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Identification and control of agricultural plant pests and diseases in Khorezm and the Republic of Karakalpakstan, Uzbekistan

by

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No 8
Хоразм вилояти ва Қорақалпоғистон Республикасида (Ўзбекистон) қишлоқ хўжалик зараркунандалари ва касалликларини аниқлаш ва уларга қарши кураш

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Қисқача мазмуни

Ушбу ишда Ўзбекистон шимолий—ғарб қисмида қишлоқ хўжалик зараркунанда ва касалликларига қарши курашга қаратилган тадқиқотлар умумлаштирилган бўлиб, бу маълумотлар тўғрисида ахборот етарлича емас. Устунлик асосий экин—ғўзага қаратилган. Буғдой, шоли, картошка тўғрисида ҳам батафсил маълумот келтирилган. Айрим ҳолларда зараркунанда ва замбуруғларнинг келтирган зарарини тасвирлаш мақсадида тарихий нуқтаи назардан ёндашилган. Кенг қишлоқ хўжалик ўсимликларига катта зарар берадиган ҳашаротлар сифатида Agrotis segetum ва Spodoptera exrgua, замбуруғ касалликларини қўзғатувчилардан эса Erysiphe communis (милдью) ва Verticillium dahliae (вилт) ларни кўрсатиш мумкин. Муҳокама қилинаётган кимёвий кураш чораларидан, биологик ҳимоялашгача ва механик чораларни турли вариантларда қўллашга кенг эътибор қаратилган. Маълум ва ишлаб чиқаришда кенг қўлланиб келинаётган кураш чоралари батафсил ёритилган. Шулардан бири — зараркунандалардан нобуд бўлган ёки зарарланган ўсимликларни йиғиб йўқотиш — умуман олганда самарали усул ҳисобланиб кейинги йиллари ҳам зараркунандалар ўчоқларини қисқартиришга олиб келади. Бошқа муҳим ва кенг қўлланиладиган кураш чоралари — ўз вақтида биологик агентларни қўллаш, табиий кушандалар фаолиятини кучайтириш ва зараркунандалар сонини узлуксиз ҳисоблаб бориш (мониторинг) дан иборатдир. Бу қоидаларни, маълум ресурслар талаб даражасида қўллаш, зараркунанда ва касалликлардан йўқотиладиган ҳосилни қисқартириш исконини беради. Бироқ узоқ муддатли ҳосилдорликни оширишга эришиш учун ирригация, ердан фойдаланиш сингари факторларни ҳисобга олиш ҳам муҳимдир.

No. 8

Идентификация и борьба с сельскохозяйственными вредителями и болезнями в Хорезмской области и Республике Каракалпакстан (Узбекистан)

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РЕЗЮМЕ

В настоящей работе приведен обзор исследований, направленных на борьбу с сельскохозяйственными вредителями и болезнями в северо-западной части Узбекистана, по которой имеется мало информации. Приоритет отдан доминирующей культуре – хлопчатнику. Детальная информация также имеется по пшенице, рису и картофелю. Местами использован исторический подход для иллюстрации меняющейся угрозы со стороны вредителей и грибов. Наиболее вредоносные организмы, наносящие ущерб широкому кругу сельскохозяйственных растений, включают *Agrotis segetum* и *Spodoptera exigua*, а также грибковые заболевания *Erysiphe communis* (Мучнистая роса) и *Verticillium dahliae* (вилт). Нематоды также являются серьезными вредителями хлопчатника. Обсуждаемые меры контроля варьируют от химических обработок до биологического контроля и механических обработок. Перечислены детальные меры борьбы, где они известны и находятся в применении. Одна из таких мер – удаление и уничтожение погибших или зараженных растений – в целом эффективна для сокращения очагов поражения или численности вредителей в последующие годы. Другие важные и широко применяемые меры борьбы включают своевременные выпуски агентов биологического контроля, стимулирование имеющихся естественных врагов и мониторинг насекомых вредителей. Применение этих правил, при имеющихся требуемых ресурсах, может потенциально снизить потери урожаев от вредителей и болезней. Однако следует учитывать и другие факторы, такие как ирригация и землепользование, для того, чтобы достичь долгосрочных улучшений в урожайности.

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ABSTRACT

This paper reviews existing research on agricultural pest and disease control in north-western Uzbekistan, for which little information is currently available outside the region. Priority is given to the dominant crop, cotton. Wheat, rice and potatoes are also dealt with in detail. In places a historical approach is used to illustrate changing pest and fungal threats to crops. Particularly harmful organisms, which afflict a wide range of crops, include the moths *Agrotis segetum* and *Spodoptera exigua* and the fungal diseases *Erysiphe communis* (mildew) and *Verticillium dahliae* (wilt), among others. Nematodes are also very destructive cotton pests. Control measures discussed range from chemical pesticide application to biological control and mechanical measures. Detailed control measures are listed where such techniques are known and available. One such measure, the removal and destruction of diseased or infested plants, is generally effective in reducing innoculum or pest levels in following years. Other important widely applicable control measures include the carefully-timed release of natural biocontrol agents, the encouragement of existing natural enemies and the monitoring of insect pests. Implementation of these guidelines, given the availability of required resources, has the potential to significantly reduce crop losses to pests and diseases. However, other factors, such as irrigation management and landuse, must be taken into account in order to achieve lasting improvements in productivity.

1 INTRODUCTION

Preservation and encouragement of beneficial species as well as suppression of harmful species requires detailed knowledge of the concerned species' biology and ecology. Community level studies of interspecific interactions as well as with their environment in ecosystems are also essential. When controlling harmful species in order to maintain or increase production particular attention should be given to the greater use of natural regulatory systems, particularly predators and parasitoids, which can determine the abundance and population dynamics of pestilent species.

Losses in agricultural fields and gardens brought about by harmful organisms, particularly insects, has for a long time focussed research on crop protection. Effective measures of insect control cannot however be developed without knowledge of pest biology and ecology. After a short overview of the history of pest research in the region, the pests, diseases and control measures for the main agricultural crops in Khorezm and Karakalpakstan are separately addressed.

1.1 A brief history of entomological research in Uzbekistan

An entomological station was established on a Murghab estate (a border area of Uzbekistan, Tajikistan and Kyrgyzstan) in 1909, and a Turkestani entomological station in Tashkent, Uzbekistan, in 1911. The studies, which were carried out in 1913-1914 in the Fergana valley by Vasil'ev (1914-1915), began gathering data on the biology, ecology and harmfulness of turnip moth (*Agrotis segetum* Schiff) and tobacco thrips of cotton aphids. The first mention of red spider mite (*Tetranychus urticae* Koch) damage to cotton was recorded by Vasil'ev (1910). Simultaneously Simonova's work (1909, 1910) on cotton pests appeared. It described the cotton ball parasite, which was subsequently named Simonova's bracon. Plotnikov (1911) described rapid bursts of *Spodoptera exigua* (Noctuidae: Ipimorphinae) reproduction in the summer of 1911.

Poisoned baits were introduced from 1915 onwards to the entomological stations and with the support of the Turkestani agricultural society as the most effective method of controlling pestilent acridids at that time.

On the basis of the research carried out between 1911 and 1917, the Turkestani entomological station recommended spraying crops with onion paste impregnated with sulphuric powder in order to control red spider mites (Vasil'ev 1924), manual gathering of harmful larvae and spraying Paris Green [Copper acetoarsenite Cu(CH3COO)2 3Cu(AsO2)2] on the affected crop .

The first data on harmful insects in Uzbekistan were gathered in the 1890s (Yahontov 1953). At that time manual gathering methods were recommended for pest control such as gathering pests with nets. Applications of biological pest control methods were first attempted in 1910-1911 by Rodetskiy, when *Trichogramma* (Trichogrammatidae), the natural parasitic wasp enemy of the codling moth *Cydia pomonella*, was delivered from Astrakhan, Russia. Biological control methods were popular around 1910, but decreased quickly in popularity due to the absence of necessary fundamental data. The insects' faunal structure in Uzbekistan was also rather unknown. It later emerged that *Trichogramma* were already present in Uzbekistan and the insignificant number of introduced individuals could not significantly increase the effectiveness of the existing stock in controlling codling moth.

Systematic study of harmful insects and the study of parasites and predators began immediately after the establishment of the Turkestani entomological station. However, there was little funding and there were only a few employees in the first decades of existence of the station. Therefore, progress was very slow; by the 1920s even major insect pests of the vital crops had not been fully investigated in Uzbekistan. Cotton at that time received little attention from researchers.

The Bureau of Plant Protection, organised under the special Plant Protection Department of the National Commissariat of Agriculture in Uzbekistan, was established in 1925 with several branches. In 1928, these were then reorganized as Plant Protection Stations; nine such stations existed in the territory of Uzbekistan (Andizhan, Bukhara, Zaravshan, Kashkadarya, Kokand, Samarkand, Surkhan-Darya, Tashkent and Khorezm). These stations carried out research alongside practical work. Research into agricultural entomology proceeded at the Uzbekistan experimental station of plant protection. The first motor and tractor equipment used for pest control in the republic appeared in 1925-1926.

In 1927, the Shirabudin (and partially Khorezm) experimental station joined in research efforts on harmful insect control and produced significant work, especially on alfalfa pests. In 1929 the main cotton committee established a specialized station for the study of cotton pests and diseases in Tashkent, which was outstanding in terms of personnel numbers and technological equipment.

In 1932, the operative service on pest control was transferred to the Uzbek base of pest control, which had existed for only two years, but in 1934 the function of controlling pests and diseases of agricultural plants was handed over to the machine-tractor stations (MTS) directly. Similarly, in the Republic of Karakalpakstan 1932 is considered as the beginning of the development of the plant protection services, when, together with the formation of collective farms, machine-combat stations (MCS) were established for pest control of agricultural plants.

The study of agricultural plant pests and cotton pests in particular began in Khorezm in the mid-1930s. These studies include Zavodovsky's (1935) work on the alfalfa bug's (*Adelphocoris lineolatus* Goeze) harmfulness to cotton in Khorezm. He was the first to establish that the alfalfa bug is a serious cotton pest. Serbinova's (1935) work confirmed the alfalfa bug's pest status and it's possible role as a carrier of cotton diseases in Khorezm and Karakalpakstan.

In the thirties much attention was also paid to the study of Acridid fauna (Voronitsky 1932) and in 1936 an anti-locust expedition was organized in Karakalpakstan. In these years significant damage to the cotton and other agricultural crops was caused by the small soil noctuid or caradrine (*Spodoptera exigua*), turnip moth *(A. segetum*), and the red spider mite *(Tetranychus urticae* Koch*)* among others (Popov 1931, Shamuratov 1979).

Alimdzhanova's research (1950), which was carried out in the mid- to late 1940s in the Turtkul, Kungrad, and Chimbay districts of Karakalpakstan, in Khazarasp district in Khorezm, and in other regions of Uzbekistan, showed that bugs (Hemiptera) make up one group of insects constantly encountered in alfalfa fields. According to her data, 39 species of bugs from 8 families were identified in alfalfa. Species of common bugs on alfalfa fields belong to the following genera: *Dolicories* Mlg. R., *Camptonus* Am. Sev., *Reduviolus* Kirby*, Adelphocoris* Reut., *Lygus* Hahn., *Poeciloscytus* Fieb., *Camtobrochis* Fieb. and *Trigonotylus* Fieb.

In the second half of the 20th century several workers studied the Acridid fauna of agricultural crops, including cotton, along the Amu Darya river in the Khorezm valley where locust plagues occur (Bekuzin 1962). In particular the Asian locust was identified on cotton and other agricultural crops (Novitsky 1953, 1963, Tsyplenkov 1970). A similar situation has developed in the region with Italian locusts. For example, the Italian locust threatened agricultural crops in 1949, 1950, 1967, and 1968 (Stolyarov 1967).

In 1952, the Phytohelminthological Laboratory of the Zoology and Parasitology institute AS UzSSR, in collaboration with the Professor Tulaganov of the Faculty of Invertebrate Zoology and Hydrobiology of the Central Asian University, organised expeditions which especially targeted the study of phytophages and soil nematodes in Karakalpakstan. The regions of Turtkul, Kuybisheb, Chimbay, Kegeylin, Shabbaz, Kipchak, Kungrad, Shumanay and Hodzhejlin were covered by an ecological fauna survey.

In Khorezm and the Republic of Karakalpakstan *Spodoptera exigua* (local name: caradrine) is of great importance as a pest of many agricultural crops (cotton, alfalfa, beet, and corn, among others). In years when large numbers are present, caradrine pests can cause huge damage to agricultural crops, especially cotton. According to Shamuratov (1967a, 1979), 295 993 ha of cotton crops were populated with caradrine moths in 1964, and 325 742 ha were occupied in 1969. Features of caradrine biology and its harmfulness, food selection, the influence of a caterpillar's fodder regime on the health of the adult, fodder regime and associated plant damage, the underlying causes of mass reproduction and other questions were examined in the study region (Atadjanov 1963; Shamuratov 1967a, 1967b, 1970a, 1970b; Khamraev and Karimov 1974; Khamraev and Abdullaeva 2001b). Other important studies on the biological and ecological features of *Spodoptera exigua* include Harin (1929), Bogush (1935, 1945, 1951, 1953, 1964), Bronshteyn (1951), Atadjanov (1963), Khamraev (1967, 1968, 2001a), and Shamuratov (1967a, 1969), Shamuratov and Aytbaev (1991a).

Erezhepova (1970) was the first to work on the structure and number of entomological complexes of the cotton growing zones in Karakalpakstan. Her work, which is based on collections of insects in cotton fields and on their weeds, revealed 13 species of locusts, 4 species of grasshoppers and crickets, and 3 species of mirid bugs (Heteroptera: Miridae). Erezhepova concluded that many species from these groups of insects are significant pests of cotton and recommended taking necessary measures for prevention of mass occurrence of those or other harmful species and for reduction of their distribution in initial stages on the weed environment of crop areas.

One generalized study on the harmful entomofauna of cotton fields in Karakalpakstan is Erezhepova’s (1972) dissertation on pests of cotton and alfalfa fields. Eight harmful lepidopteran species, 32 species of Heteroptera and 21 species of Acrididae were given. The author recommended preventative measures of control (organizational, economic and agrotechnical actions) based on ecological principles for the most important pests.

At the same time, research on the Heteroptera was carried out which up to then had been little studied in Karakalpakstan (Djalmenova 1976), who established characteristics of their distribution zones. Djalmenova first considered the interactions of Heteroptera between adjacent fields of cotton, alfalfa and other cultures. Also, weed vegetation acts as a refuge for heteropterans. She therefore recommended treating the edges of alfalfa fields adjoining the cotton fields with insecticides before the beginning of the alfalfa harvest.

Systematic supervision of development in the Southern Aral basin began in 1929-1930. A sharp increase in pest levels of cotton crop areas by red spider mites, cotton aphids, cotton whitefly, tobacco thrips, cicadas, bugs and so on (Shamuratov 1979, Khamraev and Abdullaeva 2001a) was observed in 1930-1933.

2 COTTON PESTS AND DISEASES

2.1 Overview of cotton pests

Noctuids (Lepidoptera: Noctuidae) are one of the chief threats to cotton, which is probably the most important crop in the region. Aside from them, proboscis-feeding pests such as red spider mites, cotton aphids, cotton whitefly, tobacco thrips, cicadas, bugs and so on are significant cotton pests.

2.1.1 Noctuidae

Cutworms (Noctuidae: Noctuinae) are an important component of the cotton agrobiocenosis of the southern Aral basin, in particular the Khorezm oasis (Rakhimov 1997). A number of studies is devoted to this group of insects (Kerimbaev 1976; Larchenko & Miraliev 1976; Kerimbaev 1978; Shamuratov 1979, 1991, 1993; Djalmenova 1980; Baynazarov et al. 1991; Tanirberganov 1999). Among them, the turnip moth (*Agrotis segetum* Den. et Schiff.) deserves special attention as a cotton pest. Djalmenova's (1980) investigation of noctuid biological features showed that the threat posed by the turnip moth as a general pest of cotton shoots rises proportionally to the expansion of crop area. A spatial division of the republic into areas using the degree of harmfulness of this species has been performed by Kerimbaev (1976, 1978) and Larchenko & Miraliev (1976).

One of the most important species among cotton pests in the considered zone is the cotton noctuid. This lepidopteran’s caterpillars are particularly harmful because its caterpillars prefer to feed on the plant’s growing tips. As Erezhepova (1972) notes, cotton noctuids were not widely distributed in Karakalpakstan until 1969. However, in 1969 in the northern districts of the republic it was registered in very high abundances. Especially at the beginning of August and September, 6-8 caterpillars per 100 plants were detected in the fields of the Djumanazarova farm in the district of Keygili. In Shamuratov's (1979, 1980) opinion, cotton noctuid crop damage is most destructive during mass cotton boll formation. That occurs during development of the second generation of cotton pests in this region.

Mass reproduction of the cotton noctuid in Karakalpakstan can be explained by the expansion of cotton fields and other irrigated cultures where these pests may attain abundances that cause significant harmful effects on their food plants. It is likely that expansion of alfalfa, corn and vegetable cultures has played a large role in the expansion of these pests in recent decades (Polyakov 1971; Shamuratov 1979, 1986, 1993).

Especially in the past 5 years cotton noctuids have become one of the most serious cotton pests in the Southern Aral basin. As an example, mass reproduction in 1998 and 2002 led to caterpillar numbers reaching 5-6 individuals per cotton bush (Khamraev *pers. obs.*).

2.1.2 Red spider mites *Tetranychus urticae* Koch

According to data from Shamuratov (1986), red spider mite females leave their wintering refuges in February and March at temperatures of 5-10˚C, and in the northern areas of Karakalpakstan pests leave their refuges in April (Sultanov and Torenijazov 1996). Under normal conditions in Karakalpakstan the maximal number of pests on weeds is reached in the second week of June, while on cotton the peak is reached in the second week of August (Shamuratov and Aytbaev 1991b). Mathematical models have been developed for the extensiveness and density dependence of settlement in bordering weed refuges and for the pest density in cotton. On the basis of these models simple and labor-unintensive methods of red spider mite monitoring have been developed. According to the degree of plant occupation it has been established that red spider mites develop between 10 and 13 generations within one year (Shamuratov and Aytbaev 1991b; Shamuratov 1993). Torenijazov (1998) considers that red spider mite and rusty ticks are predominant among tick-phytophagans in agrobiocenoses. In recent years (1999-2001) in the southern Aral basin it has been ascertained through study that some peculiar biological and ecological features of the red spider mite have been found to have developed, for example in development, trophic connections, and population density in the weed plants and cotton (Bekbergenova and Khamraev 2002).

2.1.3 Cotton aphids

In Karakalpakstan the most widespread and harmful species in cotton are melon or cotton aphids *Aphis gossypii* Glov., acacia aphids *Aphis craccivora* Koch. or alfalfa aphids, and the large cotton aphid *Acyrthosiphon gossypii* Mordv (Shamuratov 1979).

As a cotton pest the large cotton aphid *Acyrthosiphon gossypii* has the greatest economic significance in the northern areas of the republic of Karakalpakstan (Shamuratov and Aytbaev 1991b). A mathematical model and working table using the express train method of density estimation and degree of plant infestation has been developed for this aphid (Shamuratov 1993). The occurrence of alfalfa and large cotton aphids on cotton and their seasonal population dynamics is dependent on ecological conditions (Shamuratov 1992). Toreniyazov (1996) even argues that the deteriorating ecological conditions in the Aral Sea region (increased soil salinization, climate change) essentially influence the behavior of pest insects and that mass development of ticks, whitefly and aphids can be expected for the coming years in Karakalpakstan. Utepbergenov et al.(1996) have observed an increase in proboscis-feeding pests since 1980 in southern areas of Karakalpakstan, which produced significant harm to cotton, vegetables and melons, whereas in recent years these pests have also been on the rise in northern areas of Karakalpakstan.

2.1.4 Cotton whitefly

Mass occurrence of cotton whitefly began during the late 1980s in the Southern Aral basin (the Khorezm area, Karakalpakstan, and Tashauz district in Turkmenistan) on cotton and other agricultural crops. In the Khorezm region alone, the cotton whitefly has been recorded on more than 80 000 ha and caused damage of around 43 million rubles in 1989 (Dushamov 1991). Biological features of cotton whiteflies in Karakalpakstan have been investigated by Nurzhanov (1996) and Torenijazov (1999). The features of wintering and the terms of transition of the whitefly to cotton crops in Khorezm are covered by Dushamov (1991), and Dushamov & Matkarima (1997). The adaptation of the tobacco whitefly to conditions in Central Asia and its emergence as the most serious pest of cotton, melons, vegetables and other agricultural crops is discussed by Suharuchenko et al. (2001).

Thus, on the basis of personal materials and the analysis of references on cotton in the Khorezm region and republic of Karakalpakstan 129 phytophagous-insect and a single tick species have been recorded (Khamraev and Bekbergenova unpublished) (Table 11.1).

Table 2.1 The most destructive cotton pests include the following species:

Common name	**Latin name**
Red spider mite	*Tetranychus urticae* Koch.
Acacia aphid	*Aphis craccivora* Koch.
Cotton or melon aphid	*Aphis gossypii* Glov.
Large cotton aphid	*Acyrthosiphon gossypii* Mordv
Cotton whitefly	*Bemisia tabaci* Genn
Tobacco thrips	*Thrips tabaci* Lind.
Field bug	*Lygus pratensis* L.
Wormwood plant bug	*Lygus gemellatus* H.S
Alfalfa plant bug	*Adelphocoris lineolatus* Goeze
Asian locust	*Locusta migratoria migratoria* L
Italian locust	*Calliptamus italicus italicus* L.
Turnip moth	*Agrotis segetum* Den.et. Schiff
Cotton noctuid	*Helicoverpa armigera* Hbn.
Caradrina (local name)	*Spodoptera exigua* Hbn.

2.1.5 Cotton nematodes

Karimova (1957) discovered 22 species of nematode on cotton plants and in the soils of Kipchak, Kungrad, Shumanay and Hodzhejlin districts of Karakalpakstan. Of these *Diploscapter rhizophilus, Cephalobus emarginatus, Acrobeloides butschlii, A. karakalpakensis, Trilobus kirjanovae, Dorylaimus dogielii, D. kirjanovae, D. limnophilus, D. microdorus, D. monohystera, D. obtusicaudatus, D. rotundicauda* and *Discolaimus gossypiorum* are not found. Of the 25 species of nematode found on cotton plants and in soil the following have been recorded both in the authors' material (Khamraev unpubl.), and in Karimova's (1957) study: *Diploscapter longicaudatus, Cephalobus nanus, Eucephalobus filiformis, Acrobeles tricornis, Cervidellus insubricus, Tylenchus davainei, T. leptosoma, T. filifomnis, Ditylenchus intermedius, Pratylenchus pratensis, Dorlaimus paraobtusicaudatus, Aphelenchus cilindricaudatus, Aphelenchoides zeravschanicus, Dorylaimus macroborus* and *Dorylaimus pratensis*. Karimova did not record the following species: *Rhabditis filiformis, Cephalobus persegnis, Eucephalobus elongatus, Acrobeloides butschlii, Chiloplacus lentus, Acrobeles ciliatus, Ditylenchus dipsaci, Rotylenchus multicinchus, Aphelenchus avenae,* and *Aphelenchoides parietinus*. Thus, the nematodofauna of the cotton and soil in Karakalpakstan is characterized by 38 species of nematodes.

Once again it is necessary to note that considering the rather high species diversity of cotton nematodes in Karakalpakstan, the number of species found was insignificant (Table 11.3).

2.2 Effects of cotton pests

2.2.1 Noctuids (*Helicoverpa armigera, Spodoptera exigua*)

Soil noctuids may be found on 120 species of plants, but are almost always present on plants of 15-20 species. These plants include cotton, tomatoes, tobacco, pepper, egg plants, mung beans *Phaseolus aureus*, soybeans *Soja hispida*, corn and many others.

On cotton younger caterpillars damage flower buds and young buds of the upper plant. In the process of caterpillar development and growth they attack lower and middle branches of bushes, damaging contents of large buds and flowers. At advanced ages they bite into the feeding-generated bolls and consume seeds before they have hardened. Damaged fruit elements fall off, and large bolls rot. One caterpillar can damage up to 23 fruit elements, and crop losses may reach and exceed 12-15 %. 4-5 generations develop within one season.

2.2.2 *Spodoptera exigua* (Noctuidae: Ipimorphinae)

These are widely distributed and harmful, periodically achieving massive abundances in areas of cotton sowing, especially in the provinces of Khorezm, Bukhara and the Republic of Karakalpakstan. Larvae mainly damage cotton leaves and become considerably more voracious as they growth. During periods of mass caradrine (*S. exigua*) development the density of caterpillars can reach tens of individuals on a single plant. Adult caterpillars do not just feed on leaves, but also cut young stalks of cotton and bite into stalks and branches, resulting in "stamped" plants. They even eat away buds, and in some years (such as 1996) these noctuids perform the role of a bollworm, causing significant damage to buds and bolls (Khamraev and Abdullaeva 2001b). Five to six caradrine generations develop within one season.

