ROYAUME DU MAROC

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REVUE DE LA RECHERCHE AGRONOMIQUE MAROCAINE

Institut National de la Recherche Agronomique
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SPECIAL ARIDOCULTURE

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INSECT PESTS OF WHEAT AND BARLEY OF MEDITERRANEAN AFRICA AND WEST ASIA

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INTRODUCTION

About 55 insect species distributed across 8 orders have been described as pests of wheat and barley in West Asia and North Africa (WANA) (Miller, 1987). Most of these insects cause insignificant damage or occur only in isolated areas. Some, however, cause considerable regional crop loss while others pose problems uniquely linked to the farming system employed in a particular area (Table 1).

The peoples of West Asia and North Africa consume far more wheat and barley than they produce. In 1986 it was estimated that WANA countries imported 21.5 million MG of wheat while producing 55 million MG (FAO, 1986). Significantly, most of the wheat and barley produced in WANA is grown in areas receiving less than 400 mm rain annually. Barley predominates in the lower rainfall areas while bread wheat and durum wheat occupy a relatively larger percentage of the more favorable, higher rainfall areas (Table 2). Average yields in WANA in 1986 were about 1.7 MG/ha with losses due to insects estimated about 5.5% in wheat and 4.0% in barley (Table 3). Total losses due to

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diseases and insects approached 15% or about 8.3 MG in wheat and 2.1 MG in barley (FAO, 1986; Walker, 1975). The management of insect pests in a manner integrated with the farming systems of the region and safe to the environment could contribute significantly to stabilizing wheat and barley production in WANA.

Table 1 : **Some important insect pests of wheat and barley in West Asia and North Africa.**

Wheat Stem Sawfly	**Cephus pygmaeus**
	Trachelus judaicus
	T. tabidus
	T. libanensis
Sunn Pest	**Eurygaster integriceps**
	E. austriaca
	E. maura
	Aelia rostrata
	A. accuminata
Hessian fly	**Mayetiola destructor**
Aphids	**Rhopalosiphum padi**
	R. maidis
	Schizaphis graminum
	Diuraphis noxia
Wheat Ground Beetle	**Zabrus tenebrioides**
Ground Pearls	**Porphyrophora tritici**

Table 2 : **Percent of bread wheat, durum wheat, and barley grown at different moisture levels in West Asia and North Africa.**

	Irrigated	**400-550 mm**	**<400 mm**
Bread Wheat [a]	23	34	43
Durum Wheat [a]	5	43	52
Barley [b]	7	23	70

[a]Bayerlee and Winkelman, 1981
[b]Srivastava, 1977

Table 3 : **Crop losses due to insects and diseases (MG X 10^6)**

Crop/Region	Total Production	Losses due to			
		Insects	Diseases	Total	%
Wheat (WANA)	55.2	3.0	5.2	8.2	15
Barley					
(WANA)	17.4	0.7	1.4	2.1	12
(Non-WANA)	6.1	0.2	0.5	0.7	12

(adapted from FAO, 1986 and Walker, 1975).

The purpose of this paper is to describe some of the most important cereal insect pests in WANA, and their current level of management, and to suggest future strategies for reducing their depredations. Hessian fly will only be considered peripherally in this paper as it will be covered more intensively by other authors.

MAJOR INSECT PESTS

Wheat Stem Sawflies

Wheat stem sawflies currently are serious pests of both wheat and barley in Syria and Morocco although they also occur in Lebanon, Iraq, Iran, Cyprus, Egypt, Libya, and Turkey. Within Syria and Morocco most damage occurs in the moderate rainfall areas receiving 300 to 350 mm annually. ICARDA entomologists observed 5% to 15% losses in wheat and barley at ICARDA's main research farm at Tel Hadya, Syria in 1987 and 25% to 50% losses in 1988 (ICARDA 1988, 1989). Losses in Morocco were comparable to those observed in Syria although detailed crop loss assesments are not available. In Morocco, wheat stem sawfly damage compounds the damage already caused by Hessian fly, resulting in 100% crop losses on some farms. The most important sawfly species in Syria is **Cephus pygmaeus,** the European wheat stem sawfly, followed by **Trachelus judaicus** and **T. tabidus. T. libanensis** seems to be a minor pest in Syria. Preliminary observations suggest that **C. pygmaeus, T. tabidus,** and **T. judaicus** may also be the major sawfly pests in Morocco, although confirmed identification is still pending.

