bt*) genes encoding insecticidal toxins and plant protease inhibitor genes into most widely released rice varieties in Italy, Spain and France. Rice varieties generated in this project should eventually result in a significant decrease of pesticide use in rice-growing areas of South Europe.

2. Cultural practices:

Cultural control methods are needed to reduce insect pest populations because depending on resistant varieties only is inadequate. Certain farm operations could be modified to make the environment hostile to insect pests but favourable for rice production. Techniques such as modification of sowing date, plant density, fertilizer and water management may prevent, or even delay, the buildup of the rice insects.

2.1. Sowing date

The correct choice of sowing date is necessary to get high rice yield, and in the meantime to avoid the periods of destructive attacks of the rice leafminer.

In Egypt, rice sown on 25 May or 5 June was significantly more infested with the rice leafminer than that sown on 25 April, 5 or 15 May (Bishara 1966). Levels of *H. prosternalis* infestation were 14.60, 26.30 and 53.80% for rice sown on 15 May, 30

May and 15 June, respectively (Abdallah & Bleih, 1995). The infested leaves in late sowing (10 June) increased by 57.32% and mines by 78.68% over those of recommended date of sowing (15 May) (Foda *et al* 1997). Similarly, Jaswant Singh *et al* (1990), in India, found that rice varieties planted on 8 July suffered less *Hydrellia* damage than those planted on 15 and 22 July. Table (4) presents the infestation by *H. prosternalis* as influenced by date of sowing (Sherif *et al* 1997).

2.2. Water management

Rice leafminer adults prefer aquatic or semi-aquatic environments. The flies can float to the surface if submerged, and also walk on the water surface. Permanent flooded fields had higher rice leafminer infestations than saturated or flushed fields (IRRI 1974). Alternate flooding and draining were recommended to reduce the damage of this ephydrid. Sherif *et al* (1997) revealed that levels of eggs, mines and damaged leaves were higher in the permanent flooded plots than in those irrigated every 6, 9 or 12 days (Table 5).

2.3. Fertilizers

Nitrogen enhances the nutritional status of both plants and pests. It improves plant physiological process and augments growth rates. On the other hand, the well-nitrogen fertilized plants increase insect fecundity and feeding rate, and accelerate insect growth (more generations per crop) (Pimentel and Goodman 1978). Chemically, nitrogen results in the production of greater amounts of volatile substances attracting more pests which locate their hosts by odor (Chandramohan and Jayaraj, 1977) e.g. orzyzanone exudes from rice leaves attracting stem borers (Seko and Kato, 1950). So, double purpose; high rice yield and low borer incidence, could be achieved by splitting the nitrogen application along with plant needs.

In Egypt, rice is usually sown after clover or wheat. Sherif (1986) revealed that rice sown after clover had higher borer, *Chilo agamemnon* infestation than that sown after wheat, and explained this as a reflection to the effect of the previous crop, because clover enriches the soil with more nitrogen than does wheat. Abdallah and Badawi (1990) reported that *C. agamemnon* infestation increased by increasing nitrogen levels. Most of reports suggested that fertilization had no effect on rice leafminer damage to rice plants. IRRI Reports (1979 and 1983) indicted that nitrogen levels of 0 up to 160 kg/ha had no effect on the number of the rice whorl maggot eggs on rice plants. El-Metwally (1977) and El-Habashy (1997) found no effect to nitrogen, phosphorus and potassium combinations on *H. prosternalis* damage in rice fields.

Saroja and Raju (1981), in India, applied nine levels of potash basally at the time of planting to study their effect on the incidence of rice whorl maggot. They found that rice plants with 175 or 200 kg/ha had significantly higher whorl maggot damage than those with 0-175 kg/ha. The grain yield differences were not statistically significant. They concluded that local fertilizer recommendation (50 kg/ha) is not expected to increase whorl maggot damage in rice.