2.2.3 Red spider mite (*Tetranychus urticae* Koch)

Red spider mites are a constant and destructive cotton pest. They settle on the bottom part of the leaf and on the bract, forming colonies frequently consisting of hundreds, and sometimes thousands, of individuals. During periods of extremely high infestation the tick can cause complete leaf loss.

Plants infested by the tick in June lose, on average, 50-60% of their yield, while those attacked in July and August suffer a 25-40% and 2-6% reduction in yield, respectively (Uspenskiy 1963). During one year the pest develops between 12 and 20 generations, depending on geographical position and meteorological conditions. 20 species of red spider mite predators have been registered (Table 11.2).

This is a generalist herbivore which feeds on 248 plant species. Of these 173 species are weeds and wild-growing grassy plants, 38 species are trees and bushes and 37 species are field cultures. The specified plants belong to 62 families.

2.2.4 Aphids (Aphididae)

Aphis craccivora, Aphis gossypii, and *Acyrthosiphon gossypii* settle on a plant and suck sap from the leaves. As a result, the quantity of available carbohydrates in the stalks and roots falls sharply. The maximal observed damage from cotton aphids is up to 40% of crop yield.

In the autumn the aphids have no significant effects on crop yields, but crop quality suffers severely. During boll formation, the aphids pollute the crop with raw sticky sugary excretes on which soot fungi frequently develop. The cotton fiber thus becomes blackened, appearing as if smeared with soot.

Additionally, aphids transfer viruses and the disease *Macrosporium macrosporum* (Zimm.) Morsy by carrying sap among diseased plants. Depending on temperature the aphids develop in 3 to 20 days. They can achieve between 20-26 generations in one season.

2.2.5 Cotton whitefly (*Bemisia tabaci*)

This species causes significant and widespread damage to the cotton crop cotton and other cultivations. Its menace is essentially increased because of its ability to quickly reproduce and so rapidly increase to large population sizes. At this stage whitefly causes significant damage to the cotton. It sucks leaf juice and causes leaf deformation and discolouration (yellow). Leaves become covered with sticky sugary excretes, soot fungi appear on leaf surfaces and fibers are discoloured by the fungi. Additionally, whiteflies are carriers of many viral agents causing plant diseases, especially to tomatoes, cotton and flowering plants.

Cotton whitefly can be distinguished from all other harmful species of aleyrodides by its highly poisonous nature and has become increasingly harmful in the past 30 years on all over its range of distribution. The number of plants damaged by cotton and greenhouse whiteflies (*Aleyrodes vaporariorum* Westwood) exceeds 300 species.

2.2.6 Bugs (Hemiptera)

Lygus pratensis, L. gemellatus, and *Adelphacoris lineoptus* are polyphagous but are especially damaging for sugar beet, leguminous grasses, many spinning, olive, medicinal, market gardening, decorative, frequently grain plants and tobacco. In contrast to many Miridae field bugs damage near-mature seeds. Their larvae are resistant to frequent rain and pesticides. Eggs are deposited on the stalk and leafstalk of plants where they are well protected from both biotic and abiotic factors. Specialized entomophages, which can decrease the abundance of a pest species, are practically absent. These factors have promoted successful development and reproduction of field bugs on all cotton types. In recent years their abundances have become menacing for the cotton. According to our data, during the 1989-1996 period the loss of crop yields from bugs averages from 22.7 to 60% (depending on the cotton variety, Khamraev 2001b).

The buds damaged by bugs drop off irrespective of age, since puncture wounds are deadly to them. Damage to ovaries results in reduction of the size and weight of bolls, which may cause a partial or complete loss in yield. Depending on the age at which ovaries are attacked, the weight of bolls and characteristics of the cotton is affected and the length and output of cotton fibers change. Fiber development stops.

2.2.7 Thrips

Thrips tabaci and *T. gossypii* form widely-spaced colonies. As a result of the thrips feeding leaves become creased and take on a mosaic-like pattern with lurid yellow coloring. Quite frequently leaves dry up and die, and consequently the young plant distinctly lags behind in growth and frequently perishes. If the plant recovers from thrip attacks on the growing leaf in, characteristic fragmentary, angular holes are a typical sign of damage. The highest abundances of these insects can be observed from May up to middle of June. The number of thrips generations reaches between 6 and 7 per year.

2.2.8 Acrididae (*Calliptamus italicus, Locusta migratoria*)

During periods of mass reproduction the Italian locust (which has been observed during the last few sampling years) lives in a gregarious state in its' centers of distribution. It damages cotton, potato, sunflower, leguminous, melon plants, grain cereals and many other plants to great degrees. The larvae and adult individuals usually feed solely on round leaves and even plant stems. The typical habitat range of the Asian locust is in Karakalpakstan and is located mainly adjacent to the lower Amu Darya river. It is actually necessary to count the nests all over the Amu Darya river delta, beginning approximately at Nukus and reaching downstream to the Aral Sea. The larvae of the Asian locust feed mainly on cereals - wheat, barley and sorghum. The summer locust also harms cotton and another agricultural crops. In 2001 it was observed that under the weight of swarming insects sometimes bushy vegetation and many crops became highly bent.

2.2.9 Cutworm noctuids (Lepidoptera: Noctuidae)

Cutworm noctuids (such as *Agrotis segetum* among others) are one of the most widely distributed pests in irrigated areas of cotton production. Damage caused by noctuids is most appreciable in the Khorezm area. Caterpillars of turnip moth damage more than 160 species of plants, including cotton, alfalfa, sugar beet, corn and many others. The caterpillars damage sprouting seeds of cotton, making holes in seed-lones, cut through roots or stalks near the root, and sometimes completely consume the above-ground part of cereal-shoots. During periods of peak abundance caterpillars can completely destroy shoots, especially those of late crops. 3-4 generations develop in a season, but only the first generation harms cotton crops.

2.3 Cotton pest control measures

2.3.1 Organizational tasks

1) The most important organizational task is the development of operational workplans by each farm or biolaboratory where the following points must be considered:

- Identification of the areas of possible distribution of the overwintering and overwintered populations of pests and their natural enemies;
- Establishment of amounts of work for all equipment and transport and determination of defects;
- Establishment of required repair work for biolaboratories, the equipment and apparatus, and determination of the requirement for means and materials for repair, purchases of additional equipment and replacement of unsuitable equipment;
- Delivery of all means of biological protection in the farms, and registration of applications for nutritious mixes, grain etc.

2) Conduct inventories in all warehouses and premises in order to reveal any residues.

3) Carry out systematic, timely preparation of all warehouse premises intended for reception and storage of microbiological preparations.

4) Provide training for workers concerning protection of plants of the "Uzbek agricultural chemistry" system everywhere and regularly.

5) Provide biolaboratories with sufficient staff according to the adopted staff guidelines.

6) Improve a network of collective-farm biolaboratories: in the autumn-winter period to take effective measures on the organization of their work for the collection of necessary quantity of qualitative biological material.

7) Trichogramma and braconids could be infested by ticks (such as big-bellied or predatory ticks) during cultivation, and their food (mixed grain and food material) could be attacked by barn pests (ticks (*Glycyphagus destructor*, *Caloglyphus rodionovi*, *Acarus siro*, *Tyrophagus putrescentianaxius*), flour may bugs (*Tribolium confusum*, *Alphitobius laevigatus*, *Tenebrio molitor*, *Tenebrio obscurus*), drosophilid flies (*Drosophila melanogaster*), cockroaches (*Blatta orientalis* L., *Blatella germanica* L.), mice (*Mus musculus* L.), rats (*Rattus rattus* L., *Rattus turkestanicus* Satun), and other harmful organisms. Because of this it is necessary to wash out all glass dishes, covers, places for keeping live creature, racks, and objects used such as tables, chairs, and cases using water emulsion of laundry soap.

8) Carefully sterilize in autoclaves on a 45 minute cycle/regime under 2 atmosphere pressures at 110-135˚C products coming from warehouses, granaries, and dining rooms before use.

9) Tick-infested forage should be immediately removed from the biolaboratory and destroyed. All sacks used must be treated with kerosene. The use of a new material without preliminary sterilization is strictly forbidden. Places for keeping live animals that may be infected with ticks are to be carefully washed out with hot water.

10) Upon the occurrence of cockroaches in the premises where plant wax moth and flour moth are bred, a solution of the following makeup is to be applied: 1 part of boric acid to 1 part of sugar to 10 parts of water. This solution should be poured into Petri dishes, which are placed on floor of the premises. Water is added periodically. It is not recommended to apply this solution in areas where plant parasites are bred; it should be replaced by treatment with boiling water.

11) In order to reveal the centers of pest infestation in the cotton it is necessary to regularly carry out inspections of each field from the first instances of shoot growth up to the end of August. For this purpose in farms one specially trained inspector should be allocated per 35-40ha. The inspections are to be carried out at least once every five days from April to August.

12) Simultaneously with investigating pests, monitoring of abundances of the following general cotton entomophagous pests is advised: coccinellid beetles, golden-eyed flies, syrphid flies, *Apantelese* and *Rogas* spp. (braconid wasps), *Microptilis* spp., soil beetles - Carabidae, tick-eating thrips, *Stetorus* etc. In the same samples the number of entomophages should be counted by species and phase of development.

13) Quality control of works inspectors should be carried out by farm agriculturists and entomologists.

2.3.2 Agrotechnical actions

In the control process of agricultural pests, the actions directed towards reduction of the area of infestation centers by pests are of decisive importance. It is achieved by high standard of farming and creation of favorable conditions for the reproduction of natural enemies of pests. Some researchers (Baynazarov et al.1991) recommend early sowing of cotton, which decreases damage to shoots from winter-annual noctuid caterpillars.

1) It is advised to carry out timely and careful ploughing of all soil plots paying special attention to areas that have been under tomatoes, corn, sorghum, legumes and melon

cultures, since these are centres of concentration for pests such as turnip moth *Agrotis segetum*, Caradrina and other harmful pests.

2) The following steps are necessary:

Introduction of optimal norms of organic and mineral fertilizers applications;

Realization, where stipulated by agricultural rules, of winter moisture-retentive irrigation, and also cleansing of soil that causes a significant reduction in pests;

A timely implementation of the fields layout, harrowing, alignment of sowing soil and other agrotechnical techniques that create conditions for early spring accumulation of moisture in soil and for the creation of even soil clod structure;

Elimination of any over-irrigation in the vegetative period that causes weakening of plants and results in a decrease in their resistance to pests and diseases;

Implementation of mechanical harvesting of weeds on boundaries of cotton and other fields, roadsides, streams, ravines and personal plots with obligatory gathering and destruction of weeds. For this purpose it is necessary to plough up and dig over all corners, boundaries of plantations and around the trees (blossoming nectar-giving plants, yarrow, mint, winter cress etc., are to be removed after flowering as a forage reserve for entomophages). The period of flowering is very important for additional food for entomophages. The oviposited eggs of entomophages do not have a full cycle of development because plants dry out. Therefore, it is very important to make the entomophages move to different plants by eliminating the old plants.

3) Cleansing of old and dead bark from tree trunks and branch bases; destruction of dry and damaged sprouts and branches; removal and burning of fallen leaves; removal of trunk and young root growth and dry trees; blocking of hollows, cracks and wounds with putty; whitewash trunks with a 20 % limy milk solution.

4) The upper plant parts should be removed from the field and destroyed in order to reduce the number of eggs and caterpillars of young cotton noctuids.

2.3.3 Biological control agents and opportunities for their use in biological protection of cotton

The entomophages (insect eaters) and acariphages (aphid eaters) are represented in the cotton agrobiocenosis by a large number of species from a multitude of different insect groups and play an important role in the regulation of a number of pests.

By considering studies in the Southern Aral basin of natural enemies of the main cotton pests the following scenario results. According to Shamuratov (1979) caradrine are subject to attacks from many predatory and parasitic insects, but these entomophages have not been investigated at all in Karakalpakstan. There are no data on a role of predators and parasites in suppression of number of caradrine, which was also the case in his subsequent works (Shamuratov 1993). However other authors (Khamraev 1992) have noted that *Bracon hebetor* Say*., Microgaster spectabilis* Hal. (Hymenoptera: Braconidae), *Nabis paliter* Seid*., N. sinoferus* Hsiao., *N. ferus* L. (Nabidae) and others parasitize caradrine.

Parasitic and predatory insects play an essential role in reducing cotton noctuid abundances. According to Shamuratov (1978), a 20% reduction in caterpillar numbers by parasites can be reached on cotton fields. In Djalmenova and Kulumbetova's (1983) work it was noted that *Option lutes* L. and *Phages dimidiatus* Spin parasitize many species of lepidopterans, including winter, cotton and small soil noctuids.

A number of works (Shamuratov 1978, 1979, 1980, 1986; Shamuratov and Davletijarov 1988) have ascertained a likely natural role of a natural population of braconid parasitoid wasps. If sufficient numbers of these parasites are present on cotton fields chemical means of pest control may be unnecessary . Special attention should be paid to the role of predatory bugs, which in Karakalpakstan sometimes destroy up to 50-70 eggs of cotton noctuids (Shamuratov 1986).

Several studies (Babanazarov 1986; Shamuratov et al. 1986; Shamuratov et al. 1991) are concerned with the efficiency (between 50 and 80%) of trichogramma in controlling of cotton noctuid eggs. In contrast, the application of *Bracon* against caterpillars achieved a high biological efficiency (Shamuratov 1993, Shamuratov and Kazakbaev 1986). The following are effective predators of *A. segetum* and cut noctuids and their eggs on cotton fields: trichogramma, *Apantelese* and *Rogas* spp. (braconid wasps) *Microlestes plagiatus* (Carabidae)*, Amblyteles guinguesinctus* Kriech, tachinid flies (Diptera: Tachinidae) and predatory soil beetles. (Djalmenova and Kulumbetova 1982; Shamuratov and Utemuratov 1986; Shamuratov 1993; Tanirberganov 1999).

Currently in the Southern Aral basin *Trichogramma* is widely applied against eggs of cut and soil noctuids, and *Bracon* against soil noctuids.

60 biolaboratories, including 30 mechanized lines, exist for the cultivation of these effective parasites and other entomophages in the Republic of Karakalpakstan, In the Khorezm area 104 biolaboratories and 36 mechanised lines exist. According to information from 2000, the area of application of biological methods in the Republic of Karakalpakstan using trichogramma against noctuids and other lepidopterans has reached 208.1 thousand ha. Accordingly, these parameters have reached 674.4 thousand ha in the Khorezm area.

The first attempts at application of microbiological preparations of dendrobacillin and boverin in Karakalpakstan were carried out in the late 1960s and early 1970s against caradrine larvae (Erezhepova 1970, 1971, 1972). Consecutive application of entomophages (*Trichogramma*) and microbiological preparations (dendrobacillin) to combat cotton noctuid form one of the basic techniques of integrated cotton crop protection (Shamuratov et al. 1996). The role of entomo-akariphages in suppression of the number of proboscis-feeding pests in the cotton agrobiocenose is particularly marked.

In any given entomophagous species assemblage of predators of proboscis-feeding cotton pests there are typically 6 species present from the family Coccinellidae, 2 species from Antocoridae, 2 species from Chrysopidae, 2 species from Syrphidae and representatives of 7 families of class Arachnidae (Djalmenova & Kulumbetova 1982). A decrease in the number of red spider mites is to some extent promoted by *Sterhorus*, *Chrysopidae*, predatory bugs, hover flies (Syrphidae), and also tick-eating thrips (Shamuratov 1986). The minute pirate bug (*Orius* sp.) can also reduce the number of red spider mites. A single female may consume per day up to 110 red spider mite larvae and nymphs (Shamuratov 1993).

It has now been established that in Uzbekistan more than one hundred species of ladybirds (Coccinellidae) belonging to 25 genera exist (Mansurov et al. 2002). The overwhelming majority of coccinellids attack whiteflies, red spider mites, eggs and caterpillars of younger noctuids on cotton.

In Uzbekistan more than 100 species of aphidophages are present. Aphidophages are capable of regulating aphid numbers if a certain quantitative ratio of aphidophages to their prey is given. In particular on cotton fields, control is effective at aphidophage:aphid ratios of between 1:15 and 1:25 (Daminova et al. 2001). Among the non-coccinellid aphidophages the Chrysopidae, Syrphidae, Chamaemyiidae, Cecidomyiidae, and Aphididae are of great significance. Hymenoptera parasitize more than 10 species of Aphididae from the cotton aphid group (Table 11.2).

To combat cotton whiteflies from Israel two parasitic wasp species from the genus *Encarsia* (*Encarsia lutea* Masi and *E. luteola* Howard (=Dessorti Gerling et Rirnay), locally known as lute and disserte) were bred in the Khorezm regional biolaboratory SANIIHR and were released in the field in 1989. Within a short time *Encarsia* spp. became settled on cotton and began to act against whiteflies in several farms in the Khorezm and Tashauz regions, in Turkmenistan, and in the Republic of Karakalpakstan, where efficiency of the parasite in suppression of a number of whitefly larvae has increased from 46.3 to 79.3 % (Dushamov and Matkarimova 1997).

On the basis of unpublished data (Khamraev and Bekbergenova) and existing literature a list of cotton pest predators was assembled (Table 11.2).

2.3.4 Specific biological control methods

Biological methods of plant protection are based on the use of entomophages such as *Trichogramma*, habrobraconids and microbiological means such as dendrobacillin and biotoxibacillin.

1) To increase the efficiency of protective actions both prognosis and factual data about terms and rates of reproduction of the basic pests of agricultural crops are used. Investigation of the centers of infestation and identification of pest density are carried out by regular inspections of farmland fields and the surrounding weed and wood vegetation, with simultaneous consideration of beneficial entomofauna.

In order to uncover centers of infestation in good time, identification of pest abundances and entomophages is carried out and the data from short and long-term forecasts for terms and rates of reproduction of general cotton pests are used.

2) Microbiological means of protection are used similarly to chemical methods in the centers of infestation in order to control populations above a harmful threshold;

Aphids should be controlled if 50 individuals are found on 100 leaves;

Red spider mites at 2-5 % settling on plants with over 170 individuals per 100 leaves;

Against winter and other gnawing noctuids at 1 caterpillar per 7000 leaves;

Cotton noctuid on presence of eggs and 8-12 caterpillars of younger age on 100 plants on the middle-fibered grades of cotton and 4-6 caterpillars per 100 plants on fine-fibered cotton grades.

3) The ratio of abundance of entomophages to cotton pests where additional preventative actions are not necessary are:

For aphids 1:20 (1 entomophage for every 20 aphids);

For red spider mites 1:30;

For turnip moths 1:3

4) Due to the fact that these ratios of pests and entomophages have been deduced as a result of the generalization of available data in the whole republic, they demand further adjustment in order to properly represent the climatic differences in various regions.

When abundances of natural entomophage populations are limited or reproduction of useful and pestilent organisms are asynchronous it is necessary to seasonally apply biological agents which act directly against the pests in order to suppress the reproduction of pests in the centers of infestation.

5) Breeding of hosts and entomophages (wax moths *Galleria mellonela* and *Achroia grisella*, grain moth *Sitotroga cerealella* Oliv., flour moth *Ephestia kuehniella* (Pyralidae); trichogrammid and braconid wasps) should be organized in every region, with the breeding stock being cultivated in order to provide biolaboratories so that they can rear further insects.

6) During the cultivation of entomophages and their hosts optimum conditions, temperature and relative air humidity should be implemented.

7) The Trichogramma cultivated in biolaboratories should meet quality standards determined by the following indicators:

Fertility of 30 eggs per female

The eggs-laying females should be over 90 % of the total number of females bred.

Ratio of male to female 1:1.5-2

No more than 5 % deformed individuals

Survival rate not less than 80 %

Contamination of eggs of *S. cerealella* not less than 80 %

8) During laboratory cultivation the eggs of the grain moth *S. cerealella* are to be used as a host for Trichogramma. It is a forced laboratory host. After a long period of

breeding on these eggs the parasites become less fit, i.e suffer a reduction in average body size, fertility, life expectancy, and an increase in the number of deformed individuals, the sex ratio becomes unbalanced, and other maladaptive traits become noticeable.

9) Excessive breeding (more than three cycles of laboratory development significantly reduce the effectiveness) of Trichogramma, which occurs as a result of cultivating parasites and of constant temperature and humidity conditions, leads to the situation that on release into fields insects appear to be sluggish and intolerant of temperature changes. Therefore their search ability is strongly reduced, and efficiency of biological control subsequently decreases. To avoid this problem it is necessary to raise parasites in conditions which are as natural as possible. In *Trichogramma* holding areas such as shops, the temperature should be maintained at about 25-30˚ in the afternoon, and about 16˚ at night.

10) To increase fertility and life expectancy of *Trichogramma* females the imago should be fed with 20 % sugar syrup. It can be presented on wadded or foam rubber pads which are placed on top of the cloth tank cover. The morning feeding with sugar syrup is alternated with water delivery in the evening.

11) Short-term storage (for about 1 month at temperature +3˚C and 80% air humidity) of active Trichogramma in preimago stages (larvae, prepupae and pupae) may be carried out if necessary before release.

12) *Bracon* sp. (Hymenoptera: Braconidae) should meet the following quality indicators during cultivation in biolaboratories:

Fecundity of bracon parasitizing *Anagasta kuhniella* Zell. and *Galleria melonella* reaches 130 and 500 eggs, respectively;

The sex ratio of males and females on flour moth should be 1:1.5-2, on wax moth - 1:1;

Survival rates should be 80 and 85 % respectively on flour and wax moths;

Life expectancy of imago at a temperature of 26-28˚C is 15-20 days (when fed with 20 % sugar syrup);

Infestation of flour and wax moth caterpillars should be 98 %.

13) When braconids are continuously cultivated in the laboratory, 6-7 high-grade generations can be obtained before updating of the stock is required, i.e. in the autumn

period in order to carry out the infestation of cotton noctuids and corn moth *Tinea granella* with *Bracon* sp..

14) For the effective control of agrobiocenoses by entomophages it is necessary to release them in the early spring to control the pests developing in this period on weed vegetation in the border vegetation of cotton fields.

15) Early-spring release of *Trichogramma evanescens* to control winter and other gnawing noctuids on corn and early vegetable melon cultures is made considering a triple release of 40 thousand female parasite individuals per hectare with an interval of 5-7 days between each release.

16) In early-spring braconids should be released into alfalfa, corn, and weed vegetation into cotton field surroundings and early vegetable cultures with an interval of 7-8 days. The ratio of the parasite to the host in the first release should be 1:20, in the second 1:10 and in the third release 1:5.

17) *Trichogramma evanescens* should be applied at least twice in order to control cabbage and turnip white flies on various early and late cruciferae cultures.

18) *Bracon* sp. should be released in autumn on kenaf *Hibiscus cannabinus* L. seed to control corn moths *T. granella* in a triple release at a parasite:host ratio of 1:20 on the first release, 1:10 on the second and 1:5 on the third.

19) In order to control the eggs of *A. segetum* and cotton noctuids trichogrammid parasitoids should be released at least three times: the first at the beginning of the egg laying period, with a subsequent two releases in the next 3-6 days. Releases are carried out according to the following scheme. 60000 individuals during the first release, 80000 during the second release and 60000 during the third release per hectare. If noctuid egg laying also continues, releases of the parasite should also be maintained.

20) A day prior to the release, the trichogramma should be packaged into 1-2 liter glass bottles with one bottle per two hectares. 100 slices of rumpled filter paper should be placed in the bottles on (at the rate of one per 1 ha). Bottles should be closed with kapron grid or coarse calico and kept at a temperature of about 27-30˚ prior to the beginning of mass flying. Trichogramma should be fed with 20% sugar syrup during 2-3 h (on a bottle cap a wadded pad should be moistened with a sugary syrup). The trichogramma should be released in the morning (from 5 till 10) and evening (18 to 21) hours, displaying pieces of paper with adult trichogramma at 100 points in one hectare.

Pieces of paper are to be put in shady areas on a plant for even distribution of trichogramma and the bottle should be shaken before application of the parasite.

21) High efficiency of bracon application is achieved when parasites are distributed during occurrence of individual cotton noctuid caterpillars. Bracon should be released three times to combat each generation in a parasite:pest ratio of 1:20, 1:10, and 1:5, with an interval of 7-8 days between applications. The release should be carried out in the afternoon in still windless weather.

22) Peak efficiency is achieved with the joint application of trichogramma to control cotton noctuid eggs and bracon to control the caterpillars.

23) Highly effective protection of cotton, corn, sorghum, alfalfa, vegetable/melon cultures, and garden and wood plantings from damage by pests (such as the cotton noctuid *Spodoptera exigua*, codling moth *Cydia pomonella*) is achieved by use of microbiological preparations on a basis spore-formed bacteria of the turingiensis dendrobacillin and biotoxibacillin groups, among others. Caterpillar and younger larvae are most sensitive to these preparations. Microbiological preparations should be sprayed by means of tractors and aviation equipment.

2.3.5 Chemical methods

Chemical methods are an integral part of an integrated cotton protection system. This includes application of the below-mentioned substances.