After mating, adult female wheat stem sawflies attack the elongating portions of the internodes of wheat and barley. They usually lay a single egg in a slit in the stem cut by their saw like ovipositor. The larvae tunnel downward, eating and growing as they go. When they reach the base of the plant they make a circular incision in the stem and then form a cocoon in the culms at or below ground level. The cut stem rapidly desiccates and frequently breaks. The larvae plugs the upper lumen of the culms with frass, thereby forming a well protected resting chamber where diapause and pupation occur later in the season.

Wheat stem sawflies undergo a single generation per year. Adults are present in the field from March to mid-May, with timing of emergence dependent upon ambient temperatures. Peak sawfly emergence in Syria corresponds to the flag leaf stage in commercially grown wheat cultivars. Females outnumber males in field collected populations nearly 2 : 1. Adult sawflies feed on nectar from weeds and on honeydew secreted by aphids. Each female lays about 35 eggs, although up to 70 is possible.

Resistant wheat varieties have been developed for wheat stem sawfly control in both the United States and Canada. Breeding programs incorporating resistance in wheat have been so successful in the USA that government sponsored research programs for wheat stem sawfly research were discontinued in the late 1960's. Resistance to wheat stem sawflies is conferred primarily by a simply inherited, solid stem that may cause direct mortality to eggs and larvae through abrasion and desiccation. A number of wheat varieties have been released over the years containing the solid stem characteristic. ICARDA's bread wheat and durum wheat breeding programs currently are incorporating the solid stem characteristics into improved genotypes suitable to the WANA region. These should be available to breeders throughout the region in a few years, although parental germplasm can be obtained from ICARDA upon request. In 1987 several Moroccan durum wheat landraces were collected which had the solid stem characteristic. These have been tested and test results and germplasm will be made available to breeders in the region.Currently only one forage barley has shown promise for sawfly resistance, even though it does not possess a solid stem. Investigations are being conducted to verify and determine the nature of this resistance.

Over the years researchers at ICARDA have developed effective screening techniques for identifying wheat stem sawfly resistance in both wheat and barley (Miller, 1987). The screening procedure involves collecting larvae from infested fields in the summer and fall, storing them in refrigerators during the winter months, and rearing the adults to coincide with plant development in the field the subsequent year.

Sawfly infested fields are located in the summer by sampling for larvae and cocoons in straw stubble. When an infested field is located, a portion is undercut with a duckfoot cultivator to allow stubble collection and sorting in the field. Infested stubble is then trimmed of excess plant material, washed, and placed in perforated plastic bags. The bags are then stacked in a refrigerator and maintained at 7° C to 10° C until about one month before adult sawflies are needed. Stubble is then placed in mesh covered boxes on shelves at 25° C. When the adults emerge they are captured with an aspirator and introduced at known densities (usually 10 females/m^2 are enough to ensure that each culm is visited at least once by a female) under large screen cages placed in the field. Each cage can contain up to 180 test lines planted in 1 m rows with 30 cm row spacing. A randomized complete block design, with each cage constituting a block is used. The level of infestation is determined just prior to harvest. Each line is scored on a 1 to 5 scale for cut and lodged stems, 5 representing the most severely affected. Sixty culms of lines scoring 1 or 2 are taken to the laboratory and inspected for the presence of larvae.

Few problems are associated with the caged sawfly tests. Once the basic plot design is established and the cages are constructed, they may both be used indefinitely. Collecting infested stubble requires time and manual labor. Development of specialized equipment to collect and clean stubble would greatly speed up the process. Normal kitchen refrigerators are sufficient for storing stubble. Materials for the storage boxes, and hand held aspirators are readily available in most countries. Care must be taken that test lines are not inadvertently exposed to insecticides during their development and especially during the period when sawflies are present in the cages and in the field.