2.4. Harvest cut height

Rice is usually harvested at 5-10 cm above the soil surface keeping the majority of stem borer larvae inside stubbles. The larvae overwinter in the stubbles by late September until May when they become active, turn into pupae, and emerge as adults. From the point of view of borer control, it is required to get most of larvae inside rice straw which is subject to many practices during winter that kill the harboured larvae. Obtaining the majority of larvae inside rice straw could be achieved when the rice plants are cut as close to the soil surface as possible (Soliman and Sherif 1993, Table 6).

2.5. Straw and stubble destruction

By the end of rice season, *Chilo agamemnon* larvae move downward, inside rice stems, to hibernate in the lower parts of rice straw or mostly in stubbles under soil surface. These hibernating larvae suffer high natural mortality, but those surviving are of a significant importance as a source of borer infestation in the following season. Burning straw and stubble is a common practice, and is claimed to control stem borers (Alam & Nurullah 1977 and Boraei & Sherif 1988). It is easy to burn straw, particularly when is piled, but standing stubbles is not. After rice harvest, Chuadhry & Halimie (1976) recommended ploughing the field with a furrow-turning plough, rice stubbles are collected, dried and burnt before the harboured larvae turn into pupae. To accelerate the decays of rice stubbles, Tantawi & Isa (1981) broadcast calcium cyanamide (250 kg/ha), and estimated that more than 70% of the borer larvae in stubbles had been destroyed. Boraei & Sherif (1988) recorded 98% reduction in *C. agamemnon* larvae hibernating in rice stubbles, when the residues were burnt and the field was flooded for three days. They added that flooding not preceded by burning proved to be also effective against the borer, but this practice is impractical as it needs plenty of water (Table 7).

3. Biological Control:

The importance of natural enemy complex in the rice ecosystem was little known until the broad-spectrum insecticides reduced their numbers to ineffective levels, resulting in the resurgence of pest populations.

Examples of these pests are: brown planthopper, *Nilaparvata lugens* (Stal), green leafhopper, *Nephotettix* spp. and rice stem borers. Classical and inundative biological control approaches tried so far have been met with dismal failures, and there is little potential for this approach in rice (Ooi and Shepard, 1994). They explained that the failure may be due to the release of parasitoids to control the already indigenous insect pests. However, the release of parasitoids to control insect pests was successful in some cases; *Trichogramma* to control rice stem borers in Iran and Egypt. Here, a light is thrown on the status of parasitoids common in Egypt rice fields.

3.1. Parasitoid status in Egypt:

Rice fields of Egypt are rich in hymenopterous parasitoids that attack important insect pests (Table 8). The most important parasitoid is *Trichogramma evenescens* that efficiently parasitizes the borer, *Chilo agamemnon* eggs. The larvae of the borer were found to be killed by *Microbracon* sp. On the other hand, El-Habashy (2003) recorded about 12% parasitism on *Hydrellia prosternalis* larvae by *Opius headqusti.* Eggs of leafhoppers and planthoppers were parasitized by *Oligosita* spp., *Paracentrobia* spp., *Anagrus* spp., *Gonatocerus* spp. and *Camptoptera* spp.

3.1.1. Current status of *Trichogramma*:

Egypt Ministry of Agriculture and Land Reclamation pays a great attention to conserve the already occurring natural enemies, and to enhance their role in controlling insect pests attacking different crops, from which is rice. Preliminary studies conducted at Rice Research and Training Center from 1993 through 1997 indicated that the rice stem borer, *Chilo agamemnon* eggs are attacked by the egg parasitoid, *Trichogramma evanescens.* Data in Table (9) present the fluctuation of parasitism status of the egg-parasitoid during July, August and September (compiled data). The parasitism was recorded to be low (6.00%) on 20 July, and reached 8.97% one week later. The level of parasitism wa nearly doubled (16.13%) on 5 August, and slightly decreased on 26 August (13.20%). By early September, the parasitism reached 27.78%, and progressively increased towards the end of the season to exhibit 45.51 and 87.65% parasitism on 24 and 30 September, respectively.