Of the chemical means of controlling cotton noctuids, red spider mite, aphids, tobacco thrips and whitefly, application of the following preparations are recommended (Table 2.2):

Table 2.2 Chemical means recommended for control of cotton noctuids, red spider mite, aphids, tobacco thrips and whitefly. Legend: s.c.: suspended concentrate, d.l.s.: dry loose suspension, c.e.: concentrate of emulsion, m.p.: moistened powder.

Avaunt 15% s.c.	Karate 5 % s.c.
Admiral 10 % c.e.	Kinmix 5 % s.c.
Applaud 25 % m.p.	Konfidor 20 % s.c.
Benzophosphate 30 % c.e.	Larvin 80 % d.l.s.
Bi-58 new 40 % c.e.	Maytklin 45% c.s.

Buldok 25 % c.e.	Mitak 20 % s.c.
Carbophos 50 % s.c.	Mospilan 20 % m.p.
Cipi plus 55% c.e.	Neoron 50 % s.c.
Danadim 40 % c.e.	Nissoron 10% m.p.
Danitol 10 % c.e.	Nissoron 5 % s.c.
Danitol 10 %. c.e.	Nurell-d 55% c.e.
Danitol 30 % c.e.	Quark 10 % m.p.
Datrin 20 % c.e.	Quark 10 % c.e.
Decis 25 % c.e.	Russia sayren 55 % c.e.
Deltaphos 36 % c.e.	Urell-d 55% c.e.
Zum 10 % s.c.	Uzfen 20 % c.e.
Funanon 57 % s.c.	Vermitek 1.8 % c.e.
Grizlli 36 % c.e.	Zolon 35 % c.e.
Kalipso 48 % c.e.	

2.4 Cotton diseases and their effects

The number of registered cotton diseases is very great. The agents of diseases include viruses (which cause leaf curling), bacteria (cotton bacterial blight, local name hommos), the numerous fungi that cause withering, leaf spots, various diseases of bolls and fibers and plant parasites (*Cuscuta europaea*).

It is convenient to group these diseases by the damage they cause for practical purposes as follows. The first group includes the general diseases of cotton which develope on all parts of a plant and cause widespread damage or death of the plant Bacterial blight, and all traheomicoses, (caused by the fungi genera *Verticillium* and *Fusarium* belong here. Moreover, leaf curling and root decay occur that have great significance in the region. The second group include foliage diseases to which leaf form bacterioses and leaf black spots belong. Finally, the third group includes the local diseases shown on bolls and fibers (Shamuratov 1991).

2.4.1 Root decay *Rhizoctonia solani* Kuhn

The basic agent of this disease complex is the fungus *Rhizoctonia*. The fungus develops a wide brownish mycelium and could form pseudo sclerocies.

In the lower temperatures and higher humidity of soil the agents of cotton shoot root decay could be species of fungi from the genera *Pitium* and *Fuzarium* which are constantly present in soil, as well as in a number of other plants aside from cotton. Cotton plants are damaged by rot beginning at germination until the appearance of 3-4 leaves. Under the influence of *Rhizoctonia* decay development begins as a small dark-brown spots at the root neck and in the top part of the main root. A stain gradually increases in size and penetrates deeply into the tissue, which then collapses. The afflicted roots become covered in ulcers and cracked, plants lose turgor and become dry. Such shoots are easily pulled out of the soil.

In field conditions root decay usually appears sporadically. Development of the disease depends on seed quality and a level of agricultural technicians. Slow-growing seeds that are afflicted with microorganisms produce weak shoots that are easily infected. Agents of root decay are resident in soil and in vegetative residues.

2.4.2 Wilt *Verticillium dahliae*

The disease agents can infect the cotton from the cotyledon formation phase up to the end of vegetation. The disease becomes especially appreciable on adult plants from the budding phase. Typical indicators of advanced disease are a yellow appearance, with brown spots appearing on leaf edges and between fibers and wilting caused by loss of turgor. The leaves droop, dry out and fall down, starting from the bottom of the stalk. Plants are gradually stripped bare. In earlier phases of development the plants drop leaves, stop growth and dry up. Some stalks form new leaves, but this weakens the plants even more. Besides the chronic current form of the disease, an acute form has been observed where withering usually occurs in August and September, afflicted plants wither within 2-3 days, in this case leaves turning pale, drooping and drying up.

The infestation of a plant typically occurs through the root system and is promoted by any damage to root tissue. On entering plants, the mycelium is distributed along conducting vessels of stalks, branches, leafstalks and fibers and causes tracheomycosis or wilt.

The vegetative residues in a field or soil where the fungus survives in microsclerecyes and mycelium form serve as a constant source of infestation . Repeated sowing of cotton in the same field over several years results in fast and mass accumulation of fungus infestation in soil. Some evidence exists for the transfer of the agent of verticilious withering through seeds. Wilt affects the majority of cotton varieties and more than 350 species of various cultural and wild plants, but does not infect cereals and lilies.

The microflora of alfalfa roots and some other plants enriches soil with antagonists of *Verticillium* spp. and help to reduce concentrations of wilt-causing agents.

2.4.3 Bacterial blight *Xanthomonas malvacearum* (Erw. Smith) Dowson.

All above-ground cotton parts may be infected by bacterial blight from shoot emergence up to the end of vegetation. On cotyledons the disease appears as oily spots. Later the spots become brown, dry up and shoots perish. The stem form of bacterial blight, which appears in the budding period, is most destructive.

On bolls round brown stains arise which are concave in form, reaching in to the cotton fibres. Bolls are deformed and are either unopened or partly opened. From carpel walls bacterial material gets onto fibers and seeds. Fibers become brown, sticky and perish. On occasion bolls are not infected from the outside but through vessels and the stem.

The infestation persists mainly on and sometimes inside seeds. Infestation of seeds occurs during vegetative phases and in cotton-harvesting factories. Bacterial blight is one of the most harmful cotton diseases. Losses of a heavily diseased crop can reach 28-39%.

2.4.4 Diseases of bolls and fibers

Death of bolls and fibers results in significant losses of the crop and damage to stored production. The agents of these diseases, mainly saprophytic fungi, are widely distributed in nature.

Violet/crimson decay (*Fusarium oxysporum*, *Fusarium merismoides*). This fungus develops powerful acellular mycelia, multiplies by sporangiospore and can infect buds, flowers and bolls of all ages. On bolls small violet/crimson stains appear which quickly expand and cover the whole boll. Soon bolls become covered by a gray felt, shrink and crack. The fibers in such bolls are sometimes completely destroyed, seeds in afflicted lobes are either not formed, or have low germination capacity. Infestation of bolls occurs following damage to carpel walls by pests. Favorable conditions for development of the fungus are a relative air humidity above 80 % and temperatures of 25-28˚C.

Pink decay *Trichothecium roseum* Link. The mycelium of the fungus is multi-cellular, colorless, and endophytic. On boll surfaces the mycelia leave only conidium carriers with two-cellular conidia (asexual fungal spores), which form a gentle pink strike. The fungus disperses by air currents and boll-feeding insects. The fungus enters a boll, destroys the fiber and transforms it into a powder-like mass. High air humidity and temperatures of 28-30˚ promotes strong development of disease in a field and subsequent significant damage to bolls.

Cotton boll aspergillosis. Bolls of all ages can be infected by this fungal disease. On young (week old) bolls the carpel walls turn yellow, contents turned grayish weight, seeds collapse and become slimy. The bolls of 30-40 days become reddish-brown in color and shrink. Lobes have a dirty brown color and the fibers turn to dust, while seeds collapse after terminal fungal attacks. Infestation of bolls is connected with their damage by various pests.

Nigrosporoses, causing non-opening lobes. The fungal mycelium is colorless, repeatedly branching, multicellular, with a black conidium. Chlamydospores are formed. The fungus could infect all or several lobes. Carpel walls of afflicted bolls are partially opened and the lobes will not open. They become gray and freely drop out of bolls. For fungal development increased humidity and temperatures of 25-30˚ are optimal.

Macrosporious, underdevelopment of carpel walls and boll lobes *Macrosporium macrospora* (Limm) Morsy. The dark pressed stains with a light border appear on carpel walls. The afflicted carpel walls lag behind in growth, resulting in boll distortion, with the boll opening early. In the infected bolls fibers collapse and seed germination capacity is lost or reduced. The fungus develops in high humidity conditions at temperatures of 15˚C.

The cotton fiber disease "Shira". The initial cause of this disease is aphid excretion which flows down leaves on the spoiled fiber as sugary liquid. The liquid serves as a substrate for development of lines of saprophytic fungi of the genera *Cladosporium, Macrosporium,* and *Alternaria*, among others. A dark, soot-like fungal mark is usually formed along the thin fiber. The disease develops in the field and in storage if the product in its raw state comes in contact with aphids. The fibers with "shira" are completely unsuitable for factory machines.

2.5 Disease control measures

2.5.1 Measures for controlling *Rhizoctonia solani* Kuhn

The following control measures of disease agents are recommended: timely plowing, thorough and careful harrowing of land, a lay-out of a surface of fields and treatment of seeds by suspension of preparation consisting of sodium salts of gumin acids and copper sulfate, 30 % p. (powder) 2 kg / t or P.-4, 65% s.c. 4 l/t.

2.5.2 Measures of wilt (*Verticillium*) control

In order to control the disease agents the following agrotechnical actions are recommended. Cotton should be cultivated in rotation where no less than a quarter of the planting area should be occupied by other cultures such as alfalfa (for three years), corn, and sorghum. These cultures should first of all be planted on fields highly-infected with *Verticillium* and cultivation should be carried out under the observance of experienced agricultural technicians.

In order to suppress the disease agent fields strongly infected by wilt fungus (70% and more) occupied for 1 year with rice at its cultivation the fields should be filled with water. As a result conditions are created in which the mycelial networks of *Verticillium* collapse in the soil.

Obligatory harvesting of vegetative residues with roots (the trunk of cotton) is recommended. Their clearance from the fields and use as fuel is strongly recommended as are the following: deep ploughing of land ploughed in autumn for spring sowing (40 % of annual norm nitric and full norm of phosphoric fertilizers should be applied); dung-earthen composts should be incorporated into land ploughed in autumn for spring sowing, enriched with trichoderma (30 kg of compost on 1 hectare); and cultivating cotton varieties more resistant to verticillious withering.

Seeds should be treated with a preparation of darmon-4, 25-30% p. 3kg/t suspension.

2.5.3 Measures for controlling *Xanthomonas malvacearum*

Suggested measures include the realization of approbation (field inspection) of crops prior to harvesting, discovery of cotton fields not infected by bacterial blight and preparation and use of seeds solely from uninfected sites are important factors for effectively controlling bacterial blight.

After harvesting the cotton stalks and roots should be directly and carefully removed from the fields. Remnants should be immediately gathered in specially allocated storage facilities to be used only as fuel for heating. During cotton vegetative periods it is necessary to remove and destroy infected plants (early thinning out of shoots). Early feeding of plants with mineral fertilizers (especially potash) raises plant resistance to the disease agent.

The suspension treatment of seeds by one of the following chemical preparations is advised: the suspension should consist of sodium salts, gumin acids and copper sulfate, 30 % p.-2kg/t; p.-4, 65 % s.c. - 4 l/t; P.-4, 65 % m.p.-4 kg/t.

2.5.4 Measures for controlling boll and cotton fiber diseases.

The agents of boll and fiber diseases persist naturally in vegetative residues and in soil, and their distribution is primarily connected to damages caused by cotton pests. The basic actions in controlling these diseases should be phytosanitary and the agrotechnical methods directed towards the destruction of vegetative residues and pests of the cotton (aphids, alfalfa bug etc.).

3 WHEAT PESTS AND DISEASES

3.1 Overview of pests

Grain cereals are the basic cultures in the majority rotation of crops. The basic grain cereals, in particular wheat, are one of the most ancient cultivated plants and consequently many species of harmful insects have adapted to them over a long time. They switched from wild-growing cereals to cultured wheat, and were also imported from other countries. Apart from insects, wheat is damaged by various species of rodents, ticks, and nematodes.

It must be noted that in the Khorezm area and the Republic of Karakalpakstan information on pests and diseases of wheat is absent and consequently the data from other regions of Uzbekistan of similar soil and climatic conditions are used. This information was gained from the following sources (Vasil'ev 1973, Vasil'ev 1974; Narchuk and Tryapitsyn 1981; Azimova 1993; Khamraev et al. 1999).

Insect pests of wheat are especially diverse. About 130 species of harmful insects have been recorded on wheat. Among them are such polyphagous pests as locusts, grasshoppers, mole crickets, turnip moths and other cut noctuids, a number of click beetle (Coleoptera: Elateridae) species and punacate bugs (Tenebrionidae).

The fauna of wheat specific pests is more plentiful and diverse. The most harmful species are considered in the present chapter. In the researched area the loss of crops due to harmful insects and other pests is great. This is due to the diversity of harmful forms, the great number of pests and also the lack of spring and summer precipitation increases the significance of the damage since the warm ambient temperatures of the vegetative period enable many forms of insect to reproduce very fast, going through many generations. Absence of summer precipitation increases the amount of damage caused by such pests as bugs, cereal aphids and cicadas.

Of the wheat-associated insects in this area, representatives of the following polyphagous taxa are among the most harmful: locusts, grasshoppers, mole crickets, turnip moths, and darkling beetles. In particular great harm is caused by the Giessen fly, scutellerid (shield-backed) bugs, and grain bugs *Eurygaster* sp. Lesser but nevertheless significant damage is caused by the Swedish fly *Oscinella frit*, the beetle *Meloe xanthomelas*, stem fleas (*Chaetocnema hortensis* Geoffr., *Ch. aridula* Gyll.), stem sawflies (*Cephus pygmaeus* L.), wheat thrips (*Haplothrips tritici*) and cereal aphids

(*Schizaphis graminum*, *Brachycolus noxius*). The wheat nematode causes extreme damage within the limits of this region.

Wheat nematodes *Anguina tritici* Steinb occur on all continents and damage wheat. Nematodes are dispersed with seed material. Irrigation creates favorable conditions not only for life, but also for relocation of wheat nematodes, since larvae are carried by irrigation systems into new areas.

3.2 Effects of wheat damage by pests

3.2.1 General

Feeding of insects on wheat causes a diverse range of damage to both crop form and yield. The consequences of damage, i.e. their influence on growth and development of plants, as well as the quantity and quality of the crop, are rather diverse and depend on the type of the damage and abundance of pests present. In this respect the consequences of damage depend on the intensity and timing of damage and also conditions of plant growth, environmental conditions and the plant variety.

Except for causing direct harm when crop yields decrease or the quality of grain becomes bad, damage could indirectly cause a number of adverse consequences which may lead to yield reductions. In particular, indirect harm from damages could result when: a) resistance of plants to various external influences (frost resistance, drought resistance, fungal and bacterial diseases) changes; b) the plant catches fungal parasites directly from insect carriers; c) the staggered development of plants causes crop losses because grain matures at different times; d) loss of a crop is increased at harvest (as a result of stalk death owing to general damage) or harvesting itself become expensive; e) soil contamination is increased in connection with crop rarity.

3.2.2 Insect damage to plants

For clarity, the following part is ordered according to which insects attack the various plant structures due to the diverse range of insects that feed on wheat. Table 11.4 summarises known wheat pests.

Dormant seeds

Wheat sowed in soil could be damaged even before germination by the larvae of punacate bugs, click beetles (Coleoptera: Elateridae), sprout flies and *A. segetum* caterpillars. They feed more frequently on the nutritious germinal part of the grain. Because of its' large fat source which a plant requires for growth, destruction of the grain germ causes the plant to perish.

Root systems

Root systems of cereals are damaged by mole-crickets, click beetle larvae and *Adesmia*, grain-feeding Cerambycidae, flea beetles *Chaetocnema hortensis* (Geoffroy) and some species of Scarabaeidae. Among proboscis-feeding pests the root aphids and some species of nematodes feed on cereal roots.

The leaf blade

The leaf blade is damaged more often than other parts of a plant. Locusts, grasshoppers, caterpillars, noctuids, grain beetle larvae, a number of species of Scarabaeidae, *Lethrus* sp*., Meloe xanthomelas*, and leaf sawfly larvae (*Dolerus rufogenicutatus*) all cut leaves from the outside. The larvae of many species of flies (Diptera) mine leaves. Some species of thrips, grain bugs *Eurygaster* sp., cicadas and many species of cereal aphids suck out nutrients from leaf phloem. Damage to leaves or infringement of their normal activity slows development of the plant and is reflected in grain crop size. This influence is especially strong at low levels of soil moisture and when the quantity of humidity deposits are reduced.

Stalks

Cereal stalks are damaged both internally and externally. The larvae of stem grain sawflies, various species of stem moth, adult bibonids (gall marth flies) and *Chaetocnema aridula* Gyll larvae feed inside the stalks. Taxa that damage stalks include various species of scutellerids, *Lethrus* sp., corn dung (*Pentodon dubius* Ball), larvae of the rye stem fly, *Chlorops pumilions* Bjek, some bibionids, and giessen and swedish flies. For the most part pests damage the stalk or ear whereby the harm is abundantly clear. Many species of insects mainly cause deterioration of grain quality and reduction in its weight because of feeding inside the stalk. Included in this group are: *Cephus pygmaeus* L*., Trachelus tabidis* F., *Harmolita turkestanica* Cuss., *Harmolita rossica* Rim-Cors., *Maytiola destructor* Say., *Chlorops pumilionis* Bjerk., *Phorbia genitalis* Schnab., *Oscinella frit* L., *Meromyza nigriventris* Mcq., *Ostrinia nubilalis* Hb., *Siteroptes graminum* Reut. The grain becomes puny and yield decreases after pest damage to stalks.

Panicles

Many insects cause damage to ears and panicles as well as grains. The caterpillars of grain noctuid *(Apamea sordens* Hfn*.),* various species of grain-eating bugs (*Zabrus tenebrioides* Goeze*., Z. spinnipes* Fabr*, Z. morio* Goeze*.)*, swedish fly larvae (*Oscinella frit*), and larvae of wheat and millet flies *(Stenodiplosis panici),* a number of scutellerids (*Eurygaster integriceps* Put*., E. maura* L., *Odontoscelis purpureolineatus* Rossi), *Aelia furcula* Fieb. (Pentatomidae: Hemiptera), a stem moth caterpillar (*Pyrausta nubilalis*), various species of thrips (*Anaphothrips flavicinctus*, *Haplothrips tritici*), and wheat nematodes *A. tritici* (among others) feed directly on grain.

Grain

The grain is either wholly or partially consumed, with the nutritious part damaged in the ear by grain-eating bugs. Proboscis-feeding pests considerably reduce grain weight and worsen its quality. For example, scutellerids' feeding causes deterioration of the baking qualities of the grain, while thrips cause grain weakness. Quite often the wheat ear becomes either fully or partially bleached. In this case the ear is white and leaves the leaf sheath with completely undeveloped grains. This phenomenon is caused not by one, but many species of pests. In particular, the presence of white ear is frequently caused by cereal ticks, scutellerids, stem noctuids (*Oria musculosa* Hb*.*), and occasionally by stem sawflies.

To summarise, grain cereal losses that are brought about by pests can be rather significant. If insufficient pest control measures have been developed then some harmful insects reproduce fast in favorable climatic conditions and can cause significant damage to crops. Thus active, ongoing work on the protection of grain cereals against insect damage is necessary for increase of productivity for wheat and other grain cereals.

3.2.3 Damage by other wheat pests

Rodents are a particularly dangerous pest. They cause damage both in the field and in agricultural storage facilities. In addition, rodents have important epidemiological and epizootological significance as carriers of a whole complex of destructive disease agents including plague and tularemia. In the investigated region the most destructive rodents are the mouse-like rodents and gophers. The most serious pests of field crop cultivation, including wheat, are the Turkestani rat, house mouse, and the hamster *Cricetulus migratorius* Pall.. The mouse-like rodents are characterized by periodic mass reproduction. These periods can lead to devastation of great areas, which has been observed over the last few years. Rodents are also characterized by high adaptility to cultural landscapes and the ability to seasonally migrate, especially in autumn. In autumn rodents focus their feeding on plentiful winter crops. Prior to rodent mass reproduction a marked increase in their observed abundance over large areas usually occurs.

Curling of leaves and inhibition of stalk growth are marked in the plants attacked by the nematode. The central leaves do not often ascend from leaf sheaths. Upon entering the ovary the pests cause growth of a receptacle and consequently galls filled by a nematode are formed instead of grains. The afflicted ears are shorter and wider than healthy ones.

3.3 Control of wheat pests

3.3.1 Organizational and agrotechnical measures

For successful protection of wheat from harmful insects it is necessary to carry out preventative and destructive actions which are based on sound ecological theory and checked in the field every season.

The autumn-winter period

1) Fields should be inspected in order to assess the winter numbers, condition and habitat of *Agrotis segetum, A. exclamationis, Apomea sordens*, elaterids, and tenebrionids with crop rotations.

Inspection is carried out by soil excavation. The sampling unit is a platform of 0.25 m^2 (50 x 50 cm). Excavation for assessing noctuid caterpillars and their pupae should be made at a depth of 10-15 cm, and for assessing larvae of grain bugs, click beetles (Elateridae) and tenebrionids at 15-25 cm depth. It is necessary to carry out excavations before winter when temperatures of the soil surface are higher than 10˚C. On 100 ha 16 excavations should be made, distributed diagonally across the field.

2) Inspection of field-protecting windbelts and wood plantings is needed to reveal scutellerid bugs wintering under wood layers and to estimate their abundances.

Inspection is carried out on the platforms located through 10m in depth of the wood and through 20 m in the windbelt with an area of 1 m^2

3) Winter crops inspection of (before the frosts come) for revealing destructive pests on the plants (the Giessen and Swedish flies) by taking samples of 1m^2 soil patches. The samples are taken by two diagonals of the field. Taken plants should be cut open and inspected.

4) Inspection of locust oviposition sites, in order to establish their numbers and condition of ovipositors. This should be carried out in containers on platforms with an area of 1m^2 and the eggs should be later examined. The experimental platforms are selected on diagonal lines crossing the field. 16 samples are taken from 100 ha, the depth of excavation is 8-10 cm.

The spring preseeding period

1) The control of quality of the seed material and its conformity to the standard for maintenance of equal shoots.

2) Preseeding treatment of seeds with pesticides.

3) The immediate control inspection of fields in order to reveal the residues of stalks of cereals and weeds in which pests could overwinter, and destruction of these residues after drying the soil.

4) Verifying excavation and inspection of the presence and condition of tenebrionids, *Zabrus morio* Goez*,* and the noctuids *Agrotis segetum*, and *A. exclamationis* after wintering.

Inspection of winter fields in order to assess Giessen and Swedish flies.

6) Early harrowing of winter fields with destruction of all vegetative residues removed from the field by the harrow.

7) Clearing and reploughing of the previous year's threshing sites in order to destroy all vegetative residues.

8) Hanging of artificial nesting-boxes in order to attract insectivorous birds.

The periods of spring sowing, winter crop growth, and occurrence of summer crop shoots.

1) The early and rapid sowing of spring wheat is advisable to increase resistance to damage by cereal flies, aphids and fleas.
2) When a significant quantity of Giessen and Swedish flies exist treatment by pesticides should follow during the flying and egg-laying periods, in order to prevent settlement of growing winter and summer shoots by insects.
3) Treatment of the fields with pesticides when wintered scutellerid bugs start to appear on crops.
4) Early plowing of steam fields in order to remove the harmful insects living in the top soil horizons (tenebrionids, *Agrotis segetum*, *A. exclamationis*, and the pyralid *Loxostege nudalis* Hb.).

The periods of germination, stem formation and maturation of cereals
1) In order to discover the insects that are openly damaging cereals (scutellerid bugs and their larvae, earthen flea, *Lema melaporis* (Coleoptera: Chrysomelidae, Criocerinae) grain bugs) 1 m^2 sample points should be assessed. Sixteen platforms should be taken in 100 ha by diagonals of the field. For convenience use a meter framework made from a light wire (a quadrat).
2) An assessment of flying cereal flies and sawflies is made with the help of an entomological net (30 cm in diameter). The survey should be done on diagonals across the field (0.5 km). Five metre long swipes should be made by the net. In total 10 swipes should be performed for collection of flying insects.
3) Installation of control troughs with runny treacle for supervision of the flying and beginning of oviposition of turnip moth, exclamatory noctuid etc.
4) Fields should be treated with pesticides on the discovery on crops of two or more wintered bugs, scutellerids per m^2 and on occurrence of their larvae on crops .
5) At the end of mass oviposition by turnip moth and exclamatory noctuids the space between the rows should be harrowed. This considerably reduces the number of gnawing noctuids.
6) During mass pupation of caterpillars of the turnip moth and exclamatory noctuid loosening the soil between rows at a depth of 6-8 cm.

The period from grain-cleaning to sowing winter crops

1) In order to decrease the number of scutellerid bugs separate cleaning of grain with fast selection and threshing is recommended.
2) Removed grain should be carefully cleared, bugs and product waste should be destroyed and not used as forage for birds.
3) After harvesting grain, stem residues should be removed from the stubble-field in order to remove grain bug eggs, Giessen flies, thrips, and aphids.
4) Immediately deep land ploughed in autumn for spring sowing which destroys pests remaining for wintering in the stubble-field after cleaning the stem residues in the stubble-field.