Sunn Pest

The name sunn pest, or suni bug, actually refers to several related insects in the hemipteran families Scutelleridae and Pentatomidae that inflict similar damage on wheat and barley, and have similar behaviors and phenology (Table 1). The sunn pest is especially damaging in Turkey and Iran, although it may cause economically important damage in Iraq, Syria, Morocco, and Algeria.

The sunn pest is primarily considered a pest of wheat, although it readily attacks barley. Barley fields often appear to escape sunn pest infestation since barley generally matures earlier than wheat. Sorghum and maize are also occasional targets of sunn pest depredations.

Sunn pests damage the plant by sucking fluids from the culms and developing kernels. They often attack and "sting" grain in the milk stage resulting in shrunken and deformed kernels. A more subtle damage is caused when the sunn pest injects a proteolytic enzyme into the kernel endosperm for ingestion by the bug. Some of the dehydrated enzyme remains in the kernel after the sunn pest's departure. When this enzyme is rehydrated during dough making using flour milled from infested kernels, the gluten is degrated to such an extent that the dough loses its elasticity and cannot be used for making leavened bread or the two layer flatbreads common in West Asia (Cardona et al., 1983).

When the insects "sting" spikes that are in the leaf sheath the part of the spike distal to the point of attack may desiccate and sometimes break off after heading. The dried upper part of the spike contrasts markedly with the green lower portion. This damage is easily confused with head damage caused by frost, heat or herbicides and may be distinguished only by observations on sunn pest populations in the field or with local temperatures or data on agronomic practices. If the "sting" occurs below the spike, the entire head may wither and die. This damage may be confused with that caused by wheat stem sawflies or various species of stem borers. Stem sawflies usually cut the stem at ground level causing the stem to break off when pulled. Stem borer larvae, however, make entrance and exit holes in the stem, and larvae and frass will usually be found in the lumen upon splitting the stem.

Sunn pests are univoltine. They overwinter as sexually immature adults in the foothill of nearby mountain ranges under rocks, bark, or in refuse near cereal fields. In spring sexually mature adults migrate to cereal fields where they feed for 10 to 15 days before mating. The female lays batches of 13 to 14 eggs in paired rows on the surface of broadleaf weed or cereal leaves. One female can lay up to 150 eggs during her lifetime. Under typical springtime field temperatures. The eggs require 8 to 10 days to hatch. Nymphs disperse immediately to wheat or barley plants and pass through five instars before becoming adults. In Syria, adults are present in wheat and barley fields during March and April, during which time egg masses may also be found. Nymphs may be present in the fields from mid-March until harvest.

Chemical control, usually with an ultra low volume (ulv) application of a synthetic pyrethroid or organophosphate insecticide, is the most common control method used. Entomologists in Turkey have developed economic thresholds for both nymphs and adults. Each year large scale surveys are conducted in the regions of the Anatolian Plateau and in southeast Turkey where the sunn pest is common, and spray programs prescribed accordingly. Similar programs are conducted in Iran, and occasionally in northern Syria.

At present there are no resistant varieties for sunn pest. ICARDA entomologists have tested several lines developed for high elevation areas of WANA for sunn pest resistance. Results were not encouraging and field screenings were discontinued after two seasons. There are unconfirmed reports that varieties possessing proteolytic enzyme inhibitors are being developed in the USSR.

Much work has been conducted on developing sunn pest egg parasitoids (**Trichogramma sp.**) in North Africa and Iran. Iran built laboratory and rearing facilities and initiated large scale egg parasitoid rearing and release in the late 1960's. Recently this project has been reactivated, but with emphasis on collecting more information on the biology of both host and parasitoid to minimize ineffective parasitoid introductions and integrate biocontrol activities with chemical control efforts and cultural practices. Turkey and Syria, given the enormous expense of aerial pesticide application, are also interested in developing biocontrol capabilities including nematode endoparasites, hymenopteran parasitoids, and pathogens. Turkey has had some success in locating and enhancing local parasitoid populations in Thrace by reducing spray applications. However, there remains much to be done before these techniques can reduce the dependence on chemical control in the region.