3.1.2. Rice plants damaged by the rice stem borer in relation to the rate of *Trichogramma* release:

Release of *Trichogramma* in two waves at RRTC (Egypt) on mid-July and mid-August reduced the levels of dead hearts at all rates of release, except that at 10,000 wasps/ha (Table 10). Reduction in dead hearts ranged between 3.05% (at a rate of 25,000 indiv./ha) and 79.11% (at 55,000 indiv./ha). When 30,000 indiv. were released, a considerable reduction (48.83%) in dead hearts was performed. The latter rate of *Trichogramma* release, despite its moderate efficiency against rice stem borer, could be seen as a practical level of release from the economic point of view. In terms of white head reduction, release at a rate of 45,000 individuals/ha resulted in the highest reduction of white heads (69.71%), followed by the release of 55,000 indiv.(63.83% reduction), and release of 40,000 (62.66% reduction). Thus, the release at a rate of 45,000 indiv./ha. was the most efficient as it reduced more than two thirds of borer infestation which is considered a good result for insect control, and meanwhile an economic level of release.

3.1.3. large-scale release of *Trichogramma*:

Experiments of *Trichogramma* release on the large-scale were conducted for three successive rice seasons; 1999, 2000 and 2001 (Table 11). The parasitoid, reared in laboratory, was released as cards of parasitized eggs of *Sitotroga cerealella* at a rate of 50,000 indiv./ ha. In 1999 season, the parasitoid was released in 20 hectares sown with Egyptian Jasmine rice cultivar (as susceptible to RSB). Dead hearts were 4.26% in the fields that did not receive the parasitoid, and 1.18% in the fields treated with the parasitoid, which means 72.30% reduction in borer damage. The corresponding values of 2000 rice season were 6.98 in the non-released fields and 2.46% dead hearts in the released ones (30 ha). Thus, the parasitoid reduced the insect infestation by 64.76%. In 2001, the parasitoid was released in 60 ha. Level of dead hearts was originally low (3.99%) in the non-released fields, so the level of insect reduction was also relatively low (47.37%) compared to those of the previous seasons. The efficiency of *Trichogramma* release in suppressing the level of white heads was more pronounced than those of dead hearts. Reductions in this symptom, which is considered more effective in reducing rice yield than dead hearts, were 71.48, 80.36 and 80.08% in 1999, 2000 and 2001 seasons, respectively. Average reduction of dead hearts and white heads, over the seasons, were 61.48 and 77.30%, respectively.

For safe food consumption, insecticide-free rice is extremely important to human beings. Thus, the use of insecticides should be minimized, if it was impossible to be completely avoided. Thus, the integration among *Trichogramma* release and other control measures is important, and insecticide applications should remain as the last shoot against the rice stem borer. Since the inundative release of this egg-parasitoid in two waves (50,000 indiv./ha. each) is highly effective in reducing rice stem borer damage, there is a necessity to make the parasitoid available to be released at proper times, either in rice or in other crops. The close coordination between laboratory rearing facilities and field staff as well as timing of releases is critical for success.

3.1.4. Field application of *Trichogramma* for RSB control:

The newly initiated laboratory at RRTC for rearing *Trichogramma* has started its activity in April, 2004. The insect host, *Sitotroga cerealella* was reared on wheat grains kept in certain cages. By the complete of host life cycle, the *Sitotroga* adults were obtained, and allowed to lay eggs in containers. The fresh laid eggs were exposed to *Trichogramma* adults which parasitized the host eggs. The latter eggs were used for the release of the parasitoid in the field, or used for breeding an additional cycle for more production of the parasitoid.

The cards, containing the parasitized *Sitotroga* eggs were tied with strings and fixed in rice fields at a rate of 50,000 individuals/ha. The release was practiced twice; as early as July, and two weeks later. Thus, the natural population of the parasitoid could be enhanced for an effective control of RSB. Since most of released rice cultivars are resistant to RSB, the release was applied only in fields sown with Egyptian Jasmine, Giza 178 and hybrid rice. The fields that received the parasitoid had only 1% white heads compared to about 10% in the check fields. It was also found that fields of the parasitoid were less infested with the RSB than fields treated with Furadan (about 3% white heads). It is note worthy that the release of *Trichogramma* costs about $20 per ha compared to about $80 per ha in case of application of Furadan (the recommended insecticide).