First of all cleaning the stem residues in the stubble-field and deep plowing are carried out in those sites that were most populated with the Giessen fly, and also on fields that are being prepared for winter crops.

5) Inspection of locust egg-laying sites.
6) Inspection of wintering places of scutellerid bugs, and establishment of their average number per 1 m^2. Definition of readiness of scutellerid bugs for wintering by weighing and opening.

3.3.2 Chemical wheat pest control measures

In pest control of wheat the following chemical means are recommended (Table 3.1).

Table 3.1: Chemical control of wheat pests. Legend: c.e.: concentrate of emulsion, d.l.s.: dry loose suspension, m.p.: moistened powder, s.c.: suspended concentrate.

A quark 10 % m.p.	Fufanon 57 % s.c.
A quark 10 % s.c.	Karate 5 % s.c.
Benzophosphate 30 % m.p.	Karbophos 50 % s.c.
Bi-58 new 40 % s.c.	Kinmeks 5 % s.c.
Buldok 2.5 % s.c.	Regent 80 %
Cipi 20 % s.c.	Sumi-alpha 20 % s.c.
Danadim 405 s.c.	Sumi-alpha 5 % s.c.
Decis 2.5 % s.c.	Sumimition 50 % s.c.
Diazinon 60 % s.c.	Trebon 30 % s.c.
Fenkill 20 % s.c.	Zolon 35 % s.c.

3.4 Wheat Diseases

3.4.1 Wheat smut

Wheat is infected by five species of smut (a group of parasitic fungi that infect flowering plants): *Tilletia caries* and *Micromphale foetidum* (firm or wet smut), *Tilletia controversa* (dwarf smut), *Ustilago tritici* (dusty smut) and *Urocystis tritici* (stem smut).

Wheat smut is one of the most harmful diseases. The most crucial part of the wheat, the ear, is infected. The grain turns into a black sporous mass or frequently does not develop. In this way the yield of afflicted plants is totally destroyed.

The majority of species of smut fungi are kept from year to year as smut spores on the grain surface or in the soil. Only in relatively few species do mycelia overwinter inside the grain.

3.4.2 Wheat rust

Two rust diseases are distributed in the considered region: wheat brown rust *Puccinia triticina* Erik SS. and yellow rust *Puccinia glumarum* Er. et Henn. The rust sharply reduces productivity, winter hardiness, and drought resistance. Without harming the grain, the rust decreases the grain volume and hence weight. Annually almost 15-25% of the crop is lost to the rust. When the affliction is strong the grain produced is so small that it cannot be used.

3.4.3 Wheat root decay

Wheat root decay belongs to a number of externally undistinguished, but rather harmful diseases of grain cereals. Agents of root decay are the widely distributed species of fungi living on the outer shell and inside seeds, in soil and on dead plant residues. Agents of root decay are fungi from the genera *Fusarium* and *Cochliobolus* among others. The agent of common root decay is *Cochliobolus sativas* = *Bipolaris sorokiniana.* They more often attack spring wheat. Plants are infected with fungi at various ages. Fungi infect sprouts and roots, causing destruction of plants in the shoot phase. In the tillering phase the bottom part of the stalk is infected, growth stops or is delayed, and the stalk becomes white.

3.4.4 Fusarious infections of wheat ears

The agent of infection is *Fusarium graminearum* Schw. The disease appears on the scales of the ear and on the grain in the period of ripening. Parasitizing the plant and especially the grain, the mycelium of the fungus excretes toxins which are poisonous to humans and animals. Symptoms of the poisoning are vaguely similar to the effect of imbibing alcohol, and the disease has thus received the name of "drunk bread" in Uzbekistan.

3.4.5 Mealy dew

The infecting agent is the fungus *Erysiphe graminis* D.C., which infects all grain cereals. Leaves and leaf sheaths on which there is a fungal mark are typically infected, and during strong development of mealy dew stalks, grains, scales and awns could also be infected. This disease is very harmful, especially in destroying plants in their early stages of development. On average the grain yield is reduced by up to 32-36 % following infestatation.

3.4.6 Wheat septorious

The agent of wheat septorious is the fungus *Septoria tritici*. In some years septorious has caused significant damage to a wheat crop. Sources of the infestation are infected vegetative residues and seeds.

3.5 Control of wheat diseases

Control of smut requires a complex of agrotechnical and particular actions. The following agrotechnical actions should be included:

- Approbation of seed crops;
- Spatial isolation;
- Checking quality of sowing material;
- Protection of seeds from repeated sporing;
- Crop rotation;
- Treatment of soil and seed planting at an optimal depth;
- A role of fertilizers and microcells in cleaning soil from spore smut.

Actions for disinfecting seeds:

- Dry treatment of seeds;
- Humidity-treatment of seeds with;
- Wet treatment of seeds;
- Moist treatment of seeds;
- Thermal treatment of seeds, which is made by two methods: single-phase and two-phase.

The following chemical means are advised for use on presowing treatment of wheat seeds against the fungi (Table 3.2).

Table 3.2 Chemicals for pretreatment of wheat seeds. Legend: c.e.: concentrate of emulsion, d.l.s.: dry loose suspension, m.p.: moistened powder, s.c.: suspended concentrate, w.e.: water emulsion, w.s.c.: water suspension concentrate; p.s paste, w.s.s.: water-soluble suspension

A barrack 60 % p.s.	Raskil 60.6 % w.s.s.
Hs-2 70 % m.p.	The dividend 3 % c.s.
Hs-2 prim 70 % m.p.	Topsin-m 70 % m.p.
Pantokin 25 % c.s.	Vancit 5 % s.c.
Premis tatol 32.5 % c.s.	Vitavax 200 ff 34 % w.s.c.
Raskil 2 % m.p.	Vitavax 200 ff 75 % m.p.

3.5.1 Wheat rust

In control of rust disease agents creation and production of resistant varieties are of high significance.

3.5.2 Wheat root decay

Control of the agents of wheat root decay is basically a continuation of the complex of the agrotechnical actions directed towards the creation of well advanced plants in a crop rotation and a choice of predecessors; accumulation and preservation of moisture in soil and control of weeds; application of fertilizers; preparation of seeds for crop; terms of sowing; norm of seeding; and selection of varieties. In addition, disinfecting seeds is highly important.

3.5.3 Control of fusarious infections

To control fusarious observance of a crop rotation is recommended and it is thus necessary to take into account that other grains apart from wheat are also infected. The land is ploughed in autumn for spring sowing and plowing; optimum terms of sowing (for summer sowing early is optimal); application of phosphor-potash fertilizers; cleaning and drying of the grain to the necessary standards.

Besides improvement of the sowing material, careful clearing and sorting of the grain and disinfestation of seeds by thermal and chemical methods should be carried out.

3.5.4 Mealy dew

In order to control the agents of mealy dew early land should be ploughed in autumn for spring sowing (up to the occurrence of shoots of winter crops); reserving gaps on the fields is not intended, mowing of edges is recommended (wild cereals act as refuges for the infestation); accommodation of fields in the crop rotation (including some isolating distance between fields with winter and summer wheat); early sowing of summer wheat; correct application of fertilizers and microelements (increased doses of potash and phosphoric fertilizers reduce development of the disease to a degree); cultivation of steady sorts.

3.5.5 Wheat septorious

During development of the disease it is recommended to use the following chemical preparations to control the agent *S. tritici* (Table 3.3).

Table 3.3: Chemical control of *Septoria tritici*. Legend: c.e.: concentrate of emulsion, m.p.: moistened powder, s.c.: suspended concentrate, w.e.: water emulsion.

Alto 400 c.s.	Folikur 25 % w.e.
Alto 400 40 % s.c.	Folikur BT 22.5 % s.c.
Alto super 33 % s.c.	Impakt 25 % s.c.
Bayleton 25 % m.p.	Rex 49.5 % c.s.
Benlat 50 % m.p.	Tilt 25 % s.c.
Flamenco 10 % c.s.	Vamper 25 % s.c.

4 PESTS AND DISEASES OF RICE

4.1 General information

Rice (*Oryza sativa*) is one of the major agricultural cultures. According to FAO research rice crops are second only to wheat in importance, and its yield of 7.0-10.2% is higher than that of wheat.

Significant damage is caused to the rice crop by harmful insects, agents of diseases and weeds. According to Zaharenko (1990), annual losses of this culture's crop are 26.7% from pests, 8.9% from diseases, 10.8 % from weeds.

Hence, one of the most effective ways of increasing rice productivity is the protection of crops against numerous harmful organisms. However, for this purpose it is necessary to have data on the specific structure, biology, and ecology of harmful organisms and to develop and regularly improve techniques for controlling crop pests on the basis of these data.

Rice differs from many other agricultural crops by its hygrophytic nature. It is necessary to inundate the field with water during almost the entire vegetative period for rice cultivation. The layer of water on the rice field creates a specific microclimate.

Khamraev's (2003) paper on soil organisms of the Khorezm area and the Republic of Karakalpakstan should be consulted when considering rice nematodes and root soil in Uzbekistan.

4.1.1 A brief history of works on rice

The majority of works on fauna of rice fields of Central Asia contain data from Uzbekistan and Kazakhstan. Less data exist for other Central Asian republics. Only one work directly concerns Karakalpakstan.

In essence, the first report on pests and diseases of rice in Central Asia is Shagaev's (1940) work, which was carried out in Uzbekistan (including Karakalpakstan). Inspection of crops was executed in the last phase of rice development (from flowering until full ripeness). For Uzbekistan the general crop losses from pests and diseases were estimated by the author at 2.5-3 %.

This work presents a list of the species registered on crops of rice during inspection, their number and character of stay (unitary, accidentally). The list includes 37 species. It is this author's opinion that of these the following are the most harmful:

Oxya fuscovittata Marsh. (Orthoptera), *Gryllotalpa gryllotalpa* L. (Orthoptera), *Haplothrips aculatus* Fabr. (Thysanoptera) and *Ephydra macelloria* Egs (Diptera).

In the 1940s damages to rice were marked and new pests such as *Hydronomus sinuaticollis* Faust (Coleoptera) were discovered. In the 1950s repeated inspection of the rice compartment was carried out by Shamuratov (1989) when it is revealed that *H. sinuaticollis, E. macellaria* and *Cristoterus silvestris* cause the most significant damage to rice crops, and also attention was turned towards *Triops* (formerly *Apus*) *cancriformis* Schaff.

Dubovskiy (1966) investigated the species structure of rice damaging cicadas in East Fergana. In the work 14 species of cicadas are listed, 6 of which meet on rice frequently, and 2 in large groups. In 1958-1968 in the Uzbek SSR (including Karakalpakstan ASSR) rice pests were studied by Sborshikova (1970) who has developed precautionary and protective actions for pest control of shoots. According to the author, about 100 species of invertebrates have been registered on rice. Of these 33 species (representatives of 16 families, 9 orders) are constant pests of rice. The author considers the three most harmful species to be *Hydronomus sinuaticollis, E. macellaria*, and *T. cancriformis* (Table 11.5).

4.2 Overview of rice pests

Insect rice pests are characterized by a complex of physiological and ecological adaptations associated with living and developing on rice plants in the various ecological environments (on air, in water, in soil, and under water). Therefore study and development of control measures is associated with many difficulties, especially during cultivation of rice using seeds which have not been pre-grown in the lab.

Rice plants are damaged by many harmful insects in all phases of development from germination of seeds up to full maturation. The majority of harmful insects in the fauna of the Asian countries and America belong to the following orders and families (Table 4.1):

Table 4.1: Rice-damaging taxa in Asia and America

Order	**Families**
Lepidoptera	Pyralidae, Noctuidae, Hesperidae, Satyridae, Lymantridae
Homoptera	Jassidae, Delphacidae, Cicadellidae, Aphididae
Hemiptera	Pentatomidae (Pentatomicae, Phyllocephalidae), Coreidae
Orthoptera	Acrididae, Tettigonidae, Gryllotalpidae
Coleoptera	Chrysomelidae, Curculionidae, Elateridae
Diptera	Cecidomyidae, Tipulidae and Ephydridae
Thysanoptera	Plocothripidae

The most constant and destructive pests in these countries are:

Stem borers (clousewings) *Schoenobius intercellus* Walker, *Sesamia inferens* Walker (Lepidoptera: Noctuidae), *Tryporyza incertulas* Walker (Lepidoptera: Pyralidae), *Tryporyza innotata* Walker, *Tryporyza monostigma, Chilo simplex* Butler (Lepidoptera: Pyralidae), *Chilo suppressalis* Walker, *Chilo plejadellus* Zincken and *Diatraea saccharalis* F.

Cicadas *Nephotettix apicalis* Motsch, *N. bipunctatus* Uhler, *N. cincticeps* Uhler, *Nilaparvata lugens* Stal and *Sogata (Sogatella) furcifera* Horvath;

Bugs *Scotinophora iuridae* Burmaister, *Leptocorisa varicornis* Fabr and *Oulema oryzae*;

Tube-builders *Cnapalocrocis medinalis* Guen;

Rice noctuids *Cirphis unipuncta* Haworth;

Beetles *Hispa aenescens* Oliver and *Echinoenemus squameus* Billderg

Rice gall mosquito *Pachydiplosis oryzae* Wood Mason.

In the Far East of the former Soviet Union more than 30 species of insect pests have been observed. The most dangerous are the barley miner *Hydrellia griseola* Fall, the rice beetle *Lema suvorovi* Jacobs, the rice mosquito *Chironomus* sp., and the dark cicada *Callipygona striatella* Fall. Periodically rice caddis flies *Limnophilus stigma* Curt, rice crane flies *Tipula conjugata* Alex and rice tube-builders *Cnaphalocrocis medinalis* Guen (Lepidoptera: Pyralidae) cause large amounts of damage (Chiong Than Jian 1979).

The fauna of rice fields is convenient to consider when it is divided into three ecobiotic groups: phytobionts (insects living at the water surface), hydrobionts (animals developing underwater), and geobionts (animals developing in terrestrial areas between paddies). Clearly, at different stages of development (larvae-imago) individuals could be members of different biotonic groups (for example flies, dragonflies), but nevertheless each group is ecologically specific. Actually phyto- and hydrobionts are directly connected to rice cultures, and geobionts are indirectly connected as regulators of abundance of the first two groupings (Shamuratov 1993).

4.2.1 Phytobiontic insects

The material for this group was collected between June and July in 1983-1985 by mowing rice in paddies in a shoot phase having four leaves. Results of sampling phytobionts are listed in Table 11.6.

According to Shamuratov (1993), ceratopogonid mosquitos and shore flies *Ephydra macellaria* Egg were especially numerous during inspection. However, some species were encountered in smaller numbers. The orders of Diptera and bugs (Homoptera) had the greatest number of species in these ecological groups. Trophic connections of these orders in rice biocenoses are varied. The great majority of flies and mosquitoes live among plants on which they deposit eggs. Their larvae are saprophagous, developing on the decomposed vegetative residues which are numerous at the bottom of paddies and on the edges. Eating the decaying roots of plants they can, when abundant, cut rice shoots, resulting in the thinning of the crop (for example, *E. macellaria*). The role of specialized phytophages developing on cereals (miner and cereal flies) is insignificant because their abundances are low. On the contrary, the majority of bugs is made up by the species developing on cereal cultures. The most frequent species is the sedgy flea (*Chaetocnema conducta* Motschulsky). It is associated only with sedge of the genus *Carex*. The others feed on rice. Of these rice water weevils *Lissorhoptrus oryzophilus* (Coleoptera: Curculionidae) are of particular interest.

Predators are constituted by species of robber flies (Asilidae) and *Eumerus* among the Diptera, and mainly Staphylinidae and Anthicidae among the beetles, though coccinellids are not numerous because aphid numbers are low. It is must be noted that microclimatic features of rice paddies (such as raised humidity and relatively low daily temperature fluctations etc.), draw the attention of insects of other biocenoses. Discoveries of obviously opportunistic species of bugs such as click beetles (Elateridae), and membracids can thus be explained. Occasionally the abundance of predatory robber flies is connected with their ethological features (care, reaction at distending). The most numerous predators on rice fields are dragonflies and spiders. The latter are represented exclusively by a group that creates circular webs, that once again indicates the remarkable abundance of mosquitoes and flies in this biocenose.

The low abundance of aphids on rice shoots is probably associated with two reasons: absence of initial plant hosts and absence in the given zone of suitable phytocenoses which encourage an increase in aphid abundance. The absence of locusts in the collection (which is characteristic for inundated landscapes) hints at their later migration onto fields from places of hatching.

Thus, of the phytobionts, species which develop in water are most numerous (the majority of flies, mosquitoes, and dragonflies). The abundances of species developing only on surface parts of plants are very low, probably because of the negative influence of environmental factors (high temperatures and increased solar radiation). The only exceptions are thrips *Haplothrips aculeatus* F., whose small size allow the use of various microcover as shelter. The majority of species of this ecological order have extensive ranges (ranging from the south of Europe up to the south of Siberia), and shore flies *E. macellaria* characteristic of populated habitats. For dominant species there is a typical summer decrease in their abundance on rice crops.

4.2.2 Hydrobiontic insects

The faunistic structure of this group consists of harmful crane fly larvae, water rice weevils *L. oryzophilus* and water-loving flies, and also reed weevil bugs. The latter are associated with only one reed species, while crane fly larvae and water rice weevils damage rice, as well as the larvae and imagos of beneficial water zoophages. The list of hydrobionts is included as Table 11.7.

The overwhelming majority of hydrobionts are zoophages. Their abundance is defined by the abundances of protozoa , crustacea and other groups of planktonic organisms. Apparently, a significant part of the plankton are *Lepsampleheria* nauplius (larvae). Adult crustaceans of this species are the most numerous representatives of hydrobionts on fields. Water bugs *Notonecta glauca, N. viridis*, diving beetles *Dytiscus marginatus* and water-scavenger beetles are also numerous.

4.2.3 Geobiontic insects

These include representatives of the soil beetles (Carabidae), hooded beetles (Anthicidae), and click beetles (Elateridae) at the edges of rice paddies. This group is convenient to study using ground beetles as an example. Its species are most distributed here (Table 11.8).

Dominant species of ground beetles are made up (according to Sharova's 1981 terminology) of the following forms: flying epigeobiont, superficial- covering and litteral-cracking stratobionts, endogeobionts and digging geobionts. A general feature of dominant representatives of groups is obvious hallophily (organisms adapted to inhabiting ranges with an increased salt content).

4.3 Effects of rice pests

Regarding the existing literature on rice pests, it is possible to emphasize that rice plants are damaged by about 30 species of pests during their vegetative phase in the Republic of Karakalpakstan and the Khorezm area. But among them the most widely widespread and the most harmful include *Notostraca*, rice water weevils, shore flies *E. macellaria*, and rice mosquitoes (which are associated with a constant layer of water in their period of development). Peak abundances of invertebrates on crops is observed during germination of shoots and the beginning of tilling.

4.3.1 *Triops cancriformes*

Triops(=Apus) cancriformes Schaff (Crustacea) is a rather serious pest of rice. *Triops cancriformes* appears soon after paddies are flooded with water on crops of rice, it is unevenly distributed and it has a regional effect. The peak abundance of *Triops cancriformes* usually occurs at the end of May and in the first half of June. They are very active, gnawing sprouts of rice and causing thinning of shoots and sometimes total destruction of crops in this period. *T. cancriformes* develops in one generation and in the second half of June its abundance declines.

4.3.2 Rice water weevil

The rice water weevil *Hydronomus sinuaticollis* Ft (Curculionidae) is one of the most dangerous pests of rice shoots. Bugs appear in the mid-May-June period and start to feed, causing heavy damage to young rice plants. The female weevils deposit eggs in rice roots in June and July and then die off. Young larvae first develop inside rice stalks, then migrate to the roots and can cut them. The maximum density of larvae is reached in places with prevalent sandy soil.

Development of rice bodied *Hydronomus sinuaticollis Fst*. occurs in wet areas, and potentially this species could develop in great abundance. Damaged plants frequently emerge on the paddy water surface. This results in crop thinning. Damaged plants lag behind in growth and produce a fine panicle and puny grains (Table 11.9).

4.3.3 Shore fly

Shore fly larvae cause the greatest damage to crops during the period from shoot growth up to tillering. They cut through the roots of young plants and the shoots of rice and sprouts. Young plants become weak, chlorotic and as a result perish, rising to the surface of water. Three generations usually develop per year and the first to develop is most harmful. The greatest degree of damage can be seen on badly-planned paddies.

The effect of larval activity can be first seen in the decrease of crop density, reduction in grain weight and the growth of empty grain. In this respect it differs very sharply from rice water weevil (Table 11.10). The shore fly is most numerous on rice crops and on land recently brought into cultivation after cereals.

4.3.4 Rice Mosquitoes (*Chironomus* sp.)

Rice mosquitoes are one of the most destructive pests of rice shoots. Their range of habitats include flood plains and the waste channels filled with water where mature larvae overwinter. Adult individuals can be collected on rice systems in the weeds channels and spaces around paddies. Damage is caused by the larvae, which attack leaves of shoots floating on water. A decrease in productivity is observed when leaf damage reaches 20-25 % of the plant leaf surface area (1 larva per plant).

Rice mosquitoes develop in the presence of a constant water layer. In this respect strict observance of the irrigation regime and subsequent amount of standing water during shoot growing phases warns of the mosquitoes mass development and thus preventative measures can be undertaken that reduce its harmfulness. Crops of rice are most strongly attacked on badly planned paddies, with deep water cover and insufficient water flow. Agrotechnical measures of control include draining fields when larvae are abundant, which leads to a massive reduction in their abundance are most effective as protective actions for the control of rice mosquitoes.

4.3.5 Miner flies

Other pests of rice include barley miner flies (*Hydrellia griseo* la fall). They appear in the middle of June and deposit eggs on the upper side of leaves. Larvae leave the eggs, and mine into the leaf plate, cutting out the parenchyma cells of leaves and leaving only its thin epidermal layers. Leaves damaged by larvae fade, turn yellow and perish. 2-3 generations develop in a year. Miner flies cause significant damage. An economic threshold of harmfulness is on average one larva per two plants. In order to prevent damage it is recommended to destroy rice harvest-fields, weeds on rice fields and in their environment. Specific measures of pest control in conditions of the Central Asia have not been developed.

4.3.6 Cereal aphids

In Karakalpakstan and the Khorezm area several species of cereal aphids are also rice pests. The common cereal aphid *Schisaphis gramma* Rond. and large cereal aphid *Stiobion avenae* are capable of rapidly attaining large population sizes. Both species do not migrate and develop on various cereal plants. On rice the aphids usually appear and form rich colonies on leaves and stalks. Aphids fly from wild and cultured cereals onto rice, where they rapidly reproduce, going through 15-18 generations in one year. Aphids can cause a decrease in crop yields of up to 30 %. An economic threshold of harmfulness of 10-15 individuals per plant in the tubing period has been estimated. Application of phosphor organic preparations is recommended because they have an aphycidic action.

4.3.7 Cicadidae

Some species of Cicadidae are conspicuous on rice crops in this region. The most widespread and harmful are the six-dot cicada *Macrosteles laevis* Rib., dark cicada *Lacdelphax striatella* Fall*,* and *Oliarus nigrofurcatus* Sidq. Their larvae and imago both damage plants, draining nutrients from leaves and stalks, causing yellowing and even withering of plants. In addition cicadas are potential carriers of viral and microplasmal diseases.

Both adult and larval forms of *Lema oryza* Kuw are harmful. In the early spring bugs feed on weed vegetation, from which they pass to rice crops and feed on leaves, scraping out parenchyma in wide strips. Two generations of *Lema oryza* develop on rice.

4.4 Pest control measures

4.4.1 Agrotechnical and chemical control measures

For the reduction of rice pest abundances in Karakalpakstan and the Khorezm region the following agrotechnical receptions are of major significance:

1) Cultivation of rice in rotation of crops. A careful lay-out of rice paddies that allows the avoidance of uneven flooding and water stagnation.
2) Land ploughed in autumn for spring sowing of rice paddies and reclaimed fields after cleaning cereals and forage crops.
3) Application of mineral fertilizers during the ploughing and subsequent increase in plant resistance to the shore fly, Chironomidae, aphids and thrips.
4) Sowing of rice in optimum terms with obligatory covering of seeds in soil as late crops are strongly damaged by the shore fly. Sprouting seeds which are poorly covered by soil are destroyed by *Triops cancriformes*.
5) Watering the paddies after rice seeding and manual gathering and removal of the emerging vegetative residues. With them the rice pests wintering in the vegetative residues are also removed.
6) Observation of an appropriate water regime in rice paddies. A full application of water in rice paddies is carried out in the period from occurrence of full shoots up to the tillering phase. This facilitates a reduction of shore flies, chironomid flies, *T. cancriformes* and other pests.

In order to regulate the number of rice water weevil and shore flies in concrete ecological rice field conditions three schemes appropriate to three scenarios of water delivery to the fields and rice sowing (Chiong Than Jian 1979) have been developed.