Hessian fly

The Uniform Hessian Fly Nursery (UHFN; Dr. J.H. Hatchett, USDA-ARS, Kansas State University, Manhattan, KS, USA) consists of wheat lines possessing known genes for Hessian fly resistance. ICARDA received the UHFN in 1986 and has subsequently increased the seed and arranged for the nursey to be planted in Lattakia, Syria on the Mediterranean coast, in the Beka'a Valley of Lebanon at ICARDA's Terbol field station, near Erzurum, Turkey in cooperation with CIMMYT, at two sites in Tunisia, and at two sites in Algeria. Data from the UHFN has been collected from these sites since 1989 to identify Hessian fly biotypes occuring in the region.

Aphids

Aphids are small, soft bodied insects in the order Homoptera which suck phloem fluids from living plants. Several aphid species are common on wheat and barley throughout the Mediterranean region. However, aphids are perennially serious economic pests on cereals only in the irrigated areas of the Nile Valley, in the highland cereal producing areas of Ethiopia and Yemen, and in some coastal areas. In most rainfed wheat and barley producing areas, aphid populations appear to be held in check by the extreme dry, hot summers and cold winters typical of the Mediterranean region and by natural parasitism and predation. Wheat and barley in much of WANA escapes serious infestation because the crop matures before aphid populations attain economically damaging levels.

Growing wheat in irrigated paddocks, however, appears to increase relative humidity sufficiently to provide a favorable micro-environment for aphid development. In the irrigated wheat fields of the Nile Valley in Egypt and the Sudan aphid populations begin to build up in March and December, respectively, before the wheat matures. As a result, massive infestations of **Rhopalosiphum padi** in Egypt, or **Schizaphus graminum** in the Sudan may be observed on heading wheat. Currently, repeated applications of contact insecticides are used in both countries when aphids infest approximately 15% to 25% of the plants in a field.

In the Sudan, and to a lesser extent in Egypt, aphid problems are exacerbated by the heavy use of chemical insecticides on cotton to control whiteflies. Because wheat fields are interspersed among cotton fields, the pesticide may drift onto the wheat. The result is to kill aphid predators that may have reduced aphid populations naturally. By the time predators reestablish themselves, aphid populations become unmanageably large. Aphid management on wheat is therefore closely linked to whitefly management on cotton. Recent attempts to reduce the use of chemicals on cotton may also have the secondary effect of enhancing aphid predators on wheat and therefore reduce the number of pesticide applications now required on both crops. In addition, unpublished studies in the Sudan indicate that naturally occurring populations of aphid predators, namely coccinellids, may be artificially augmented early in the season to allow natural control of the aphids before the populations become too large. If future studies bear this out, mass rearing of coccinellids for release in farmers fields may provide an alternative to the use of chemical insecticides.

Aphid resistant or tolerant wheat varieties may provide another alternative to insecticides. A number of methods have been developed to screen cereals for aphid resistance, but central to all methods is the requirement of infesting healthy test lines with sufficient numbers of healthy aphids. An aphid screening laboratory has been constructed at Giza, Egypt where national program scientists screen exotic and Egyptian germplasm against **R. padi** and **S. graminum** (Elenin et al. 1989). The technique involves growing twenty plants of each test line in a shallow tray about 5 cm deep which are later thinned to 10 seedlings per row. Aphids cultured on wheat for at least two generations are introduced onto each plant immediately upon emergence. Clippings of the host plants carrying aphids from the stock culture are placed along each row of test plants. The aphids readily migrate onto the test plants. The initial starting density of aphids on the seedlings is adjusted as needed to two aphids per seedling. The seedlings are observed daily and rated for damage after two weeks. Depending on the aphid species used, ratings may be based on counts of the number of aphids per seedling (**R. padi**) or on the extent of damage caused to the plant (**S. graminum**). Plants showing promise are observed for an additional 24 hours, after which the trial is terminated, plants are destroyed, and the soil and trays prepared for new tests. Lines showing potential resistance or tolerance are rescreened twice in the laboratory before being field tested. The field tests are conducted in "hotspots" where aphid populations are normally high. Currently, material from the Giza aphid laboratory is tested in Middle and Upper Egypt and at three sites in the Sudan. The field tests provide confirmation of the observed seedling resistance or tolerance in adult plants. Egyptian field tests are heavily weighted towards the dominant **R. padi.** The Sudan tests are conducted almost exclusively against **S. graminum.**