3.2. predators

3.2.1. Insect predators

The role of predators as natural enemies in rice fields have received little attention. In the Philippines, Pantua and Litsinger (1984) reported that up to 65% of the eggs of yellow stem borer were consumed by the long-horned grasshopper, *Conocephalus longipennis*. The predators prevailing rice fields in Egypt were surveyed during the period from 1999 to 2002 (Table 12). Twenty six species belonging to sixteen families were surveyed. The predators were belonging to eight orders, but mainly to orders Coleoptera and Hemiptera.

3.2.2. True spiders

True spiders are generalist predators, and effectively regulate insect pest populations. The spiders have many advantages that enhance their role in regulating pest populations, 1) can survive in case of scarcity of prey, 2) feed upon different species of pests and 3) have a relatively long life history, and thus, can meet different stages of insects.

Twelve spider species, arranged in seven families, were surveyed from rice nurseries and/or paddies. Four species belong to family Araneidae; 3 species (*Araneus* sp, *Argiope* sp and *Cyclosa* sp) are rarely occurring, while the fourth one (*Singa* sp) was frequently surveyed. Family Salticidae occupied the second rank as for number of encountered species, having three ones. *Bianor* spp. were common in nursery and paddy (from May to September), *Plexippus paykulli* Aud. frequently occurred in the paddy (August-September), while *Cosmophasis* sp. was rarely captured from both nursery and paddy throughout the rice season. Families Clubionidae, Lycosidae and

Theridiidae were each represented by one species, *Clubiona* sp. (frequent), *Pardosa* spp. (common), and *Theridion* sp. (common). These three spiders were obtained in traps along the rice season. *Tetragnatha* spp. (Tetragnathidae) were commonly occurring in paddy fields from July-September, but *Thanatus* spp. (Philodromidae) was rarely detected from mid-August to September.

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Table 1. Common Field Pests of Rice in Egypt

Common Name	Scientific Name	Family	Order
Rice stem borer	*Chilo agamemnon* Bles.	Pyralidae	Lepidoptera
Rice leafminer	*Hydrellia prosternalis* Deeming	Ephydridae	Diptera
Bloodworm	*Chironomus* sp.	Chironomidae	Diptera
Mole crickets	*Gryllotalpa gryllotalpa* L.,	Gryllotalpidae	Orthoptera
	G. africana Pal de Beauv.		
Tabanid fly	*Atylotus agrestis* Wied	Tabanidae	Diptera
Stink bugs	*Nezara viridula* L.	Pentatomidae	Hemiptera
	Nysius ericae (Schill)	Lygaeidae	Hemiptera
Grasshoppers	*Aiolopus strepenes* (Latr.)	Acrididae	Orthoptera
	Acrotylus insubricus (Scop.)	Acrididae	Ortheptera
	Euprepocnemis plorans (Charp.)	Acrididae	Orthoptera
	Heteracris littoralis (Ramb.)	Acrididae	Orthoptera
	Anacridium aegyptium L.	Acrididae	Orthoptera
Long-horned grasshopper	*Conocephalus conocephalus* (L.)	Tettigonidae	Orthoptera
	Nephotettix modulatus Mel.	Cicadellidae	Homoptera
Leafhoppers	*Balclutha hortensis* Lindb.	Cicadellidae	Homoptera
	Empoasca decedens Padi.	Cicadellidae	Homoptera
	Macrosteles ossiumnilssoni L.	Cicadellidae	Homoptera
	Sogatella capatron Fen.	Delphacidae	Homoptera
Planthoppers	*S. vibix*	Delphacidae	Homoptera
	S. furcifera	Delphacidae	Homoptera
	Oliarus sudanicus Lall.	Delphacidae	Homoptera
	Florithrips traegardhi	Thripidae	Thysanoptera
Thrips	*Arvicanthis niloticus* Dosm.	Muridae	Rodentia
Field rat	*Rattus ruttus rattus* L.	Muridae	Rodentia
Black rat	*Rattus norvegicus* Berk.	Muridae	Rodentia
Brown rat			
	Passer passer domesticus	Passeridae	Passeriformes
Nile sparrow			
	Procambrus clarkii (Girard)	Cambaridae	Decapoda
Crayfish	*Orconectes virilis* (Hagcn)	Cambaridae	Decapoda