Scheme I: Given conditions of early water delivery to the fields and early sowing of rice an integrated system of rice protection should include the following elements:

1/ Land should be plowed in autumn, from mid October up to mid November;

2/ Application of pesticides to seeds, in the first weeks of April;

3/ Use of light-lamps from mid April through to mid August;

4/ Spring treatment of soil up until the 25th of April;

5/ Early water delivery to the fields;

6/ Rice sowing from the 25th April until the 5th May;

7/ spraying of propanid on the full rice shoots.

Scheme II: Given average conditions of water delivery to the fields and average terms of rice sowing (15th-20th May). In addition to the measures stated in scheme 1, it is recommended to apply lidan to soil before water delivery to the fields and rice sowing if more than 10 rice water weevil larvae are present in one soil sample.

Scheme III: Given late water delivery to the fields and consequent late rice sowing (after June the 5th), in addition to the elements of rice protection applied in schemes 1 and 2, the following measures are also recommended: Spraying besevin on rice shoots during tillering when 1.5-2 bugs on average are present on a 25x25 cm^2 soil area.

During rice vegetative periods it is advisable to use the following chemical preparations for controlling shore flies, rice mosquitoes, cicadas and aphids: diasin 60% s.c. 1.0-1.2 l/hectare, fufanon 57% s.c. 0.5-1.0 l/hectare, trobon 30% s.c. 0.4 l/ha.

4.5 Rice diseases

In the researched region rice is afflicted by disease during all vegetational periods and while in storage. In occasional cases the main causes of death are the influence of soil and climatic conditions or secondary infestation by saprophytic organisms. In the overwhelming majority of cases deaths are caused by parasitic fungi and bacteria.

The loss caused by diseases is expressed in the growth and inhibition of plant development, deformation of vegetative parts, ear emptiness, grain weakness and reduction of its technological qualities. A major outbreak of disease could result in total crop destruction.

The generally observed number of rice diseases in the various soil and climatic zones of the region is in excess of ten. In practice 6-8 diseases are currently of significance in crop protection, and can be subdivided into non-parasitic and phytopathogenic categories.

4.5.1 Non-parasitic diseases

Straight-line panicle. Characteristic attributes of disease are upright panicles. As a consequence there are no complete leaf sheaths. Disease often occurs on reclaimed soils, after dry cultures, as a result of incomplete decomposition of organic soil substances.

Chlorosis. Chlorosis (yellowing) of leaves and stalks is a result of high crop density, lack of soil iron or a nitrogen surplus. Yellowing of leaves occurs on humus-rich soils after long periods of flooding and absence of nitrates.

White ear. Red-brown discoloration and deformation of panicles is shown on fields with a low soil water penetration.

4.5.1 Phytopathogenic diseases of shoots

Root decay. This is a widely distributed disease causing a decrease in the germination capacity of field seeds, thinning and destruction of shoots. It is visible from the beginning of germination of seeds in soil. It infects buds, initial roots and coleoptiles. Afflicted sprouts usually perish. A gray strike is observable on shoots in the first and second leaf phases. Leaves become yellow and fade. The disease is caused by the fungi *Ahlia prolifera* and *Pitium* sp. among others. On plants fungal mycelia with spores are formed, which overwinter in the vegetative residues in the soil. It infects crops growing in the spring.

Fusarious shoots. *Fusarium oxysporum* causes rotting of roots, sprouts and shoots. Sprouts perish, and the infected shoots turn yellow and lag behind in development.

Brown stains appear on leaves and stalks, and excrete black-brown fungal sclerocies which are agents of disease.

Helminthosporious. Infects the root neck of rice shoots, forming a stain covered with a gray raid. Plants fade and break at the base. The disease also infects adult plants. The mycelium of the fungus winters in the soil.

4.5.2 Phytopathogenic diseases of adult plants

Pyricularious. An infecting agent, the fungus *Pyricularia oryzae*, is strictly aerobic. This is the most dangerous rice disease known in Uzbekistan and Karakalpakstan. The disease is visible in leaf, stem and panicle forms. The leaf form occurs on rice plants at the beginning of the panicle formation stage. Brown-gray stains appear on the leaves, which, in the process of growth, become stretched longways into an oval shape with pointed ends. A dark brown strip borders the edges of spots. During intensive development of disease the stains merge and leaves dry up. Leaf bases are affected and the leaf breaks off.

The stem form of *P. oryzae* is evident due to blackening and in formation of characteristic constriction points near nodes on plants stalks. Stalks in this place are blackened, become thin and break off. If the bottleneck shape is similar to that of the panicle from then branches and ear scales become covered with stains. As a rule, such panicles do not produce grains. As a result of this disease rice plants form empty ears, soft grains or perish completely. In intense outbreaks development of all three forms of pyricularious are simultaneously visible.

Sources of the pyricularious infection include seeds, vegetative residues and wild cereals. Mycelia of a fungus might be present in the seed germoplasm, in the endosperm or on the seed surface between the fruit layer and floral scales.

The infection is transferred with liquid-drop moisture (rains, fogs), wind, and insects in all phases of plant development. Development of the fungus is promoted by high air humidity, drought, constant temperatures of 20-30^{o}C and excessive nitric fertilizer applications.

The fungus overwinters in rice straw, weeds, reed, rushes, and millet-like cereals, forming spores and infecting rice plants in the spring. In a dormant state mycelia and conidies of a fungus could stay viable for 3-5 years. Of the cultural cereals, this fungus infects wheat, barley and corn.

Helmintosporious. This is caused by the fungus *Helminthosporium oryzae*. This disease is widely distributed in new sowing areas poor in nitrogen, and in sandy soils. The fungus agent lives in rice seeds, straw and harvest-field in the open field and in storage as mycelium. Fungus development begins when temperatures approach 15-16^{o}C. When this condition is fulfilled, rice plants begin to become infected. All vegetative and generative organs of plants are infected – from root sprouts and coleoptiles up to floral scale and the grains in panicles. On the root neck of the infected young plants a gray/olive shaded dense strike of fungus-agent spores appears. Leaves are covered with brown or black stains in a typical ellipse form and are bordered by a brown strip.

During heavy fungal outbreaks the stains merge, causing a burnt appearance, and then dry up. On ear scales and grains the fluffy black mass consisting of the spore and mycelia of the fungus is formed. The damaged knots of stalks and panicles darken and dry out and the grain becomes weak or completely dies off.

Sclerocial Decay. The agent is the fungus *Sclerotium arisa*. It infects the bases of the rice stalks under the layer of water. One of the most typical symptoms of disease is when tillering is highly delayed.

At the point of death the stalk is bleached at the base and cracks exist between knots. Grayish mycelia with numerous black and brilliant rounded sclerocies are found inside the plant as well as in the leaf sheath cavities. Dark olive velvety stains appear on leaves. Such leaves dry up prematurely. Infected plants strongly cluster, new sprouts are formed from axils buds, which turn yellow and die off. The grain becomes weak. Affliction strongly reduces the crop size and quality of the grain.

Shoot fusariosis. A dangerous disease of rice caused by the fungi *Fusarium* sp. Shoots and adult plants are infected causing sprouts to rot. The infection takes place in seeds and soil. Rice becomes infected more often on saline soils or on water-stressed crops. As a result thinning is observed and bald patches form on the field.

Root necks and roots become rotten in more mature rice. The base of the stalk turns brown and easily comes away from the roots. Afflicted rice struck with disease lags behind in growth, becomes yellow in color, panicles could be relatively undeveloped and be sterile. Infection of seeds occurs during maturation and cleaning in the field. Their coloration is brown or motley.

The fungus infects knots of the stalk as well. Knots blacken, but in contrast to pyricularious-affected plants do not crack. The spotty brownish stains could be on leaves. The plant becomes dirty brown in color and development is completed late. Damaged rice starts to wither in dry and hot weather. Leaf ends become braided and dry up and panicles frequently remain empty.

4.5.3 Phytopathogenic diseases of rice grain in storage

Fusarious. Caused by several species of fungi of the genus *Fusarium*. The external attributes of grain infection is distinct. On detection of pinkish-red or gray grains in samples all seeds should be subjected to inspection.

Helminthosporious. On the infected seeds longitudinal dark-brown stains are formed under the cover, and seeds become brown in color with a wrinkled surface. Spores of the fungus-agent are on the surface, and mycelia are situated inside seeds.

Pyricularious. This has no appreciable external attributes on seeds. The infected sowing material should be exposed to biological analysis. The seeds from crops where at approbation contamination exceeded 5 % are not considered suitable for sowing. The infected seeds possess low germination energy and germinating capacity and become a source of infection.

Alternarious. On the seeds distinct external attributes of infection are absent. Analytical definition is required. Seed sowing qualities degrade.

Aspergillosis. This is characterized by complex saprophytic fungi, that cause seeds to spontaneously warm up in storage. Sometimes in this case harmful toxins are produced.

Seed mustang. The saprophytic fungi nitium, trichoderma, risolus etc. form a musty-like strike of various density and coloring (from dark-olive up to light gray or yellowish) on the grain surface in conditions of raised humidity.

Red spots. These are caused by fungi. Reddish points or stains are formed on seeds.

Black seeds. This can be observed on the maturing grains in panicles.

Pink grains. These develop when harvested plants are kept in heaps for a long period. Both diseases are also caused by fungal organisms and result in a decrease of seed quality and damage to rice.

4.6 Disease control measures

4.6.1 Shoot disease control measures

In order to prevent disease, destruction of the vegetative residues on which the fungus overwinters is necessary in addition to treating seeds with fundazol 50 % m.p. 2.0-3.0 kg/t.

4.6.2 Pyricularious control measures

In order to maintain rice seeds free of pyricularious it is necessary to treat them with fundanizol, (50 % m.p. 2.0-3.0 kg /t of seeds) before sowing. Careful rice storage (even regular airing) promotes the reduction of a significant amount of infected grains. The rational application of nitric and phosphoric fertilizers act as a pyricularious preventative.

On rice fields that are proving unsuccessful due to pyricularious one of the following fungicides should be used: benlat 50% m.p. (m.p.) 2kg/ha, topsin M. 70% m.p. 1.0-1.2kg/ha, folikur BT 22.5% suspended concentrate 0.4l/ha. The first spraying (by light aircraft) should be carried out before flowering, the second after flowering, with the third application (if necessary) taking place 10 days after the second. 200 liters of the solution should be applied per hectare. During preventative treatment the quantity of preparations should be decreased twice.

Weedy cereal plants act as reservations of pyricularious in nature. Therefore it is necessary to regularly mow weeds (or to treat them with appropriate herbicides) on ditches, roadsides and irrigation canal banks.

In autumn, after harvesting, straw must be taken from paddies to areas beyond the limits of the field and the harvest-field must be ploughed to depths of up to 25cm. The fungus perishes upon being deeply buried in soil.

4.6.3 Measures for control of *Helminthosporium oryzae*

It is necessary to treat seeds before seeding and treat crops by the same preparations, as with pyricularious. Observance of alternation of cultures in the crop rotation, destruction of the plant residues, and introduction of resistant sorts are also required.

4.6.4 Measures for controlling *Sclerotium arisa*

Removal of plant residues is important for the prevention of disease. Strict observance of a crop rotation, an optimum water regime during the vegetative period, as well as introduction of resistant varieties are the main measures of sclerocies control.

4.6.5 Measures for controlling *Fusarium* sp.

For the control of fusarious preseeding treating of seeds with granosan (see pyricularious), observance of crop rotation, and destruction of the plants residues is recommended.

5 PESTS AND DISEASES OF SUGAR BEET *BETA VULGARIS* L.

5.1 Pest overview

Sugar beet is widely cultivated in the Khorezm region and is heavily damaged by harmful insects. This can be primarily explained by the abundance and variety of insect species for which sugar beet is especially attractive as feed (Table 11.11). Moreover shoots of sugar beet develop very slowly in the spring, and the damage by insects is especially destructive in this period. Pestilent insects include both polyphagous species which also feed on the plant family Chenopodiaceae. Sugar beet pests have adapted to this culture, and have been crossing on to it from wild-growing and weed plants for many years. Various harmful insects have maintained associations with weed plants up to the present.

Among polyphagous insects the following typically cause the most damage: meadow moths *Loxostege nudalis* Hb., turnip moths and other cutting noctuid species (*Agrotis segetum*, *A. exclamationis*), *Tanymecus palliates* L., *Poeciloscytus cognatus* Fieb., and *Chaetocnema breviuscula* Fald. In some years scale noctuids, caradrine, and silphids (Coleoptera: Silphidae) are the main agents of crop damage. Many species of bugs and cicada are the most significant pests of beet which, in addition to damaging beet directly, are carriers of plant viruses.

Of the pests specific to sugar beet which have adapted to this culture, the most destructive include common and east beet weevil (*Bothynodes punctiventris* Germ., *B. toveicollis* Gebl.), common beet fleas *(Chaetocnema concinna* March.), and southern beet nematodes (*Rotylenchus multicinctus*). The following specialized species are of lesser significance: root and striped beet weevil (*Bothynoderes foveicollis* Gebl., *Chromoderus contluens* Fabr.), stalk-eaters such as *Lixus cardui* Ol., beet fly (*Pegomyia hyosciami* Panz.), *Cassida nebulosa* L., and *Atomaria linearis* Steph.

5.2 Effects of pests

The following pests cause the most damage to beet in the region: 1) turnip moths (*Agrotis segetum*, *A. exclamationis* L.,: Lepidoptera: Noctuidae) 2) beet fleas (*Chaetocnema concinna* March., *Chaetocnema breviuscula* Fald.), 3) beet weevils (*Bothynoderes punctiventris* Germ., *B. toveicollis* Gebl.), 4) caradrine (*Spodoptera exigua*) 5) beet moths (*Loxostege nudalis* Hb) and 6) *Epicauta erythrocephala* Pall.

5.2.1 Turnip moth (*Agrotis segetum*) and *A. exclamationis*

The caterpillars of these two species causes damage in equal measures. The most damage is caused by noctuid caterpillars to beet shoots. The beet sown in May suffers most heavily during the first generation of noctuid development. Earlier sowings suffer much less as plants have time to grow and become developed before the first generation of caterpillars appears. The summer generation noctuid is less numerous, as high summer temperature negatively affects their development. In autumn noctuids concentrate mainly on late crops of small plot cultures.

5.2.2 Beet flea

These fleas damage shoots heavily. As a rule, damage results in the delay of shoot development. The damaged plants recover considerably when well watered. The fleas damage all areas of sowed beet.

5.2.3 Beet weevils

As pests of shoots of sugar beet in region beet weevils become increasingly significant with each year. During inspections *Bothynoderes subfuscus* var. *innocuus* Fst was frequently encountered as described by Plotnikov (1911).

5.2.4 Caradrine

Caradrine mass reproduction has been observed on sugar beet in Uzbekistan mainly with the formation of aggregations in the Khorezm area.

5.2.5 Beet moth

These pests are endemic in Uzbekistan. Caterpillars of the first instar strip a leaf, leaving only its skeleton. The leaf becomes curly, and braided by webs. Firstly central leaves of the plant rosette are damaged by caterpillars followed by the larger peripheral leaves.

5.2.6 Beet fly

This species is widely distributed. It has, however, no appreciable economic significance. The larvae of beet flies mine beet leaves. The leaves become almost entirely covered by mines when heavily infested, reducing the available sunlight-assimilating surface of the plant.

5.2.7 Beet stalk-eater moth

This moth is very widely distributed in all beet sowing areas in Uzbekistan. It has no great economic significance for industrial beet. The stalk-eater moth has however considerable significance for beet transplantation as the damages caused by it cause stalks to break and consequent marked loss of the seed crop.

5.2.8 Lamellicorn beetles

March chafers (*Melolontha afflicta* Ball) and June chafers (*Amphimallon solstitialis* L.) among others (subfamily Melolonthinae) have been registered in all beet sowing areas with an average density from 0.05 up to 3.6 individuals per m^2 (Juravleva 1953).

5.2.9 Beet nematodofauna

The fauna of beet nematode and root soil is characterized by 9 species in a sample of 177 individuals (Tulaganov 1958). Among the harmful nematode species *Rotylenchus multicinctus* and *Aphelenchus avenae* are noteworthy. *Eucephalobus elongatus* is the dominant species (Table 11.12).

5.3 Control measures for sugar beet pests

For a successful control of sugar beet from pests it is necessary to carry out the whole range of industrial-organizational, agrotechnical, chemical, biological and other measures.

5.3.1 Industrial-organizational measures

1) Correct implementation of crop rotation according to schemes adopted in adjoining beet-growing districts. The beet should be located as far as 500 m distant from beet plantations from the previous two years. The distance should be as great as 1 km between the source, commercial beet and other plantings.
2) Strict implementation of the complex of measures of tillage, application of fertilizers and plant care.

3) Annual soil-excavation undertaken in autumn and a control excavation in spring to identify the numbers and state of pests in their wintering grounds.

4) Systematic monitoring of emergence and development of pests so that control measures can be prepared.

5) Strict observation of measures such as soil ploughing, tillage (cultivation), fertiliser application and plant care.

5.3.2 Early-spring period (prior to emergence of sugar-beet shoots)

1) Prior to emergence of pests, edge ditches should be made with trap wells around the previous years beet plantation.

2) Pre-sowing insecticide treatment of seeds should be performed to make shoots of sugar beet more toxic for pests.

3) Sugar beet should be sowed as early possible. Insecticides should be applied along seedbeds together with fertilizers to protect underground parts of plants from damages caused by the larvae of scarabaeids and elaterids, *Atomaria linearius*, *Pemphigus fuscicornis* and other pests.

4) If the number of *Bothynoderes punctiventris*, *B. subtuscus* var. *innocuus*, and *Tanymecus palliates* is high, boundary trap ditches should be made around new crops.

5) After harvesting and cleaning of roots and shoots, all residues and the remaining parts of surface must be removed, collected into "kagats" for storage and covered with soil.

6) Weeds near the forest belt and along the roads should be mown; weeds should be controlled on fields using herbicides and mechanical devices.

5.3.3 Period from emergence sugar beet shoots until spreading of leaves above the seedbeds

1) As soon as shoots of sugar beet emerge, insecticide treatments should be applied to control flea beetles *Chaetocnema* (Coleoptera: Chrysomelidae), leaf rolling weevils (Coleoptera: Attelabidae), curculionids, whitefly and other pests (zolon 35% c.e. 3.0-3.5 l/ha; nugor, 40% c.e. 0.5-1 l/ha; danadim, 40% c.e. 0.5-1 l/ha; mospilan, 20% m.p. 0.2-0.5 g/ha; marshal, 25% c.e. 1-1.5 l/ha is also recommended against weevils).

If the danger of pest infestation persists, repeated treatment of sugar beet shoots should be applied until their leaves join together (or close up) in the seedbeds (using the same chemicals as mentioned in point 1).

2) Soil should be tilled in row-spaces, which enables better growth and development of plants.

3) Trichogramma release (40 000 to 50 000 per ha) at the beginning of and during the mass oviposition by *A. segetum* moths as well as the other species of noctuids.

4) The boundaries of plantations should be treated with phosphoorganic drugs when the initial colonies of *Aphis tabae* emerge (nugor, 40% c.e. 0.5-1 l/g; danadim, 40% c.e. 0.5-1 l/ha.; carbofos, 50% c.e. 0.6-0.8 l/ha).

5.3.4 The period from leaf-spread until harvesting

1) A the boundary of sugar beet plantations should be treated with insecticides two or three times during the migration of the larvae of *Pemphigus fuscicornis* from the neighboring beet plantations and goosefoot weeds (nugor 40% c.e. 0.5-1 l/g.; danadim 40% c.e. 0.5-1 l/ha.; carbofos, 50% c.e. 0.6-0.8 l/ha).

2) In the years of mass breeding sugar beet should be treated with nugor, 40% c.e. 0.5-1 l/ha; danadim, 40% c.e. 0.5-1 l/ha; carbofos, 50% c.e. 0.6-0.8 l/ha should be applied.

5.3.5 Post-harvesting period

1) Thorough and complete harvesting of the commercial and mother beet, removing of all roots from seed parts should be made, since *Pemphigus fuscicornis* as well as the other pests can overwinter in them.

2) Sugar beet should be strictly checked for damaged roots while storing in “Kagats”.

3) Deep autumn tillage with plow and colter should be performed. This significantly reduces the numbers of *Pegomia betae*, *Pemphigus fuscicornis*, as well as the other pests.

5.4 Diseases of sugar beet

According to Nijazova (1967), the following diseases of sugar beet have been reported in the Khorezm oasis:

On tubers: mealy dew (*Erysiphe graminis*), a black mould which may afflict young tubers.

On leaves and roots: rhizophagous *Phoma betae* Frank., mealy dew (*Erysiphe communis Grev.* f. *betae* Pot.), cercosporious (*Cercospa beticola* Sacc.), spotted zones (*Phoma betae* Frank.), black spotted leaves, fusarious roots (*Fusarium* Link.), brown decay (*Rhizoctonia aderholdii* Ruhl.), (*Moniliopsis aderholdii* Ruhl.), kagat decay (*Botrytis cinerea* Pers), bacterially-inflicted leaf spots (*Pseudomonas aptata* Stapp.), tail decay bacterial scab mosaics (*Bacterium scabie genum* (Faber) Stapp.), curled leaves, albication (not caused by microorganisms), hollowness of roots (*Bacterium tumefaciens* Sm.et Town.), dry spottedness (not caused by microorganisms) and drying leaves (not caused by microorganisms), burns on leaf edges and blades, stripness of veins and leaf stalks, root choking, chlorosis.

Other: Nitric starvation (chlorosis starvation, nitrogen, magnesium, manganese; leaf-edge necrosis – potassium starvation; brownish leaves – phosphorus starvation; decay of core and dry decay of root – boric starvation; dry spottedness or leaf sun burn), potash starvation, dodder (*Cuscuta europaea*).

Rhizophagous and mealy dew are the most widespread and harmful diseases, followed by kagat decay, cercosporious and dodder.

5.4.1 Sugar beet rhizophagous

Rhizophagous is a disease of beet shoots caused by the development of pathogenic microorganisms, the presence of adverse conditions for sprout development and poor quality of seeds. The following fungi are common: *Rhizoctonia* Kuhn., *Fusarium* Link., *Alternaria* Hess., *Mucor* Micheli, *Penicillium* Link., *Cladosporium* Link., *Rhizopus* Erenb., *Macrosporium* and *Aspergillus* sp., most frequently on sprouts damaged by them. Nijazova (1967) determined the agent of rhizophagous to be the fungus *Rhizoctonia solani* Kuhn.

Rhizophagous is one of the most widespread and harmful diseases of sugar beet. Susceptibility to infestation of this culture by rhizophagous reaches 21-42 %, and on average 9-22 %.

5.4.2 Cercosporious

The fungal agent is *Cercospora beticola* Sacc (Denteromycetes: Hyphales). Cercosporious is one of the most harmful diseases of beet. The major physiological processes are disrupted: Transpiration increases by 3-4 times relative to typical values, dissimilation of carbonic acid decreases more than 10 times, and nitrogenous exchange ceases on death of the leaves in the plant. Root growth is reduced by a factor of approximately 2 because leaves die on mass. Sugar content is increased considerably (from 3 up to 7 %). As a consequence this results in a marked shortage of sugar from the area (on 6-70 %). The earlier the occurrence of mass development by an infecting agent and the higher the incidence of plant death, the greater the shortage of sugar.

5.4.3 Mealy dew

Mealy dew is one of the most widespread diseases of sugar beet. The agent of mealy dew of sugar beet is the fungus *Erysiphe communis* Grev f. *betae* Poteb. On average mealy dew infects sugar beet from 41.6 up to 85.5 %, and at a maximum has been known to afflict entire crops. Loss of the sugar beet crop due to mealy dew averages 20.46 % (Nijazov 1967).

5.5 Control of sugar beet diseases

5.5.1 Control of rhizophagous

The following agrotechnical actions are important for controlling rhizophagous:

1) The land should be plowed in autumn, which buries organic residues on which pathogenic microorganisms could develop;

2) Sowing of sugar beet with selected seeds when soil begins warming up at soil temperatures of not less than $5^{\circ}C$;

3) Prevention of formation of soil crust and realization of preliminary treatment of seeds.

5.5.2 Control of cercosporious

In order to control the agent of the disease field clearing is recommended after gathering beet in their first and second years of life. In order to increase the resistance of plants to cercosporious the following are of special significance: the application of fertilizers (with a prevalence of potash) and feeding plants in the period of cultivation and closing (jointing) of leaves above seedbeds .

For chemical measures of cercosporious control the following preparations are recommended for spraying during plant vegetative periods: alto 400ks 40% s.c. 0.15-0.2 l/ha, benlat 50% m.p. 0.6-0.8 kg/ha, Bordoss liquor 6.0-8.0 (according to copper vitriol) l/ha. It is necessary to apply this preparation steadily to beet affected by cercosporious.