The Russian wheat aphid, **Diuraphis noxia,** has become a serious pest of wheat and barley in the Ethiopian highlands cereal growing areas since 1973, when it was first detected in a single province. The following year it was found in every province sampled. This period was also during the onset of a prolonged drought in Ethiopa broken by the return of monsoon summer rains in 1988. Estimates from small plot studies placed damage caused by **D. noxia** in barley at about 70% and in wheat near 60% in some regions near 2000 m in elevation (IAR, 1987). Heavy rainfall is positively correlated with low aphid population size, although it is not known if the rain causes direct mortality or causes the aphids to migrate elsewhere.

D. noxia is also present throughout the Mediterranean region, but like other cereal aphid species in rainfed wheat, it rarely poses serious economic problems. The aphid appears to be adapted to areas with relatively cool, dry winters. For example, 1989 was one of the driest winters on record in Syria with over 40 nights receiving freezing temperatures. The following spring, the aphid was found in late planted material maintained under partial irrigation. Similarly, in Algeria Russian wheat aphid infestations expanded from isolated spots in a few fields to nearly 100% infestation in the High Plateau during a prolonged drought from 1987 to 1990, whereas in 1991 when rainfall returned to normal aphid populations were very low.

D. noxia is a potentially serious pest in the region because a single feeding aphid can kill a tiller. Though the exact mechanism is unknown, feeding aphids probably inject toxic salivary compounds into the phloem as they feed, much like **S. graminum.** Leaves attacked by as few as one aphid will show yellow striping and curling within 24 hours. Frequently the leaves are curled so tightly that only **D. noxia,** along with a few other cereal aphid species, are able to live inside the rolled leaves. If the plant is infested early in its development, the central spike may wither and die, while plants infested later show stunting, rolled leaves and chlorosis. To date, no sexual forms of the aphid have been identified, all offspring being produced parthenogenically. It is also unknown where the aphid overwinters, though some researchers suspect that alates migrate to alternate hosts. Because of its recent discovery in North America, where it has caused large economic losses in wheat (140 million USD in Oklahoma in 1987 alone), there is considerable interest in developing parasitoid and pathogenic control methods. Similarly, much effort is now devoted to developing resistant varieties of wheat and barley, though as of yet, no resistant varieties are available for use in the Mediterranean region.

Wheat Ground Beetle and Ground Pearls

Wheat ground beetle and ground pearls are included in this paper not only because they are economic pests of cereals, but also because they illustrate the importance of considering the farming system of a region as well as entomological factors. Wheat ground beetle, **Zabrus tenebrioides**, primarily infests wheat and barley in Turkey and Syria, but is also found in Iraq and Iran. Insect populations increase during seasons with an annual rainfall of 400 mm to 500 mm. Adults feed on sown seed and on the grains of developing spikes. Larvae feed on seedling roots and leaves. In feeding, the larvae crawl onto the plant at night and pull the leaves underground where larvae form a feeding chamber in which they devour the leaves. Gradually the entire plant is pulled underground and consumed. A single larvae can eat 10,000 mm2 of leaf, the equivalent of about 25 wheat plants. Heavy infestations can completely denude a wheat field in within two or three weeks.