Source: Sherif *et al* (1999)

Table 2. Estimated rice yield losses caused by insect pests on a world basis.

Region	Yield loss %
Asia	31.5
People's Republic of China	15.0
Africa	14.0
South America	3.5
North and Central America	3.4
Europe	2.0

Source:Cramer (1967)

Table 3. Screening of breeding materials to infestation with rice stem borer and rice leafminer-RRTC, Egypt-2004.

Breeding material	Target insect	Total	%				
			Resistant	Moderately resistant	Moderately susceptible	Susceptible	Highly susceptible
New introductions	RSB	34	8.82	35.29	38.24	14.71	2.94
Preliminary yield trials	RSB	156	15.84	41.54	29.58	6.50	6.54
Aromatic rice	RSB	14	0.00	42.86	57.14	0.00	0.00
New plant type (super rice)	RSB	12	0.00	8.33	8.33	16.67	66.67
Promising lines	RSB	48	18.75	62.50	18.75	0.00	0.00
Promising lines	RLM	48	0.00	16.67	75.00	8.33	0.00
Hybrid rice (multi location)	RSB	9	0.00	0.00	100.00	0.00	0.00
Hybrid rice (final yield trail)	RSB	5	0.00	0.00	100.00	0.00	0.00

Source: RRTC report (2005)

Table 4. Rice infestation by *Hydrellia prosternalis* as influenced by date of sowing, Egypt-1997.

Date of sowing	Av. per 100 rice leaves		
	Eggs	Mines	Damaged leaves
May 1st	1.17	5.1	3.17
May 15th	29.72	69.72	35.22
June 1st	55.22	137.61	42.78
June 15th	69.61	165.83	64.11

Source: Sherif *et al* (1997)

Table 5. Rice infestation by *Hydrellia prosternalis* as influenced by water regime, Egypt-1997. *Source:* Sherif *et al* (1997)

Irrigation interval	Av. per 100 rice leaves		
	Eggs	Mines	Damaged leaves
Permanent flooding	33.18	150.29	57.50
6-day	21.90	73.71	42.50
9-day	12.55	41.60	22.86
12-day	11.62	32.39	18.96

Table 6. Distribution of *Chilo agamemnon* larvae hibernating in rice residues as affected by harvest level. *Source:* Sherif *et al* (1999)

Harvest level (cm)	No. of larvae/40 hills			Larvae (%)	
	Total	Straw	Stubble	Straw	Stubble
0	376	281	95	74.73	25.27
5	400	276	124	69.00	31.00
10	544	281	263	51.65	48.35
15	296	122	174	41.22	58.78
20	320	81	239	25.31	74.69
25	240	65	175	27.08	72.92
30	446	133	313	29.82	70.18

Table 7. Reduction in *Chilo agamemnon* larvae hibernating in rice stubbles due to post-harvest operations, Egypt-1998.

Post-harvest operation	Alive larvae/50 stubbles	Larval reduction %
Burning + flooding	1.50	98.35
Flooding	4.00	95.61
Irrigation	42.52	53.32
Burning + ploughing	50.38	44.69
Burning	67.14	26.28
Ploughing + irrigation	84.85	6.84
Ploughing	88.00	3.38
Check (untreated)	91.08	-

Source: Boraei and Sherif (1988)

Table 8. Hymenopterous parasitoids surveyed from the Egyptian rice fields.