5.5.3 Control of mealy dew

For the control of mealy dew it is necessary to carry out plowing (in autumn for spring sowing) at depths of 28-32 cm where pests occurrence is delayed. Cleaning of vegetative residues is also recommended. Application of mineral fertilizers increases the resistance of sugar beet to mealy dew. Regarding chemical measures of mealy dew control, spraying of the following preparations is recommended during the plant vegetative period (Table 5.1):

Table 5.1: Chemical control measures for *Erysiphe communis*

Bauleton 25 m.p. 0.6 kg/ha	Lime-sulfuric broth (LSB) of 0.5-1.0 degree by Boma
Benlat 50% m.p. 0.6-0.8 kg/ha	Sulfur. 80% m.p. or colloidal sulfur 4.0-6.0 kg/ha
Bordoss liquor 0.6-8.0 kg/ha on copper vitriol	Ground sulfur 15-30 kg/ha

6 POTATO PESTS AND DISEASES

6.1 Pest overview

The increase of potato cultivation as well as the substantial increase in its productivity have accelerated the widespread introduction of advanced cultivation and mechanization techniques in the Republic of Uzbekistan. It is necessary to carry out a series of actions, in particular, planting of potato plants on very favourable soils, as well as providing protection against potato pests, in order to achieve an increase in productivity.

More than 50 species of polyphagous insects are conspicuous on potato plants in Uzbekistan. The most destructive specific pest of the potato is the Colorado potato beetle *Leptinotarsa decemlineata* Say. Of insects those that have quarantine significance in Khorezm, the colorado potato bug *L. decemlineata* is one of the most threatening in the region and causes enough damaged to be frequently quarantined.

The insects which damage potato tubers and the larvae of click beetles (Elateridae) in particular are capable of causing great harm. Damaged tubers become unsuitable for eating and unstorable for long periods. Larvae, chafers, caterpillars and cut noctuids could also cause substantial damage to tubers. In recent years stem, gall, and potato nematodes have become significant in abundance.

Many species of proboscis-feeding insects feed on leaf juices, and are carriers of various (mainly viral) potato diseases such as leaf curling and mosaic pattern-forming diseases.

Leaf-cutting insects are of no great importance. Those occurring on the potato include fleas and mainly caterpillars of polyphagous butterflies. They are seldom encountered in large quantities on potato plants.

See Table 11.13 for a list of pests that damage potatoes in the region.

6.1.1 Potato nematodes

Karimova (1957) found 29 nematode species living in potato plants in the Kipchak, Kungrad, Shumanay and Hodzhejlin districts of Karakalpakstan. Among them *Peronilaimus saccai* Rham was registered for the first time in the USSR in 1950.

Tulaganov (1958) investigated potato plants and preroot soil. Samples were taken in 5 districts - Kuybisheb, Kegeylin, Chimbay, Shabbaz and Turtkul. Inspections were mainly made during flowering periods. At this time 75 samples were taken: 25 each from stalks and leaves, root systems and root soil respectively. Results are shown in Table 11.14. 9029 nematode individuals were found in the 65 samples. Of these: 133 are from stalks and leaves (in 17 samples), 7515 individuals were from the root system (in 23 samples) and 1381 individuals from the soil. Roots of all plants taken for the analysis were investigated for the presence of potato and gall nematodes in the plant.

Gall nematodes *Meloidogyne marioni* have been found in Kuybisheb and Chimbaj districts. Potato nematodes *Heterodera rostochiensis* have not been found.

The nematodofauna of potato and periroot soil is characterized by 43 species, belonging to 20 genera in Tulaganov's (1958) work (Table 11.15). According to Table 11.15, several species are abundant and widely distributed. These include *Eucephalobus elongatus, Aphelenchus avenae* and *Aphelenchoides parietinu*. The overwhelming majority of potato nematode species are insignificant in number.

Saprozoic nematodes are represented by 19 species. Of these *Diplogaster longicauda* was found in one potato root system sample in Turtkul with an abundance of 4936 individuals.

Harmful potato nematodes include the following species: *Meloidogyne marioni*, *Ditylenchus dipsaci, Rotylenchus multicintus, Pratylenchus pratensis, Aphelenchus avenae, Aphelenchoides* Kuhn, *A. parietinus*. 693 stem nematode individuals were found. Of these 647 were registered in root systems and periroot soil. All plants on which stem nematodes were discovered did not display characteristic attributes of disease. 621 stem nematodes individuals were found in 4 potato plant root systems in the Chimbaj district. These plants displayed signs of disease.

Gall and stem nematodes are the most serious potato pests among the known harmful nematodes. Conditions in Karakalpakstan are favourable for the development of these nematodes. Hence, they could cause widespread damage to agriculture in Karakalpakstan.

6.2 Pest control measures

6.2.1 Control of *Lepinotarsa decemlineata*

Lepinotarsa decemlineata is a dangerous pest but is not widespread in the Khorezm oasis and the Republic of Karakalpakstan. However, large-scale control measures of plant quarantine are taken to prevent this pest from penetrating into this area.

6.2.2 Control of *Aculops lycopersici*

Against mite/tick *Aculops lycopersici* Massee, the following chemicals are used: Grizli 36% (0.25 kg/ha), Nissoran 10% m.p. (0.3 kg/ha); Neoron, 50% c.e. (1.5 l/ha), Danitol, 10% FLO (2 l/ha) and Carbofos, 50% c.e. (in greenhouses, 2.5 l/ha; in open plantations, 1.2 l/ha); Mitak 20% (2.5 l/ha), Omait 570 EW 57% (1.5 l/ha), Vertimek 1.8% (0.1-0.2 l/ha).

6.2.3 Control of cicadids and aphids

Against aphids and cicadids, BI-58, 40% c.e. 2-2.5 l/ha is used.

6.2.4 Control of elaterids

Talstar, 10% c.e. 0.6 l/ha is used against elaterids.

6.2.5 Control of *Agrotis segetum*

Decis 2.5% c.e. 0.5 l/ha is used against *Agrotis segetum* when its' density reaches 0.8 to 1 larva per m^{-2}.

6.2.6 Control of nematodes

To control nematodes, only undamaged tubers should be planted. During the crop rotation, potatos should be planted in the same place only after a three or four year interval. Potatos should be harvested early if planted in spring and planted in early summer. Weeds and stubbly remnants should be destroyed where opportunity arises. An early autumn tillage should be performed. Potatos should be carefully sorted before storage and planting. The optimal storage regime described previously should be maintained. In order to prevent accumulation of nematodes it is necessary to treat infected sites with chemical preparations.

6.3 Potato diseases

In the region the potato has been cultivated for more than 100 years, but its productivity in these conditions is very poor because various diseases cause significant damage to the potato crop.

6.3.1 Potato fusarious

The pathogenic agents are the fungi *Fusarium oxysporum.* It is necessary to note that in recent years the area of agricultural crops afflicted by *Fusarium* sp. has extended. This disease affects not only cotton, but also potatoes, tomatoes, beet, eggplants and other vegetable or melon cultures. The proportion of overall damage to potato crops by fusarious can be between 4 and 58%.

Fusarious can decrease growth of plant vegetative organs by between 11.4 and 29.6 cm, and also stalk mass reduction at flowering has been been observed to be reduced by 26g. One plant showed a 101g loss in mass at maturation. Decrease of productivity of a potato in comparison with healthy plants causes a 75g to 213g loss in mass per plant (Rahimov 2001).

6.3.2 Common scab *Actinomyces scabis* (Thaxter) Gussow

The agents are members of the radiant fungi which are widely distributed in soil. It only infects tubers. Common scab is a harmful disease. During widespread outbreaks of disease wastes of food potatoes increase, tubers decrease in significance as a commodity, and the quality of seed worsens.

6.3.3 Ring decay [*Corynebacterium sepedonicum* (Sp.et. K.) Skapt.et Burg]

The agent of disease is a bacterium from the Mycobacteriaceae family. This disease is extremely harmful, as strongly afflicted tubers usually decay and do not produce shoots. Additionally ill plants form tubers much less than healthy plants as a result of their generally poor condition. Losses of a potato in certain years which are favorable for the development of an infecting agent have been observed between 20 and 40%. The main sources of infection are tubers.

6.4 Potato disease control measures

6.4.1 Measures of control for potato fusarious:

A clean bedding material, prepared from healthy plants, should be used. Potato cultivations should be alternated with with other cultures that are relatively unaffected by fusarious, such as onions, alfalfa, leguminous and cereal cultures. Application of 100-120 kg / ha of *Trichoderma* sp.. All agrotechnical measures for controlling diseases from previous chapters should be undertaken.

6.4.2 Measures of control for common scab

Measures of control include observance of a crop rotation. Strongly afflicted common tubers are not recommended for use in planting.

6.4.3 Measures of ring disease control

Potato crops should be checked 2-3 times in summer, from the end of flowering up to cleaning, with diseased plants being removed. Potatoes should be dried in sunlight and sorted before being stored. Storage should be according to strict conditions. Potatoes should be bred according to clan selection of healthy bushes with application of serological diagnostics. Plantings of tubers on seed sites should only consist of whole tubers (Golovin et al. 1971).

7 POPLAR PESTS AND DISEASES (*POPULUS NIGRA* L.)

7.1 Pest overview

City plantings of poplars in the region are of great significance. They provide shade and cool in summer months. Trees work as windbreaks to shield their surroundings from dust, absorb carbon dioxide from the air and provide oxygen, promoting better living conditions in cities.

An adverse factor for development of city tree plantings, including poplars, is the quickly-reproducing insects which not only weaken trees, but frequently cause death. For example, in cities a large number of poplars perish under attack from the cerambycid Sart Longhorn beetle *Aeolesthes sarta.*

According to Gershun (1951), between 25 and 38 species of pests have been registered in different species of poplar. In particular the black poplar (*Populus nigra* L.) is damaged by the following pests listed in Table 11.16.

7.2 Effects of pests

7.2.1 Poplar bug *Monosteria inermis*

A large amount of damage to poplars is caused by *Monosteria inermis* (Hemiptera: Tingitidae). The larvae and adult individuals drain sap from leaves. In addition they cover leaves with sticky excreta which block stomata and disrupt the leaf metabolism, thus causing them to dry out.

7.2.2 Aphids (Homoptera, Aphidinea: Aphididae)

Aphids attack many tree species, and the poplar in particular suffers heavily. As a result of feeding on leaves and sprouts the trees’ nutrient supply becomes deplenished and growth is delayed. Some species of aphids cause growth of formations in the form of galls and tumours inside which they live.

7.2.3 Coccids (Homoptera: Coccoidea).

The inactive proboscis-feeding insect pests belong to the suborder coccids or Coccinea and Diaspididae. The majority of coccids species that are harmful to tree species, including poplar, belong to three families: Diaspididae, Coccinea, and Pseudococcidae. The type of damage caused by these pests is very variable. Settling on trunks and branches, coccids extract nutrients from the phloem. Such damage causes bark to die off and sprouts to curl and dry out. Strongly afflicted trees suffer a reduction in annual growth.

7.2.4 Buprestidae (Coleoptera)

Buprestidae, *Melanophila picta* settles on the young poplar from the age of one to five years. Settlement on the root neck leads to frequent plant death. *Capnodis miliaris metallica* develops on old trees. Larvae bore courses along the trunk on the border between living and dead wood.

7.2.5 Cerambycidae (Coleoptera)

Of the Cerambycidae the greatest damage to poplar is caused by the beetle *Aeolesthes sarta* Solsky. *Aeolesthes sarta* infests many wood and fruit tree species, but it is especially devastating to poplar, elm and willow. *A. sarta* attacks externally healthy, viable trees and gradually kills them .

7.3 Specific pest control measures

A more extensive discussion of non-specific pest and disease control measures such as sanitary felling is given in chapter 7.5.

7.3.1 Control of *Monosteria inermis*

To in order to control this species, trees should be sprayed with organic phosphor and pyrethroid preparations.

7.3.2 Control measures for Aphididae

Again, organic phosphor and pyrethroid preparations.

7.3.3 Coccid control measures

When controlling coccids precautionary actions are most effective:

1) Attentive survey and, when appropriate, rejection of the landing material for detection of coccid presence.
2) Chemical and thermal disinfection of bedding material.

3) During periods of mass reproduction chemical measures of control such as use of talstar (0.1 %), karate (0.05 %), and danitol (0.02 %).

7.3.4 Control measures for *Melanophila picta*

In controlling *Melanophila picta* it is necessary to carry out sanitary felling of infested trees in autumn, winter and in spring until April. This will prevent development of the insects concerned and is intended to reduce the number of bugs leaving infested trees.

7.3.5 Control of cerambycid beetles

Measures of control are extremely complicated, especially in city conditions. Mechanical destruction of bugs is recommended during flying periods (May) at night,. It is important to destroy dead trees in due time. In the beginning and middle of the flight period a double application of pesticides to trees is recommended: talstar (0.1 %), karate (0.05 %), decis (0.05 %), Ambush (0.1 %) and sumi-alpha (0.1 %). It is recommended to cover stems and wounds of trees with insecticide-integumentary putty, consisting of the following mix : clay mixed with manure (1:1), decis (0.1 %) and copper vitriol (0.5 %).

7.4 Poplar diseases

7.4.1 Leaf diseases

The fungi described below belong to the most widespread and destructive agents of poplar leaf diseases.

Symptom: Brown spots on leaves. The agent is the fungus *Marssonina populi* (Lib) Hand. The oval, brown (with darker or black border), merging stains can be observed on the poplar leaves.

Symptom: Grey spots occur on leaves. The agent is the fungus *Sertoria populi* Desm. Fine oval or oblong light gray stains with a border are formed by this disease.

Symptom: Grey spots on aspen (*Populus tremuli*) leaves. The agent is the fungus *Gloesporium tremulae* Pass. On aspen leaves large irregular-shaped yellowey grey stains with brown borders are formed.

Symptom: Spotted leaves form on aspen. The agent is the fungus *Melampsora pinitorqua* A. Braun. *M. pinitorqua* is a two-bodied fungus with a full cycle of development. Summer and autumn stages of the fungus develop on aspen and white poplar leaves causing yellowy-brown and dark brown scab formations on them.

Poplar leaf rust

Poplar leaf rust is caused by other fungi of the genus *Melampsora*. Yellow stains of the rust are formed on leaves and cause yellowness and drying out of leaves. On flat orange leaves (at summer stage) and dark brown (at autumn stage) small "cushions" develop. The rust is caused by the fungi *Melampsora ulmi-populina* Kleb*, M. larici-populina* Kleb. and *M. laricis* Hart.

Poplar mealy dew

The agent is the fungus *Unicula salisus* Wint. f. *populorum* Radh. The felt-like mycelium forms on both sides of leaves, mainly on top*,* and creates merging spots. Even especially strong plants can suffer from mealy dew in nurseries, with young ones being strongly afflicted. However, significant damage has been discovered in more adult trees in recent years.

Poplar scab

The agent is the fungus *Fusicladium hadiosum* Lind*.* On the damaged leaves dark brown oral or irregular-shaped stains are formed. The agent is the fungus *Taphrina aurea* Fr. Bubble-like golden-yellow or brown swellings appear on the upper parts of poplar leaves.

7.4.2 Diseases of trunks and branches: The fungi that cause dessication of sprouts and branches

The agents of the diseases causing drying out of sprouts and branches are fungi, which are described below.

Fungus *Valsa nivea* Fr. Conidium stage *Cytospora nivea* (Hoffm) Sacc.

This causes occurrence of scattered mounds (picnids) up to 1mm in diameter with the white top rising from under the bark epidermis on the afflicted weak and partially dried poplar sprouts and branches.

Fungus *Nectria cinnabarina* Fr. Conidium stage *Tubercularia vulgarus* Tode.

Initially the fruit organs of the fungus are red, then they become brownish, and spherical with a diameter of about 0.5 mm. Conidial fructification appears similar to small brown "cushions". *N. cinnabarina* infects a number of deciduous tree species, including a poplar as a saprophyt, and it infects some sprouts and branches or entire young plants as a severe parasite, causing their death.

Fomes polyporus =_Fomes fomentarius_ L. ex Fr. (Gull)

The decay caused by this fungus is characteristically light yellow mixed with numerous black hyphae and lines separating healthy and damaged wood. In its final stage of rotting the wood becomes very fragile and is easily split.

Fomes polyporus is very widely distributed. It develops on many species of deciduous trees and particularly on aspen as a saprophyte. On some species, for example on poplar and birch, the fungus develops semi-parasitically. It develops less often as a parasite and only on other species. For example walnut trees *Juglans fallax* and *Juglas regia* shows signs of a parasitic affliction. The infection of weakened living trees by spores begins in the dry branches of the crown.

Sulfum-yellow polyporus _Laetiporus_ (=_Polyporus_) _sulphureus_

The agent is the brown cubical rot *Laetiporus sulphureus* Bull. Band et sund (=*Polyporus sulphureus* Bull. Fr.). Decay in its initial stages is bright brown, becoming duller. In the final stage of development of the decay cracks penetrate into the woods layers, breaking it up into prismatic slices. The white thick film of suede-like mycelia accumulates in cracks. *Laetiporus sulphureus* Bull. is widely distributed. The fungus develops as a parasite as well as a saprophytic organism, especially on tree stumps. Decay caused by the fungus marr the best parts of trunks of older trees and could develop and destroy wood in the forest products prepared from afflicted trees.

Old poplars are often infected with *L. sulphureus*, but the economic significance of this fungus in various species in poplar forests is little known and, on the available evidence, not great.

Dryads saddle (_Polyporus squamosus_ Huds.ex Fr.)

Decay is white and develops following infection of a wound in the center of the trunk. Narrow oblong cracks appear in the final stage of decay development. The white mycelium develops inside them. Rotten wood breaks up into characteristic fine plates and cubes.

P. squamosus is roughly distributed from St Petersburg to the southern part of the Vologda, Kirov and Sverdlovsk areas and southern areas to Crimea, Transcaucasia, and the Central Asian republics. Outside of the former USSR it is present in Western Europe, and present but insignificant in the USA. It develops on many deciduous species and is typical on older growing trees, as well as on wind-felled trees and stumps. The degree of damage in poplar plantations is great.

White mottled Rot (*Ganoderma applanatum* Pat (=*Fomes applanatus* Gill.))

Decay causes light colouring of wood in the initial stages of development, where coloring is spotty and longitudinal. In the final stages of rotting the wood becomes light yellow and mottled. Longitudinal spongy areas containing polyporus are formed in the wood.

This rot is widespread across almost all areas of the world. It develops on stumps of many fallen deciduous trees. Less frequently it colonizes living trees (in a few species, including poplar and aspen). Living trees are infected through wounds on the roots and at trunk bases. The mycelia penetrate into the core, rising upwards, and at the same time expanding on the alburnum (sapwood) surface and can cause destruction of trunks.

***Inonotus hispidus* Bull. Karst (=*Polyporus hispidus* Fr.)**

Decay is central, and brown in the initial stages. When the tree begins drying the layers of wood burst apart and begin breaking out.. Afflicted wood becomes yellowish-white and separated from healthy wood by a rather wide dark brown border. In some cases decay damages the alburnum.

Inonotus hispidus is distributed in more southerly areas of the European part of the Commonwealth of Independent States (CIS), in Kazakhstan and Central Asia. It develops on live trees including wild apple and walnut, and it expands less often on a lot of other deciduous sorts, including a poplar. Infection of trees occurs through dead branches and various injuries. Decay develops more often in a topmost part of a trunk and in branches that are being attacked by aphids. Poplar mortality caused by *I. hispidus* has not been investigated but is apparently insignificant.

Honey agaric (*Armillaria mellea* Vahl: Fr.) Kummer

The honey agaric forms special versions mycelium submitted flat white rhizomorph organisms that develop under adjoining bark, and round, brown, strongly branching rhizomorph organisms that develop under the lagging beneath the bark, on the bark surface and in soil. Insect boreholes in the wood provide external apertures for fungal spores.

Decay of wood arises in the process of penetration of fungal mycelia (rhizomorph) under the cortex and it distributes itself here. It reforms on roots and trunks of deciduous species. Honey agaric is distributed across all parts of the world. It may develop on many wood and shrub (about 200 species) deciduous and coniferous breeds.

7.5 Specific disease control measures

7.5.1 Poplar leaf rust

For rust control spraying with Bordeaux mixture in the early spring and summer is recommended (Vanin 1955).

7.5.2 *Nectria cinnabarina*

The series of following actions is necessary to control *N. cinnabarina* which causes dessication of sprouts and branches:

1) Scrapping and burning drying and dried sprouts and branches in the spring (March, April) and/or autumn (September, October);

2) Protection of plantings from cattle, mechanical damage and frosts.

7.5.3 *Fomes polyporus*

Special measures of *Fomes polyporus* control in poplar and aspen plantings are unnecessary. Regular selective sanitary fellings is recommended as a control measure.

7.5.4 *Laetiporus sulphureus*

In necessary cases selective sanitary fellings of afflicted trees should be made. These should be determined by fruit organs developed in May and June.

7.5.5 *Polyporus squamosus*

For control, only selective sanitary felling of older trees strongly damaged by this fungus is necessary.

7.5.6 *Ganoderma applanatum*

Strongly afflicted trees should be removed by selective sanitary fellings.

7.5.7 *Inonotus hispidus*

In order to control *I. hispidus* it is necessary to cut down trees afflicted with the fungus, and also to gather fruit organs in June, shortly before the spore-forming period.

7.6 General poplar pest and disease control measures

7.6.1 Economic measures of forest control

All economic forest actions should be directed towards increasing biological resistance of poplar cultures and the creation of conditions adverse for mass reproduction of harmful organisms. It is very important to make correct selection of species and intraspecific forms of poplars for plantings. If species of poplars do not correspond to conditions of the planting site or these conditions worsen, tree growth is sharply reduced and trees are also more vulnerable to pests and diseases.

Poplars grow better on more fertile soils. Their needs also include high light requirements and a good water supply with enough drainage to prevent standing water. During poplar maintenance fellings trees afflicted with pests or diseases, or those that are lagging behind in growth or twisted in form, should all be removed. They must be immediately removed from the plantation, and in necessary cases after felling should be treated with pesticides.

Significant attention should be given to sample of newly settled pests and afflicted trees. Selection of trees is conducted based on a number of attributes: presence of a brown “flour” substance at the base of the trunks, presence of pupal cases of Aegeridae and Cossidae, by swellings at trunk bases, by cancer wounds, cracks on trunks from which brown sap flows, red leaves in July, and exit holes of pests from the families Ipidae, Cerambycidae and Buprestidae. In addition, the presence of dry branches in crowns and the condition of foliage is considered. Felling should be carried out in the period when pest larvae are under the bark of trees. This disease sharply reduces growth and the tree becomes a center and source of infection.

After fellings and removal of trees from new settlements it is necessary to immediately remove and burn felled trees. The prepared wood should be taken out immediately, cut short or processed by chemicals, and infected wood should be cut into metre lengths of firewood and split.

7.6.2 Physicomechanical measures of control

Physicomechanical measures of control are of lesser use and should be applied in the centers of infection only. They are limited to the destruction of insects and sources of infection (fruiting bodies on trunks and leaves of trees, open wounds etc.) with the help of special brushes, rakers, scrapers and other instruments. It is possible to scrape off eggs laid by the unpaired silkworm without particular expense at times when the infection is only weakly developed. Scraping works even better when used interchangeably with coating of laid eggs with chemical substances. For this purpose black oil mixed with with kerosene, tar, petroleum, and other substances is used.

Sometimes insects are shaken out of foliage onto cloths, are collected in buckets or are destroyed in own web jacks. All these methods do not demand special methodology and are in practice very infrequently applied.

Barriers and traps are used more often. They can serve not only as a means of removing pests, but also for forecasting their abundance. Barriers, in the form of glutinous rings on trees and ditches, are arranged so that insects cannot get to the nutrition source. The application of glutinous rings is applied against caterpillars of butterflies of females and bugs which live under the bark, creeping from the ground up to the crowns for feeding after overwintering or hatching in the soil. Currently this technique is used mainly with a view towards monitoring the increase in the number of pests (winter diverse-line moth, silkworms and others). Caterpillar glue is used for ringing plants. A substance should be used that is not washed off by rain, does not run down the trunk and does not become hard at temperatures of up to 45°C. The optimal timing of ringing depends on the periods when caterpillars or wingless females ascend tree trunks to the crowns.

Ditches with steep walls (up to 0.5 m in width and depth) should be excavated to block the way to insects such as curculionids and grasshoppers as they dig around nurseries and plantations.

Traps with mercury lamps can be used to survey the number of pests and to monitor their abundances. Light traps with a source of ultra-violet light instead of typical electric incandescance lamps produce an incomparably better effect. Appropriate light sources in traps include high pressure mercury-quartz lamps such as PKA (PKA -4 with 220 watt capacity, PKA -2 capacity of 375 watt, lamps of ultra high pressure SBDSh-250-3 and others). Function and effect of light-lamps depend on the design of the trap device.

In nurseries and plantations poisoned baits are used such as pieces of bark, grains of corn, an oil cake, heaps of fresh grass etc. These preferred insect foods are laced with pesticides, phosphids, and/or zinc. Baits cause many insects (darkling beetle *Tenebrio* sp., mole crickets (Gryllotalpidae), cutworm noctuids, and curculionids to perish during feeding.