Because the larvae climb the leaves at night before consuming them, they are susceptible to the foliar insecticide applications commonly used to control them in northern Syria and Turkey. Clean fallows or rotations with legumes are also effective in reducing population size because the insects feed only on cereals or wild grasses. **Zabrus** problems arise when these control measures are not implemented. If farmers cannot afford insecticide applications, if the extension system breaks down, or if the farmer or the farm policy makers decide against using fallows or rotations, large **Zabrus** populations can become established within two or three years.

The farming practices that promote **Zabrus** also promote ground pearls, **Porphyrophora tritici. P. tritici** is found commonly in Turkey, Syria, and Iran. **P. tritici** prefers barley but will also infest wheat. The insect sucks fluids from the roots and lower stems of seedlings, causing withering and sometimes death if infestations exceed about 12 insects per plant. Eggs are laid in the soil and the minute first instar larvae overwinter within small chambers in the soil. When seedlings are present, larvae migrate to the lower stems inside the leaf sheath where they attach themselves to the plant with sucking-piercing mouthparts.

Second instars form a purple cyst at the base of the plant which give rise to third instar larvae (about 3 to 5 mm long). Adults may be observed in early June as wax covered, segmented homopterans having the appearance of small cotton balls, hence the name "ground pearls".

Ground pearls are easily controlled by treating seeds with systemic insecticides. Clean fallow is also effective in reducing population size. However, farmers in the marginal cropping, desert fringes of Syria normally continuously plant barley without fallow. In years of adequate rainfall they harvest grain and sell it or use it as seed the next year. In very dry years when the crop fails, they graze sheep on the drought affected plants and thus receive some income from the crop. Continuous monoculturing of barley in drought stressed regions provides an excellent habitat for ground pearls to become established. Once ground pearls are established in a field, the infestation expands over the course of three to five years until the entire field is infested. High rainfall years will reduce populations, but not eliminate them. Dry years are especially damaging, as the insect flourishes on stressed plants.

The problem facing the entomologist in both cases is not just how to control the insect, but rather, how to adjust the system so that the insect is managed while insuring that the farmer receives some annual income from his land. Current research stresses the development of drought resistant vetches which can be rotated with barley to provide forage for sheep and reduce or prevent **P. tritici** and **Zabrus** infestations. When such an alternative crop is available the farmer will be able to maintain a yearly income from his land by grazing his sheep on the land and also control the insect pest.

CONCLUSION

Many countries in the Mediterranean region share common pest problems on wheat and barley. ICARDA stresses the need for cooperation between these countries, and between international centers, to devise and implement integrated pest management programs for these pests in an environmentally sound and economically feasible manner. The use of resistant varieties of wheat and barley will form the keystone of some of these pest management schemes as the costs can be shared by research institutions with the benefits, the resistant varieties, being passed on to farmers at relatively low cost. Hessian fly, wheat stem sawfly, and aphids are pests most likely to be controlled by the development and strategic release of resistant germplasm. Other pests, such as the sunn pest, wheat ground beetle, and ground pearls, will require different and perhaps more complex management systems.

RESUME

Plusieurs pays méditerranéens ont des problèmes communs d'insectes nuisibles du blé et de l'orge. L'ICARDA met un accent particulier sur le besoin de coopération entre ces pays et avec les centres de recherche internationaux pour formuler et mettre en place des programmes de lutte intégrée contre ces insectes qui prendraient en compte les aspects écologiques aussi bien qu'économiques. L'utilisation de variétés résistantes sera le pilier de ces programmes car le coût de leur développement peut être partagé par les organismes de recherche, mettant ainsi ces variétés à la disposition des agriculteurs à un coût modéré. La mouche de Hesse, le cèphe du blé, et les pucerons sont des exemples d'insectes nuisibles qui pourraient être contrôlés par le développement et la diffusion de variétés résistantes. D'autres insectes tels que la punaise des céréales, les larves de **Zabrus tenebrioides,** et les Margarodidae exigeront des approches différentes et sans doute plus complexes.