Family	Species	Host [a]
Trichogrammatidae	*Trichogramma evanescens* Westw. *Oligosita* spp *Paracentrobia* spp	RSB eggs LH & PH eggs LH & PH eggs
Mymaridae	*Anagrus* spp *Gonatocerus* spp *Camptoptera* sp *Anaphes* sp	LH & PH eggs LH & PH eggs LH eggs Curculionids & Chrysomelids
Diapriidae	*Trichopria* spp *Loxotropa* sp *Psilus* sp	Larvae & pupae of dipetrous
Driynidae	*Echthrodelphax migratorious* Benoit	*Sogatella* nymphs
Braconidae	*Microbracon* sp *Opius* sp	RSB larvae RLM larvae
Platygasteridae	*Platygaster* sp	Gall midge (egg-larva)
Elasmidae	*Elasmus* sp	Skipper larvae

Source : RRTC (1999-2002)

a RSB: rice stem borer LH : leafhopper
PH : planthopper RLM : rice leafminer

Table 9. Natural parasitism of *Trichogramma evanescens* on rice stem borer eggs in rice fields.

Data of examination		Borer eggs (No.)	Parasites (No.)	Parasitism (%)
July	20	50	3	6.00
	27	78	7	8.97
Aug.	5	93	15	16.13
	12	82	14	17.07
	19	118	18	15.25
	26	250	33	13.20
Sept.	3	540	150	27.78
	10	411	141	34.31
	17	230	109	47.39
	24	156	71	45.51
	30	162	142	87.65

Source : RRTC report (2004)

Table 10. Reduction in rice stem borer infestation as influenced by rates of *Trichogramma* release.

Rate of release (1000 indiv./ha)	Dead heart		White head	
	%	Reduction %	%	Reduction %
Check	4.26	-	11.06	-
10	4.45	-4.46	8.20	25.86
25	4.13	3.05	6.18	44.12
30	2.18	48.33	5.96	46.11
35	3.55	16.67	6.28	43.22
40	3.71	12.91	4.91	55.61
45	2.26	46.95	3.35	69.71
40	2.10	50.70	4.13	62.66
55	0.89	79.11	4.00	63.83

Source : RRTC report (2004)

Table 11. Damage of rice stem borer as influenced by two release of *Trichogramma* (50,000 wasps/ha. each).

Year	Treated area (ha)	Dead heart (%)			White head (%)		
		Untreated	Treated	Red.	Untreated	Treated	Red.
1999	20	4.26	1.18	72.30	11.50	3.28	71.48
2000	30	6.98	2.46	64.76	14.92	2.93	80.36
2001	60	3.99	2.10	47.37	12.15	2.42	80.08
Average		5.08	1.91	61.48	12.86	2.88	77.31

Source : RRTC report (2004)

Table 12. Predatory insects surveyed from the Egyptian rice fields.

Order	**Family**	**Species**
Coleoptera	Carabidae	*Abacetus* spp *Bimbidion* spp *Microlestis* sp
	Staphylinidae	*Paederus alfierii* Koch *Paederus memmonius* Erichson *Philonthus* pp
	Coccinellidae	*Chilomenes vicina isis* Crotch *Chilomenes vicina nilotica* Muls.
	Anthicidae	*Anthicus* sp
Hemiptera	Reduviidae	*Reduvius tabidus* Klg. *Onocephalus* sp
	Anthocoridae	*Orius* spp *Xylocoris* sp
	Mesoveliidae	*Mesovelia vittigera* Horv.
	Veliidae	*Microvelia* sp
	Belostomatidae	*Lethocerus niloticus* Stal.
Odonata	Agrionidae	*Ischnura senegalensis* Ramb. *Hemianax ephippiger* Burm.
Hymenoptera	Formicidae	*Monomorium* spp *Selenopsis latro* For.
	Vespidae	*Polistes gallica* L. *Polistes fedorata* Kohl.
Orthoptera	Tettigoniidae	*Conocephalus conocephalus* L.
Dermaptera	Labiduridae	*Labidura riparia* Pall.
Neuroptera	Chrysopidae	*Chrysoperla carnea* Steph.
Thysanoptera	Aeolothripidae	*Aeolothrips* sp