7.6.3 Biological control

Biological measures of control are carried out by application of predatory and parasitic insects (entomophages), applications of fungi, bacteria and viruses that infect pests (a microbiological method), as well as using entomophagous birds and other vertebrates.

The following measures of control could be used: introduction and acclimatization of entomophages, artificial cultivation of entomophages and their release into the wild, the resettlement of entomophages into the area, assistance to natural reproduction of entomophages with the help of forest actions, application of entomopathogenic microorganisms, rationalization of chemical control of harmful insects for the preservation of entomophages, and the use of entomophagous birds.

For the protection of poplar plantations and their attainment of biological resistance it is necessary to involve and keep useful insects and birds engaged inside the area in moving entomophages and application of entomopathogenic organisms.

Resettlement of entomophages inside the target area consists of mass release of specialized parasites or predators within the pests center's of activity by transfer from the low density pest aggregations into areas with higher pest densities. The success of this method is tied to the assisted reproduction of entomophages.

Assistance to natural reproduction of entomophages can be realized by simple economic actions. In order to attract and provide additional food for entomophages the following are recommended: preservation of grassy plants, planting of nectar rich plants in clearings and artificially cultivated forest areas, loosening of wood layers in order to assist birds in finding insects, and preservation of hollow trees and other preferred overwintering sites of entomophages.

Application of entomopathogenic organisms consists in use for pests control entomopathogenic fungi, bacteria and viruses. To control leaf cutting insects bacteritic preparations, in particular dendrobacillin (among others) should be applied.

Encouraging avian entomophages

Protection and attraction of birds in plantings can be encouraged by the following actions:

1) Educating the population about the beneficial effects of birds, and that birds and their nests should remain unmolested; culling of the most harmful predatory birds and animals (by shooting and trapping).
2) Observance of caution when carrying out forest tasks in poplar plantations in order to maintain current and potential bird nest sites;
3) Maintenance of convenient nest sites means leaving remnants of poplars and sanitary fellings of hollow trees, preserving undergrowth, and hanging out artificial nesting-boxes.
4) For creation of convenient nest sites for birds that openly nest on soil, it is recommended to cut branches so that they are clustered more on branches of bushes and at the basis of bough trees, creation of green hedges, and dense bush vegetation and margins.
5) In the winter when birds do not have enough forage, it is necessary to feed them in woodland areas to assist survival in winter and early-spring.

8 ELM PESTS AND DISEASES (*ULMUS DENSA* LITV)

8.1 Pest overview

The elm has a special place among decorative, green, protected forest trees in Uzbekistan, and their role in the Khorezm oasis is even more highly respected. Consequently they occupy prime locations in green areas and are an almost characteristic feature of the oasis. In recent years there has been a sharp increase in tree death due to pest damage. The most threatening of these are from the families Cerambycidae, Buprestidae and Scolytidae and various leaf-eaters as well as a complex of proboscis-feeding pests. Injury by pests frequently promotes infection of trees by various pathogens. The significance of cerambycids is also amplified because with infected elms the pests pass to other tree species, including fruit trees, often causing tree death.

Due to their economic significance *Aeolesthes sarta* and *Scolytus orientalis* Egg are allocated to a group of very destructive elm pests that can devastate trees. The leaf-eater insect *Galarucella luteola* Műll belongs to the most destructive pests because the trees damaged by it could well be subject to infestation by secondary pests such as the elm bark beetle (*Scolytus* sp.). Of the useful species chyrsopids, various coccinellids, and also tick-eating thrips are of practical significance (see Table 11.17).

8.2 Effects of pests

8.2.1 *Aeolesthes sarta* Solsky

Inspection of the plantings carried out in the Khorezm area has shown that elms are the trees most prone to infestation by *Aeolesthes sarta* (Coleoptera: Cerambycidae). In the neighbouring population in the republic of Karakalpakstan 21.3% of elms are infested, in the Tashauz region of Turkmenistan 20.7 % and in the Khorezm region 30.7 % of elms are infested. Poplars, willows, and fruit trees such as apples, and pears are typically heavily attacked by it. As a consequence of attack by *Aeolesthes sarta* trees show signs of affliction and begin to dry out. Study of diameter and growth backlog of elm-trees populated by *Aeolesthes sarta* has shown that trees, from the moment of colonization on, immediately suffer decreasing growth rates and, depending on the quantity of larvae on a tree, dry out within 5-6 years. Fruit trees could dry out within 2-3 years. The analysis of tending growth of the pest-populated and pest-free trees has shown that the average gain of the populated trees is reduced by between 4.1 and 28.2 %, and the current gain by 64.3-83.9%. Usually the trees annual growth declines by more than 50 %. Their canopies take on a dry appearance and they begin to dry out. (Hudoberganov 1994).

8.2.2 *Scolytus orientalis* Egg

Following inspections of affected elm plantations it has been established that the proportion of infested trees in 1989 was over 11%, and in previous years (1962-1964) was only 2.9 % (Eremenko 1967). It has been observed, that colonization of trees by *S. orientalis* has increased. As is well known, *S. orientalis* is not only an agent of tree dessication, but they are also carriers of the dangerous dutch elm disease (*Graphium ulmi* Sch) (Ozolin 1984). Young trees dry out much faster. Increasing losses of tree growth have been observed in recent years. Decorative local species of elm dry out much faster than a pinnate-branchy elm that has been introduced in the last few years.

Observations have shown that a local species of elm, after settling by *S. orientalis*, die within two years, but introduced trees perish in 4-5 years. This testifies to the introduced species' greater resistance to the pests.

8.2.3 Elm leaf-eater (*Galerucella luteola* Mull)

G. luteola (Coleoptera: Chrysomelidae) is distributed in all areas of Uzbekistan, causing significant harm, and is especially predominant in settlements. The principal harmful stage are larvae which feed on the bottom side of a leaf, leaving only the upper epidermis. Trees subsequently lose leaves and take on a burnt appearance. Repeated settling of trees in the same year could become a reason for their settlement by *S. orientalis*. Bugs overwinter in bark cracks.

It has been established that harmfulness of elm leaf-eaters in the local cultivated elm species is less expressed than in introduced pinnate-branchy elms, owing to fast production of new leaves by introduced elms. On local species of elm new leaf growth proceeds more slowly. This causes asynchronous development with the second generation of leaf-eaters. The bugs of the second generation are forced to attempt to disperse onto other trees.

8.2.4 Elm aphid

Of the proboscis-feeding pests aphids and ticks have marked effects. The most widespread and harmful aphid is the elm aphid (*Tinocallis saltans* Nevs). Photosynthesis is disturbed in leaves, because the pest sucks juice out of leaves and causes their premature abscission. Aside from this aphids reallocate sugary substances over leaf surfaces, polluting them and the area under the tree canopy.

The aphid hatching period begins in the first decade of April, and peak births occur at the end of April and the beginning of May. The number of pests then begins to fall, and in the beginning of September it increases again.

8.2.5 Ticks and mites

Of mites, the most significant is the common red spider mite (*Tetranychus urticae*). Settlement occurs from the middle of June, reaching a maximum in July. Strong affliction of leaves causes their premature abscission.

8.3 Control of Elm pests

8.3.1 Control of *Aeolesthes sarta*

In 1988-1990 field and industrial tests of insecticides against larvae and adults of *Aeolesthes sarta* were carried out by Hudoberganov. It is necessary to treat adults two or more times, and thus the first treatment has also the significance that beetles that have come later deposit their eggs on the treated bark surface, where the eggs die. The second treatment also destroys bugs, simultaneously perniciously operating on larvae hatching from eggs at the end of the 2nd week or at the beginning of the third week of May.

Results of double treatment are displayed in Table 11.18 where it is shown that the most effective treatments appear to be in variant decis, cimbush, talstar and karate which cause reductions of between 92 and 96.7% in comparison with chlorophos (79.9%) and unitary treatment with dimilin (75%).

From the point of view of availability and ecological safety, both physical and physicomechanical pest control methods are of certain interest. Mechanical destruction of *A. sarta* with the help of lights at twilight, (at the beginning of imago outing) is recommended. The method should only be carried out in May.

8.3.2 Control of *S. orientalis*

M. Hudojbergenov (1994) tested a number of modern preparations in control of *S. orientalis*. Results are given in Table 11.19.

8.3.3 Control of *G. luteola*

The described research (Table 11.20) has shown that a low concentration of the following chemical and hormonal preparations is sufficient for protection of elms from each pest generation: decis, 2.5% c.e. at the concentration of working fluid 0.01% , danitol, 10% FLO 0.02%, sumi-alfa, 5% c.e. 0.005%, EIM, 12% c.e. 0.01%.

8.3.4 Control of the elm aphid *T. saltans*

Against aphids the following preparations are the most effective: karate 55 s.c. (0.05 %), talstar 10 % s.c. (0.1 %) mavric 2U 25 % s.c. (0.1 %).

8.3.5 Control of ticks and mites

The following preparations show the highest efficiencies: biotoxibacilline (0.3 %), neoron (0.05-0.1 %), mitak (0.1-0.2 %), sulfur m.p. (0.1 %), talstar (0.05 %).

8.4 Elm diseases

8.4.1 Dutch elm disease

The well known and dangerous dutch elm disease is caused by the agent *Graphium ulmi* Sch and frequently spread by *S. orientalis*.

8.5 Elm disease control measures

8.5.1 Control of dutch elm disease

The most effective way of controlling this disease is by reducing its spread using sanitation measures to decrease the population of *S. orientalis* vectors. See Table 11.19 for an assessment of chemical treatments.

9 SUMMARY

This paper reviews the most significant pests and diseases of the main agricultural crops in Uzbekistan and measures for their control. Priority has been placed on cotton since it is the most widespread crop in Uzbekistan, and pest control techniques are both relatively well known and widely used.

The most harmful organisms include the lepidopterans *Agrotis segetum* and *Spodoptera exigua* and the diseases *Erysiphe communis* (mildew) and *Verticillium dahliae* (wilt), among others. Nematodes are also particularly destructive to cotton crops. Control measures discussed range from chemical pesticide application to biological control and mechanical measures. The removal and destruction of diseased or infested plants or vegetative residues is particularly important, as this reduces innoculum or pest levels in following years. Additionally, new planting material should only be taken from disease and pest free stocks. Pest inspections should also be carried out to assess the degree of infestation, and natural enemies such as parasites should be encouraged. Although pesticide use in Uzbekistan has plummeted due to economic reasons (Vlek et al. 2001), future consideration must also be given to the improvement of targeting chemicals at specific pests. In particular, leaching of excess chemicals into the groundwater and irrigation channels must be reduced. These pesticides accumulate in groundwater and main water bodies such as the Amu Darya river, and this water is frequently used as drinking water by the inhabitants of downstream areas. It is important that the environmental effects of persistent and harmful chemicals such as DDT, which were in widespread use in the Soviet era, are considered when planning further chemical applications. Biological control may constitute a cost effective, environmentally friendly and self-regulating alternative to large-scale pesticide applications (Neuenschwander 2004). However, doubt remains as to the overall success rate of biological control and their possible effects on natural communities (Louda et al. 1997, Roderick and Navajas 2003), and as to the capacity of Central Asian bio-laboratories to breed control agents (Matthews 2001).

Uzbek farmers face a challenge in having to identify and deal with a complex of interacting pests and diseases with limited resources and low-tech solutions, and a considerable research need also still exists. Despite these conditions, and provided farmers have access to some of the chemicals and biocontrol measures detailed here and sufficient resources for their implementation, crop losses to pests are expected to decrease. However, while pests and diseases do have a significant impact on yields, other important factors such as landuse, soil, fertiliser application and irrigation must be considered to achieve lasting increases in productivity.

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Glossary

Biological control: the control of the numbers of one organism as a result of natural predation by other, typically human-introduced predators

Chemical preparations:
c.e.: concentrate of emulsion,
d.l.s.: dry loose suspension,
m.p.: moistened powder,
s.c.: suspended concentrate,
w.e.: water emulsion,
w.s.c.: water suspension concentrate;
p.s.: paste

Republic of Karakalpakstan: An autonomous region in north-western Uzbekistan
ZEF: Center for Development Research, Bonn

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11 APPENDIX

Table 11.1 Cotton pests in the Khorezm region and Karakalpakstan (from Khamraev and Bekbergenova (unpublished))

Order	**Suborder**	**Family**	**Genus and species**
Class Arachnidae Order Acariformes			*Tetranychus urticae* Koch
Class Insecta Order Orthoptera		Tettigonidae	*Tettigonia caudata* Charp *T. viridissima* L
			Docticus albifrons Fabr
			Platyellis affenus Fieb
			P. escaleria iranica Rme
			*P. intermedia intermedia (*Aud Serv*)*
		Oecanthidae	*Oecanthus teranicus* Uv
		Gryllidae	*Gryllus bimaculatus* De G
			Tartarogryllus burdigalensis Latr
		Gryllotalpidae	*Gryllotalpa gryllotalpa* (Lart)
			G. unspina Sauss
		Pyrgomorphidae	*Pyrgomorpha conica deserti* B.B.
		Acrididae	*Dericorys albidula* Aud
			D. annulata roseipennis Redt
			D. tibialis Pall
			Oxya fuscovittata Marsch
			Colliptamus barbarus cepholates F.
			C. italicus italicus L.
			C. turanicus Serg
			Trisoicefrinus pterostichus F.W.
			Hetracris adspersus Redt
			H. littoralis similis Br. W
			Anacridium aedyptium L.
			Acrida oxycephala Pall.
			Tryxalis exemia Eichwald
			Gonista sagitta Uv.
			Ramburiella turcomana F.W.
			Dociostaurus plotnikovi S.str.Uv.
			D. tartarus S. str. Stshelk
			D. maroccanus S. str.Thunb
			D. (s) kraussi nigrogeniculatus Serg Tarb
			Chorthippus angulatus S. str. Serg
			Eracromius tergestinus Charp
			Aiolopus thalassinus Fobr.
			Hilethera turannica Uv

Order	**Suborder**	**Family**	**Genus and species**
			Locusta migratoria mingratoria L.
			Pyrgodera armata F.W.
			Mioscirtus vagneri rogenhoferi Sauss
			Oedipoda caerulescns L.
			O. miniata miniata Pall
			O. miniata atripes B.B.
			Acrotylus insubricus inticitus Walk
			Sphingonatus satrapes Sauss
			Sphingoderus carinatus Sauss
Dermaptera		Labiduridae	*Forficula tomis Kol.*
Homoptera	Auchen-orrhyncha	Cicadidae	*Cicadatra querula* (Pall)
			Chloropaalta ochreata (Mel)
		Cicadellidae	*Asiandia asiantica* Kusn
			Empousca meridiana Zach
			Kybousca bipunctata osh
			Austroagallia zachvatkini Vild
	Aleyro-doidea		*Bemisia tabaci* Genn
			Trialeurodes vopararirum Westw
	Aphidinae	Pemphigidae	*Rectinasus buxtoni* Theob
			Smynthurodes betae Westw
		Gallaphididae	*Therioaphisi trifolii* Mon
		Aphididae	*Aphis craccivora* Koch
			A. gossypii Glov
			Acyrthosiphon gossypii Mordv.
			Myzodes persicae Sulz
			Brachyunguis plotnicovi Nevs
	Coccoidea	Pseudococcidae	*Pseudocaccus comstoci* Kuw
Hemiptera		Pentatomidae	*Dolycoris penicillatus* Horv
			Nezara viridula L.
		Rhopalidae	*Liorhyssus hyalipus* F.
		Lygaeidae	*Lygaeus eguestris* L
			Nisius graminicola Kol
		Tingidae	*Monosteira inermis* Harv
		Miridae	*Adelphocoris lineolatus* Goeze
			Lygus pratensis L.
			L. gemelatus H.S.
			L. rugulipennis Popp
			Poecilosytus cognatus Fieb
Thysanoptera		Thripidae	*Anaphothrips shirabudinensis* Jach
			Thrips tobaci Lind
			Th. flavus Schr

Order	**Suborder**	**Family**	**Genus and species**
			Th. francenioe Bagn
			Th. gossypii Tach.
Coleoptera		Scarabaeidae	*Lechrus bituberculifrons* Lebed
			L. scoparius F.W.
		subfamily Rutelinae	*Cyriopertha glabra* Gebl
		subfamily Melalanthinae	*Amphimallon solstitialis* L
			Madotrogus gladricollis Rtt
			Polyphylla adspersa Matsch
		Elateridae	*Acoloides grisescens* germ
			Agriates meticulosus Cand.
			Melanotus fusciceps Gyll
			Pleonomus tereticollis Men
		Tenebrionidae	*Dailognatha nasuta* Men
			Opatriodes punctulatus Brulle
			Penticus dilectans Fold
			P. rufescens Muls
			Zophosis scabriuscula Men
		Meloidae	*Mylabris beguttata* Gelb
			M. frolovi Germ
			M. schrenki Gebl
		subfamily Halticinae	*Haltica deserticola* Wse
			H. palustris Wse
			Podarica malvae Ill
		Curculionidae	*Clenus (Stehanophorus) stabrus* gyll
			Megamecus variegatus Gebl
			Phacephorus argyrostomus Gyll
Lepidoptera		subfamily Noctuidae	*Agrotis segetum* Den.et. Schiff.
			A. exclamationis L.
			A. insilon Hufn
			Euxoa agricola Bsd.
			Xestia c-nigrum L.
			Dychagyrris flammetra Den.et. Schiff.
			Discestra trifolii Hufn
			Leucanis zeae Diponchel
			Cucullia biornata F.d. W.
			Spodoptera exigua Hbn.
			Acontia luctuosa Den.et. Schiff
			Autoqrapha gamma L
			Trichoplusia ni Hb

Order	**Suborder**	**Family**	**Genus and species**
			Plusia festucae L.
			Grammades rogenhoferi Bohatsch.
			Aleucanitis flexuosa Men
			Helicoverpa armigera Hbn Den.et. Schiff
Hymenoptera		subfamily Formicinae	*Lasius alenus* Forst
		subfamily Megachilinae	*Megachila argentata* L.
			Megachila sp.
Diptera		Anthomyiidae	*Delia platura* Meigen

Table 11.2: Predators of cotton pests in Khorezm and Karakalpakstan (from Khamraev and Bekbergenova *unpubl.*). Note that pr indicates predators; p parasites and hp hyperparasites.

Group	**Suborder**	**Family**	**Sort and species**
Hemiptera		Miridae	*Campylomma verbasci* M.D.
			C. diversicornis Reut x
			Camptobrochis punctulatus Schill
		Antocoridae	*Orius niger* Wolff x
			O. olbidipennis Reut x
			Antrocoris pilosus Jach x
		Nabidae	*Nabis palifer* Seid pr
			N. sinoferus Hsiao pr
			N. ferus L. pr
			Halonabis sareptanus Dohrn pr
		Reduvidae	*Coranus aegyptius* F. pr
		Lygaeidae	*Geocoris arenarium* Jakh pr
			G. lapponicus Fall pr
Thysonoptera			*Aelothrips intermedius* Bagn pr
			Scolothrips acariphagus Jakh pr
Coleoptera		Scarabidae	*Colosoma auropunctatus* Hbst pr
			Cicidella littoralis F. pr
			C. decemimpustulata Men pr
			C. sublacorata Sols pr
			Clivina fossor L. pr
			Broscus punctatus Dej pr
			B. seaistriatus F.W. pr
			Megacephala euphratica armenica Cast pr
			Siagona curopao Dej. Pr
			Scarites terricola Bon. Pr
			Sc. Planys Bon. Pr
			Bembidion lampros Hbs. Pr
			B. varius Ol. Pr
			B. quadripustilatum Serv. pr
			B. quadrimaslatum L. pr
			Neobicus glasunovi Jonni pr
			Tachys angustulus Rtt pr
			T. bistriatus Duft pr
			T. quatristiatus Soh pr
			Chlaenius triscis Bchall pr
			Ch viridis Men pr
			Pterostichus sodalicus Heyd pr
			P. cupreceus L pr
			P. soriceus Pisch pr
			Calathus halonois Schell pr
			C. melanocephalus L. pr

Group	Suborder	Family	Sort and species
			Ophonus rufipes Dag. pr
			O. griseus Oz. pr
			Motabletus fuscomaculatus Motsch pr
			Microletes plaglatus Bust pr
			Aoupalpus elegans Doj pr
			Tahyura tetraspila Sals pr
			Brachianus hamatus F.W. pr
			Br. ojacula as F.W. pr
			Harpalus distinguandus Durf pr
			Hemianlax magio Mon pr
			Platutorus fomini Deg pr
			Anisodactylus signatus pr
		Coccinellidae	*Coccinella septempunctata* L. pr
			C. udecimpunctata L. pr
			Coccinula elegantula Ws. Pr
			Sterhorus punctillum Wse. Pr
			Coccinula quatuordesipunctulata L. pr
			Adonia variegata Gz. Pr
			Exochomus flavipen Thunb. pr
			Propylla gustuordecimpunctata L. pr
			Scymnus frontalis Fabr. pr
			S. subvillosus Gz. pr
			Synharmonia conglobata L. pr
		Staphylinidae	*Phylonthus concinnus* Graw pr
			Ph. palitus L. pr
			Ph. fuscipennis Menn pr
			Ph. splendens F. pr
			Oxyllus rugosus (F) Grav pr
			Paederus fuscipes Curt. pr
			Thachyporus hypnorum F. pr
			T. nitidulus F. pr
Neuoptera		Chrysopidae	*Chrysopa carnea* Steph pr
			Ch. septempunctata Wesm pr
			Ch. phyllochrama Wesm pr
			Ch. dubitans Mel pr
			Ch. prassina Burn pr
			Ch. albolineata Kill. pr
			Ch. nigricostata pr
Hymenoptera		Ichneumonidae	*Amblyteles guinguesinctus* Kriechp
			Barylypa (Amabilis) rusta Holmg p
			B. delector Thunb. p

Group	**Suborder**	**Family**	**Sort and species**
			Brachineumon sp. p
			Ctenichneumon panzeri Wesm p
			Diadegma tianshanica Kok p
			D. (Meloboris) velax Holmg p
			Enicaspilus tournieri Sn. U. p
			E. ramidulus L. p
			E. rassicus Kok. p
			Ichneumon sarticorius L. p
			Netelia fuscicornis Holmg p
			N. sampleacea Graw p
			Sinoforus xanthostomus Graw p
		Braconidae	*Ananteles tibialis* Curt p
			A. kazak Tel p
			A. talengai Tobias p
			A. ruficerus Hal p
			A. vanessae Reinh p
			Chelonus oculator Panz p
			Ch. annilipes Vesm p
			Mocrocentrus callaris Spin p
			Microgaster flavipalpis Brulle p
			M. spectabilis Hall p
			Rogas dimidiatus Spin p
			Ro. Rossicus Kok p
			Rogas dimidiatus L. p
			R. bicolor Spin. p
			Bracon hebetor Say p
		Aphididae	*Aphidus ervi* Hal p
			Praon objectum p
			P. dorsale Hal p
			P. exolectum Nees p
			P. volucre Hal p
			Lysiphlebus fabatum March. p
			Diaeretiella rapae M.Intosh p
			Trioxys asiaticus Tel p
		Eulophidae	*Euplectrus bicolor* Swed p
		Trichogrammatidae	*Trichogramma evanescens* Westw
			T. pintoi Woegole p
		Vespidae	*Vespa orientalis* L. pr
			Velistes sallicus L. pr
		Formicidae	*Formica subpilosa* Rurs pr
			Cataglyphus scenescens Havi gastra Koz pr
			C. setipes turcomanica Em. pr
			Camponotus turkestanicus May pr
			Tetramorium inerme E. pr

Group	**Suborder**	**Family**	**Sort and species**
		Pteromalidae	*Catallacus ater* Ratzenburg hp
			C. crassipes (Masi) hp
			Pteromalus sp. hp
		Aphidae	*Andrena carnabaria* L.
			A. aulica F.Mor.
			A. discaphoza F.Mor.
			A. funebrus Paund
		Sphecidae	*Padalania affinis*
			P. atrocyanea
			P. ebenina
			P. tygei
			P. hirsita
			Amonophila mucipsa Mer
			A. elongata Mer
			Astata rufipes Macs
			Atizus koenigi F.M.
			Oxybelus lamellatus Ol.
Diptera		Syrphidae	*Syrphus vitripennis* Mg. S. pr
			S. ribesii L pr
			S. corollae F. pr
			S. balteatus Deg pr
			Sphaerophoria scripta L. pr
			Sph. ruepelli Wd. pr
			Scaeva pyrastri L. pr
			Sc. albamaculata Moc. G. pr
			Paragus aegyptius Mg. pr
			P. tibialius Fall. pr
			P. bicolor F. pr
			P. pulcherimus Stal pr
			P. quadrifasciatus Mg. pr
			Metasyrphus corallae F. pr
			Iochiodon scutellaris F. pr
			Episyrphus balteatus Dg. pr
		Tachinidae	*Tachina tohdendorphi* Zim p
			Exorista larvarum L. p
			E. xanthaspis Hd. p
			E. civilis R.D. p
			Gonia bimaculata Rond p
			G. clipida Rond p
			G. capitata R.D. p
			Conis bimaculata Wied p
			Spallansania hebes FU. p
		Chamaeyiidae	*Leucopis caucasica* pr
			L. ninae Tanas pr
			L. glypiniora Tanas pr