Mots clés : Cèphe du blé, punaise des céréales, pucerons, **zabrus, Porphyrophora.**

ABSTRACT

Many countries in the Mediterranean region share common pest problems on wheat and barley. ICARDA stresses the need for cooperation between these countries, and between international centers, to devise and implement integrated pest mangement programs for these pests in an environmentally sound and economically feasible manner. The use of resistant varieties of wheat and barley will form the keystone of some of these pest management schemes as the costs can be shared by research institutions with the benefits, the resistant varieties, being passed on to farmers at relatively low cost. Hessian fly, wheat stem sawfly, and aphids are pests most likely to be controlled by the development and strategic release of resistant germplasm. Other pests, such as the sunn pest, wheat ground beetle, and ground pearls, will require different and perhaps more complex managment systems.

Key words : Wheat stem sawfly, Sunn pest, aphids, **Zabrus, Porphyrophora**

ملخص

تتقاسم عديد من دول حوض المتوسط آفات حشرية معروفة على القمح والشعير. وتؤكد إيكاردا على الحاجة إلى تعاون تلك الدول فيما بينها وبين المراكز الدولية للخروج ببرامج مكافحة متكاملة لهذه الآفات مع تنفيذها بأسلوب سليم بيئيا ، وممكن اقتصاديا. وتشكل زراعة أصناف مقاومة من القمح والشعير حجر الزاوية في تدابير إدارة الأفات، طالما أنه يمكن تقاسم النفقات بين هيئات البحوث والفوائد التي يمكن أن تنقل إلى الزارع ، بواسطة الأصناف المقاومة ، بنفقة أقل نسبيا. إن ذبابة هس ودبور الحنطة المنشاري والمن آفات يرجح أكثر مكافحتها بتطوير واعتماد استراتيجي لأصول وراثية مقاومة . وهناك آفات أخرى كالسونة ، وماضغة بادرات الحبوب ، ولآلىء الأرض Porphyrophora tritici ستتطلب نظم مكافحة مختلفة وربما أكثر تعقيدا.

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Photo 1. : Adult female Hessian fly, **Mayetiola destructor** (Say), resting on a leaf. The ovipositor is extended in the calling position suggesting she is releasing a pheromone to attract males. (Photograph by J.H. Hatchett)

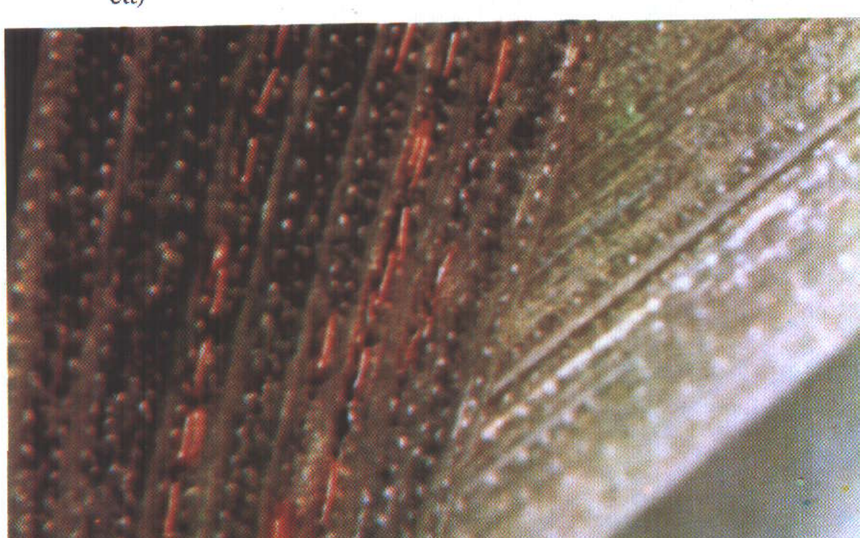

Photo 2. : Reddish eggs of the Hessian fly on the upper surface of a wheat leaf. (Photograph by J.H. Hatchett).