Source : RRTC report (2004)

إدارة آفات الأرز الحشرية

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مركز البحوث والتدريب فى الأرز – مركز البحوث الزراعية – مصر

تتعرض نباتات الأرز فى جميع أنحاء العالم للإصابة بأكثر من ١٠٠ نوع حشرى ، إلا أن عشرين منها فقط تمثل أهمية اقتصادية . وتنقسم هذه الحشرات إلى :

١ – متغذيات على الجذور ٢ – ثاقبات الساق ٣ – نطاطات الأوراق والنباتات

٤ – متغذيات على الأوراق ٥ – متغذيات على الحبوب

وتعتمد خطة مكافحة هذه الآفات على استخدام عدة طرق مجتمعة هى : الأصناف المقاومة ، العمليات الزراعية ، المكافحة الحيوية علاوة على المكافحة الكيماوية إذا لزم الأمر . وفى مركز بحوث الأرز (سخا – كفر الشيخ) يتم سنوياً تقييم مواد التربية لتحديد المقاوم منها لحشرتى ثاقبة الساق وصانعة أنفاق الأوراق ، وذلك لإدخالها فى برامج التربية للحصول على أصناف جديدة. وفى معهد بحوث الأرز الدولى (بالفلبين) تجرى محاولات لهندسة الأرز وراثياً باستخدام بكتيريا باسلس للحصول على أصناف مقاومة للثاقبات، ولكن تظل مشكلة ظهور سلالات مقاومة من الحشرة ضد البكتيريا قائمة . ومن ناحية أخرى فإنه يمكن تطويع العمليات الزراعية لتقليل تعداد الحشرات ، حيث وجد أن زراعة الأرز مبكراً (خلال النصف الأول من مايو) وإطالة فترات الرى نسبيا (علاوة على تفادى الغمر المستمر) تقلل من إصابة المحصول بصانعة أنفاق الأوراق . كما أن قطع سيقان الأرز عند الحصاد بالقرب من سطح التربة بقدر الإمكان يقلل من تعداد يرقات الثاقبات الداخلة فى البيات الشتوى . كما يوصى بالتخلص من بقايا المحصول (القش وكعوب الأرز) لإبادة يرقات الثاقبات داخلها . يجرى حالياً بمركز بحوث الأرز بسخا الاهتمام بعناصر المكافحة الحيوية لمكافحة حشرات الأرز ، حيث وجد أن طفيل اليرقات *Opius hedqusti* يقوم بالقضاء على حوالى ١٢% من تعداد صانعة أنفاق أوراق الأرز ، كما يهاجم بيض نطاطات الأوراق ونطاطات النباتات بطفيليات *Oligosita* spp, *Paracentrobia* spp, *Anagrus* spp, *Gonatocerus* spp, and *Camptoptera* spp

ويجرى حالياً إطلاق طفيل الترايكوجراما مرتين كل منها بمعدل ٣٠,٠٠٠ فرد / فدان (٧٥,٠٠٠ فرد / هكتار) لمكافحة ثاقبة ساق الأرز ، وبالتالى أمكن تقليل نسب الإصابة بالقلوب الميتة بمقدار ٦١,٤٨% والسنابل البيضاء بمقدار ٧٧,٣١% . وعند حصر الحشرات المفترسة فى حقول الأرز ، ثبت وجود ٢٦ نوعاً تنتمى إلى ١٦ عائلة و ٨ رتب أغلبها غمدية الأجنحة ونصفية الأجنحة ، وعلاوة على ذلك أمكن حصر ١٢ نوعاً من العناكب الحقيقية المفترسة تنتمى إلى سبع عائلات أهمها عائلتى Araneidae and Salticidae.