Table 11.3 Nematodes found in cotton plants and root soil (from Tulaganov 1958)

N	Nematode species	Kuybishev district			Kegeylin district			Chimbay district			Shabbaz district			Turtkul district			On all areas			In total
		Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depthp 0-10m	Stalks and leaves	Root system	Soil depth 0-10	Stalks and leaves	Root system	Soil depth 0-10	
1	*Rhabditis filiformis* Osche						7												7	7
2	*Diplogaster longicauda* Claus											1						1		1
3	*Cephalobus nanus* de Man.			1												2			3	3
4	*Cephalobus persegnis* Allgen		21	10		3	29						1					24	40	64
5	*Eucephalobus elongatus* Thorne		1	1	2	4	16					1		3	2		5	8	17	30
6	*Eucephalobus filiformis* Schuuemans Stekhoven			1			1								2			2	2	4
7	*Acrobeloides bűtschlii* Steiner et Buhrer												6						6	6
8	*Acrobeloides tricornis* Thorne			2			1												3	3
9	*Chiloplacus lentus* Thorne		1															1		1
10	*Cervidellus insubricus* Thorne		1															1		1
11	*Acrobeles ciliatus* Linstow.						1						1						2	2
12	*Tylenchus davainei* Bastian						1												1	1
13	*Tylenchus filiformis* Andrassy						23												28	23
14	*Tylenchus leptosoma* de Man							1									1			1
15	*Ditylenchus dipsaci* Filipjev								1									1		1

N	Nematode species	Kuybishev district			Kegeylin district			Chimbay district			Shabbaz district			Turtkul district			On all areas			In total
		Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depth 0-10m	Stalks and leaves	Root system	Soil at depthp 0-10m	Stalks and leaves	Root system	Soil depth 0-10	Stalks and leaves	Root system	Soil depth 0-10	
16	*Ditylenchus intermedius* Filipjev.			3			10												13	13
17	*Rotylenchus (Helicotylenchus) multicinctus* Golden.						9												9	9
18	*Pratylenchus pratensis* Filipjev		1			9						5	1					15	1	16
19	*Aphelenchus avenae* Bastian			29	2	13	28			1						1	2	13	59	74
20	*Aphelenchus cylindricaudatus* Bastian													1			1			1
21	*Aphelenchoides parietinus* Bastian					5						1						6		6
22	*Aphelenchoides zeravschanicus* sp.nov.						3								4			4	3	7
23	*Dorylaimus* sp.									1									1	7
24	*Dorylaimus paraobtusicaudatus samarcandicus* Tulaganov			7															7	7
25	*Dorylaimus pratensis* de Man			2			9			1									12	12
	Total																9	76	209	294

Table 11.4 Arthropod and vertebrate wheat pests

Arthropod species-Arthropoda
Order Acariformes (ticks) - Acariformes

Aceria tritici Schevich	*Tyrophagus putrescentiae* Schrann
Acarus siro L.	*Chortoglyphus arcuatus* Troup

Order Orthoptera – (grasshoppers, crickets)

Phaneroptera falcata Poda	*Ramburiella turcomana* F.W.
Tettigonia viridissima L.	*Dociostauris (*s.str.*) maroccanus* Thunb
Decticus albifrons F.	*D. (*s.str.*) tarratus* Stshebk
Platycleis intermedia Serv	*Chorthippus albomarginatus karelini*
Gryllus bimaculatus Deg	*Epacromius tergestinus* Charp.
Melanogryllus desertus Pall.	*Locusta migratoria migratoria* L.
Tartorogryllus burdigalensis Latr.	*Oedaleus decorus* Germ
Gryllotalpa gryllotalpa L.	*Oedipoda caerulescens* L.
Gryllotalpa unspina Saus.	*Oedipoda miniata miniata* Pall.
Calliptamus italicus italicus L.	*Sphingoderus carinatus* Saus
C. turanicus Sorg Tarb.	

Order Homoptera
Suborder Cicadidae Auchenorrhyncha

Philaenus spumarius L	*Euscelis linlolatus* Brulle
Cicadella viridis L	*Psammotettix striatus* L.
Zyginidia sohrab Zachv. opacipennus Leth	*P. dubovskyi* Vilb.
Circulifer opacipennus Leth	*Diplocolenus abdominalus* Fall
Balclutha rosea Scott	*Muirodelphax aubei* Perr
B. rhenana Wgn.	*Dicrannotropis beckeri* Fieb
B. mitjajevi Glab	*Toya propinqua* Fieb
Macrosteles laevis Rib	*Javesella pellucida* F.
Microsteles quadripunotulatus Kbm	*Pentastiridius leporinus* L.
M. fieberi Edw	*P. pallens* Germ.
M. forficulus Rib	*Reptalus rufocarinatus* Cusn
Stenometopiellus sigillatus Hpt	*Hyalesthes obsoletus* Sign.
Cucadula divaricata Rib	*Scorlupaster asiaticus* Leth

Suborder Aphidinea (aphids)

Forda marginata Koch	*Rungsia kardjumovi* Mordv
F. trivialis Pass	*Rhopalosiphum maidis* Fitch
Geoica lucifuga Zennth	*R. padi* L
Paracletus cimiciformis Heyd	*Schizaphis grammina* Rond
Tetraneura ulmi L.	*Brachycolus noxius*
Anoecia corni F.	*Macrosiphum avenae* F.

Order Hemiptera (bugs)

Eurydaster integriceps Put	*Camptobrochis punctulatus* Schill
Odontoscelis purpureolineatus Rossi	*Lygus pratensis* L.
Aelia furcula Fieb	*Stenodema turanicum* Reut.
Plomana prasina L.	*Trigonotylus ruficornis* Geoftr.

Order Thysanoptera (thrips)

Anaphothrips rutus Gmel	*F. tenuicornis* Uz.
Frankliniella intonsa yb.	*Thrips tabaci* Lind.

Suborder Tubulitera

Haplothrips aculeatus F.	*H. tritici* Kurd

Order Coleoptera (beetles)

Bembidion quadrimaculatum L.	*Stegobium paniceum* L.
Amara similata Gyll	*Rhizopertha dominica* F.
A. aenea Deg.	*Helophorus micans* Fald
A. bitrons Gyll.	*Clon cerambycinus* Sem.
A. Ingenua Duft.	*Ozyzaephilus surinamensis* L.
A. consularis Duft.	*Opatrum sabulosum* L.
A. apicaria Payk.	*Blaps halophila* Fisch.
A. auliea Panz.	*Tenebrio molitor* L.
Zabrus tenebrioides Goeze	*Tribolium confusum* Duv
Z. spinnipes Fabr	*T. castaneum* Hrbst.
Ophonus azureus Fabr	*T. destructor* Uyyt.
O. rufipes Deg.	*Meloë variegatus* Donov
O. griseus Panz.	*Meloë xanthomelas* Sols.
O. calceatus Duft.	*Lema melanopus* L.
Harpalus distinguendus Duft.	*Labidostomis metallica centrisculpta*
Amphimallon solstitialis L.	*Chaetocnema aridula* Gyll.
Dolichosoma lineare Rossi.	*Ch. hortensis* Geott
Tenebrioides mauritanicus L.	*Phyllotreta vittula* Redtenb.
Ptinus tur L.	*Sitophilus granarius* L.
P. raptor Strum.	*S. oryzae* L.

Order Lepidoptera (butterflies)

Nemapogon gramellus L.	*Euxoa temera* Hb.
Sitotroga cerealella Oli v.	*Agrotis segetum* Den.et Schiff.
Pyralis farinalis L.	*A. exclamationis* L.
Euxoa agricola B.	*Apamea sordens* Hfn.
Euxoa tritici L.	

Order Hymenoptera

Cephus pygmaeus L.	

Order Diptera (flies)

Mayetiola destructor Say.	*Oscinella frit* L.
Stenodiplasis panici (Rond) Plotn	*Meromyza nigriventris* Mg.
Oscinella fustucae Mesnil	

Phylum Chordata
Class Aves (birds)

Passer domestricus L	*Passer montanus* L.

Class Mammalia (Mammals)
Order Rodentia (rodents)

Citellus fulvus oxianus Thoms	*Mus musculus sevestzivi* Kaschl.
Allactaga ebater Licht.	*Cricetulus migratorius* Pall.
Rattus turkestanicus Satun.	*Pallasiomys erythrourus* subsp. *eversmanni* Bogd.

Table 11.5 Common rice pests in Uzbekistan (by Sbortchikova 1970)

Systematic position	**Number of individuals in 16 samples (1m^2)**			**Plant damaging proportion (%)**
	Shoots	**Tillering**	**Maturing**	
Order Orthoptera				
Phagonur viridisema L.	0	0	4.6	0.8
Calliptamus italicus italicus	0	0	2.0	0.6
Oxya fuscvitata Marsh	0	0	3.3	21.2
Locusta migratoria migratoria L.	0	0	1.6	0.5
Gryllotalpa gryllotalpa L	0	0	0.2	0.3
Gryllotalpa unispina	0	0	sole	0.3
Order Trichoptera				
Limnophilus stigma Gurt	57	15	0	70
Order Coleoptera				
Hydronomus sinuaticollis Ft	130	566	570	61.2
Lema suvorovi Jacobs	0	single	Single	Single
Order Diptera				
Eyhydra macellaria Egs	182	69	30	61.3
Hydrellia griseola Fall	6	single	0	un
Chironomus sp.	0	286	0.4	30.0
Tipula sp.	0	single	0	un
Order Thysonoptera				
Haplothrips aculatus Fabr	0	0	144	40.5
Order Homoptera				
Delphax striatella Fall	0	0	1.4	6
Psammatetix striatus L.	0	0	2.1	29.4
Cicadella viridis L.	0	0	2.1	29.4
Macrosteles sexnotatus F.	0	0	2.0	2.8
Schizophis gramina Rond	0	0	single	single
Sipha mididis Pass	0	0	single	single
Brachicolis noxus Mordv	0	0	un	single
Order Hemiptera				
Eurygaster integriceps Put	0	0	2.0	2.8
Aelia melonata Fieb	0	0	1.3	3.6
Dolicoris penicillatus Horv	0	0	1.2	1.4
Order Lepidoptera				
Pyrausta nubilalis Hb.	0	single	0	single
Nymfula mympheata	0	single	0	single
Phytometra festuca L.	0	single	0	single
Laphygma exiqua Hb.	0	single	0	single
Agrotis segetum Schiff.	0	single	0	un
Class Crustaceae, Order Phillopoda				
Triops cancriformis Schaff	26.9	1.2	0	87.1
Lepsampleheria danalacenses Bsois	589.1	0	0	80

Table 11.6 Families of phytobiontic insects inhabiting rice paddies (by Shamuratov 1993) Note that: + means rare (less than 25 % of all samples), ++ means frequent (25-50 of all samples), and +++ means numerous (more than 50 % of all samples).

Taxon	**Abundance**	**Feeding method**
DIPTERA Epfydridae	+++	Phytophage
Dolichopodidae	++	Saprophage
Otitidae	++	Saprophage
Tophritidae	+	Phytophage
Muscidae	++	Saprophage
Syrphidae	+	Saprophage
Microposidae	+	Saprophage
Agromysidae	++	Phytophage
Chloropidae	+	Phytophage
Stratimyidae	+++	Saprophage
Asilidae	+	Zoophage
Ulidiidae	++	Saprophage
Phortidae	+	Saprophage
Chronoaidae	+++	Saprophage
Culicidae	++	Saprophage
Tipulidae	+	Saprophage
ORTHOPTERA *Oceantus turanicus* Uv	+	Phytophage
Locusta migratoria L	+	Phytophage
COLEOPTERA Curculionidae *Hydronomus sinuaticollis* Fst	++	Phytophage
Chrysomelidae - *Chaetocnema conducts* Motsch	+++	Phytophage
Chaetocnema hortensis Geoffr	++	Phytophage
Phyllotreta vitulla Redt	+	Phytophage
Pachnephrus Duft	+	Phytophage
Lathridiidae *Corticaria* sp.	+	Mycetophage
Coccinellidae *Coccinella undecimpunctata* L.	+	Zoophage
Anthicidae *Anthicus* sp.	++	Zoophage
Elateridae *Staphylinidae* sp.	+++	Zoophage
Elateridae *Agriotes maticulosus* Cand	+	Phytophage
ARANSI *Larinis* sp.	+	Zoophage
Tetranatha sp.	+++	Zoophage
THYSANOPTERA *Haplothrips aculeatus* Farb	+++	Phytophage
LEPIDOPTERA *Eusarcoris incospicuus* H-S	++	Phytophage
Trygonotylus ruficornis Geoffr	++	Phytophage
Antheminis varicornis Jak	+	Phytophage
Eurydema maracandica Csh	+	Phytophage
Adelphocoris sp.	+	Phytophage
HYMENOPTERA *Pteromalidae*	++	Parasitoid
Trichogrammatidae	+	Parasitoid
Ichneumonidae	+	Parasitoid
Braconidae	+	Parasitoid

Halcicidae	+	Pollinator
HOMOPTERA Aphididae	+	Phytophage
Delphacidae	++	Phytophage
Cicidoellida	+	Phytophage
ODONATA *Sympetrum* sp	+++	Zoophage
Cocnagrion	++	Zoophage

Table 11.7 The hydrobiont species that inhabit rice paddies (1983-1985) (from Shamuratov 1993). Note that: + means rare (present in less than 25 % of all samples), ++ means frequent (in 25-50 % of all samples), and +++ means numerous (more than 50 % of all samples).

Orders, families, species	**Abundance**	**Prevalent form**
CRUSTACEAE	+	Detriophage
Triops (=Apus) cancriformis	+++	Detriophage
Lepsampleheria dahalacensis	+++	Detriophage
HEMIPTERA *Corixa* sp.	+++	Zoophage
Sigara sp.	++	Zoophage
Gerris sp.	+	Zoophage
COLEOPTERA *Berosus spinosus* Steph.	+++	Zoophage
Hydrophilus flavires Trev	++	Zoophage
Enochrus sp.	++	Zoophage
Helophorus sp.	+	Zoophage
Eretes sticticus	++	Zoophage
Hydaticus grammicus	++	Zoophage
Rhantus pulverosus Sterh	++	Zoophage
Cybister lateralimarginalis Deg	+	Zoophage
Coelambus flaviventris Mots.	++	Zoophage
Coelambus parallelogramus	++	Zoophage
Coelambus impressopunctatus Schal	+	Zoophage
Bidessus geminus F.	+++	Zoophage
Bisessus hamilafus Gyll	++	Zoophage

Table 11.8 Geobiont inhabitants of rice paddies (by Shamuratov 1993). Note that: + means rare (found in less than 25 % of all samples), ++ means frequent (25-50 % of all samples), and +++ means numerous (more than 50 % of all samples).

Latin name	**Abundance**	**Life form**
Cicindela obliguenfasciata	+++	Flying epigeobiont
C. nox	+	Flying epigeobiont
C. nemoralis Oliv	++	Flying epigeobiont
C. sturmi Men	+++	Flying epigeobiont
C. sublacerata Sols.	+++	Flying epigeobiont
C. contorta Fd.	++	Flying epigeobiont
C. deserticola Fald	+++	Flying epigeobiont
C. litterifera Chand.	+	Flying epigeobiont
C. orientalis Dej	+	Flying epigeobiont
Megacephala euphratica	++	Flying epigeobiont
Calosoma auropunctatum, Hbst.	+	Walking epigeobiont
Scarites terricola Bon	+++	Digging geobiont
S. angustus Chand	+++	Digging geobiont
S. salinum Dej	++	Digging geobiont
Clivina ypailon Dej	+++	Digging geobiont
Dyaschirius siciler Zin	++	Digging geobiont
D. rufimanus Fieach.	++	Digging geobiont
D. politus	++	Digging geobiont
D. mtisus Dej	++	Digging geobiont
Dyaschirius pusillus Dej	+++	Digging geobiont
D. rufimanus Fieach.	+	Digging geobiont
D. scripfrons Fleisch.	+++	Digging geobiont
D. cyllndricus Dej	+++	Digging geobiont
D. chalubens turanicus En.	+++	Digging geobiont
D. syriacus Puts	++	Digging geobiont
D. rufipes Dej	+	Digging geobiont
Apotomus sampleaceus Eej.	+	Digging geobiont
Siagona europaea Dej	+	Surface-cover strabiont
Broscus astaticeus Ball	+++	Digging geobiont
B. nemistriatus F.S.	+	Hovering geobiont
B. varium Ob.	+++	Surface cover strabiont
B. laevibase Reitt	+	Surface cover strabiont
B. fumigatum	++	Surface cover strabiont
B. quadripustulatum Serv.	++	Surface litteral strabiont
B. ustum Quens.	+++	Surface litteral strabiont
Tachys centriustatus Rtt.	++	Endogeobiont
T. lenkoranus Csibi	++	Endogeobiont
T. micros Fisch.	++	Endogeobiont
T. vittatus Motsch.	+	Endogeobiont
Pogonus luridipennis Germ.	+++	Surface substrate strabiont
P. iridipennis ic.	++	Surface substrate strabiont

P. orientalis Dej.	+++	Surface substrate strabiont
Chlaenius inderiensis Motsch	+++	Surface substrate strabiont
Chl. spoliatus rosai.	+	Surface substrate strabiont
Chl. alutaceus Gebl	+	Surface substrate strabiont
Chl. steveni Quons	++	Surface substrate strabiont
Poecilas subcoeruleus Quons	+++	Surface substrate trabiont
Pterostichum lisooderus Chd.	++	Surface substrate strabiont
Pt. jaxartis Tschit	+	Surface substrate strabiont
Daptus viiatus F.W.	+++	Surface substrate strabiont
Pseudophonus rufipes Deg	+	Strabiont-slitter
Harpalus pevtzovi Tschit	+	Strabiont-slitter
Stenolophus proximus Dej	+	Strabiont-slitter
Hemiaulax morio Men	+++	Strabiont-slitter
Acupalpus elegene Dej	+	Strabiont-slitter
Anthracus bivittatus Reitt	++	Strabiont-slitter
Trichocellus sp.	++	Strabiont-slitter
Dichirotrichus ustulatus Dej	++	Strabiont-slitter
Anisosactylus pseudoaeneus Dej.	++	Strabiont-slitter
Mnuphorus sellatus Geble	+	Undercracking strabiont
Drominus nigriventris Floms	+	Undercracking strabiont
Microlestes plagiatus Duft	++	Undercracking strabiont
Cymindes equestria Gebl	+	Undercracking strabiont
Polystichum connazus Fonrer	++	Undercracking strabiont
Suphfum oleus Rossi	+	Undercracking strabiont
Parazuphlum chevrolati lap	+	
Brachinus brevicollis Motsch	+	Undercracking strabiont
Mastax thermarus Stev	+	Undercracking strabiont

Table 11.9 Damage to rice caused by weevil *Hydronomus sinuaticollis* Fst. (from Sbortchikova 1970)

Intensity of infestation by pupa of bodied	Density of standing plants m^{-2}	Grain failure %	Weight of 1000 grains (g)	Crop 100 kg/ha	Losses	
					Metric centner /ha	% of the control
Not infested	390	12.0	31.7	74.8	0	0
Weakly infested (40-50 pupae / m^2)	384	15.7	30.0	72.1	2.7	3.7
Strongly infested (180-250 pupae / m^2)	332	20.6	27.3	56.8	14.9	20.0

Table 11.10 Damage caused by shore flies (from Sborschikova 1970)

Degree of contamination of crops	No. of harvested plants m^{-2}	No. of branches with ears	Grain failure (%)	Weight 1000 grains (g)	Crop 100 kg/ha	Losses	
						Metric centner /ha	% of control
Not infected	273	1.2	9.9	30.8	71.9	-	-
Infected (40-50 individuals / sq. m)	355	1.2	11.6	30.3	69.6	2.3	0.31
Strongly infected (180-250 pupae/ sq. m)	31.6	1.1	15.3	29.0	61.4	10.5	10.3

Table 11.11 Taxonomic structure of sugar beet pests

Order Orthoptera

Gryllus campestris L.	*Acrida oxycephala* Pall
Gryllotalpa unspina Sauss	*Locusta migratoria migratoria* L
Calliptamus turanicus Sorg Tarb	*Oedallus decorus* Germ
Calliptamus italicus italicus L	

Order Dermaptera

Forticula tomis Kob	

Order Homoptera

Auchenorrhynha	*Aphis fobae* Scop
Cicadella viridis L	*Pemphigus fuscornis* Koch
Aphidinea	*Myzodes persicae* Sulz

Order Hemiptera

Eurdema oleracea L	*Poeciloscytus cognatus* Fieb
Palamena angulosa Matsch	*Orthotylus flovosoarsus* C.Sahlb
Lugaeus equestris L	*Adelphocoris lineolatus* Goeze

Order Coleoptera

Atomaria linearis Steph	*Cleonus confluens* Fähr
Blaps halophila Fisch	*Cleonus fasciatus* Műll
Meloe variegatus Donov	*Cleonus solicitus* Gyll
Longitarsus asperifoliarum F	*Cleonus menetriesi* Gyll
Cleonus (B) punctiventris Germ	*Cleonus leucophaeus* Men
Cleonus pictus Pall	*Cleonus subfuscus* var *innocuus* Fst
Cleonus conirostris Gebr	*Cleonus verrucosus* Gebl
Cleonus lacerta Cherv	*Cleonus elongates* Gebl
Cleonus limis Men	*Lixus sinuatus* motsch

Cleonus granosus Zoubk	*Chaetocnema breviuscula* Fald
Cleonus anxius Gyll	*Epicauta erythrocephala* Pall
Cleonus sygnaticollis Gyll	*Tropinota hirta* Poda
Cleonus desertorum Fst	*Amphimallon solstitialis* L
Cleonus foveicollis Gebl	*Melolontha aflicta* Ball
Cleonus declivis Ol	

Order Lepidoptera

Laxos tegenudalis Hb	*Scotia crassa* Hb
Euxoa cursoria Hfn	*Discestra trifolii* Hfn
Agrotis segetum Den.et Schiff.	*Mamestra brassicae* L
A. exlamationis L	*Mythimna vitellina* Hb.
A. ipsilon Hfn	*Spodoptera exigua* Hbn
A. carticea Schiff	*Autographa gamma* L.

Order Diptera

Pegemyia hyociami Panz	

Class Arachnoidea

Tetranychus urticae Koch	

Class Mammalia

Ellobius talpinus Pall	

Table 11.12 Nematodes discovered in beet plants and root soil in Karakalpakstan (by Tulaganov 1958)

N	Name of nematode species	Turtkul district			In total
		Stalks, leaves	Roots	Soil of 0-10 cm	
1	*Diplogaster longicauda* Claus,1863	-	57	-	57
2	*Cephalobus cornis* Thorn,1937	-	-	2	2
3	*Eucephalobus elongatus* Thorne,1937	38	8	24	75
4	*Eucephalobus filiformis* Andrassy, 1954	2	-	-	2
5	*Ditylenchus intermedius* Filipjev,1934	-	-	3	3
6	*Helicotylenchus multicinctus* Golden, 1956	-	-	2	2
7	*Aphelenchus avenae* Bastian,1865	-	2	32	34
8	*Trilobus* sp.	-	-	2	2
9	*Dorylaimus monhystera* de Man,1880	-	-	5	5
	Total	40	67	70	177

Table 11.13 Potato pests

Aculus lycopesici Massec
Phizoglyphus echinopus R.et F
Family Poduridae (Class Collembola)
Onychiurus armatus Tullb
Order Orthoptera
Gryllotalpa gryllotalpa L
Gryllotalpa unspina Saus
Locusta migratoria migratoria L
Oedipoda caerulescens L
Order Homoptera
Suborder - Auchenorrhyncha
Hyalesthes obsolethus Sign
Austroagallia zachvatkini Vilib
Philaenus spumarius L.
Empoasca meridiana Zachv
Macrosteles laevis Rib
M. quadripunctulatus Kbm
Psammotettix atriatus L
Toya propinqua Fieb
Dictyophara europaea L
Reptalus rufocarinatus Kusn
Brachyprosopa bicornis Kusn
Suborder Aleyriodoidae
Trialeurodes vaporariocum Westw
Bemisia tabaci Genn
Suborder Aphidinea
Aphis frangulae Kalt
Aphis nasturtii Kalt
Aulacorthum solani Kalt
Myzodes persicae Sulz
Neomyzus ciricumflexus Buckt
Order Hemiptera
Orthotylus eleagni Jak
Poeciloscytus cognatus Fieb
Order Thysonoptera
Frankiniella intonsa Tryk
Frankliniella palleda Uz
Thrips tobaci Lind
Harlothrips subtilissimus Hal
Order Coleoptera
Aclypaea undata Műll
Amphimallon solstitialis L
Subcoccinella vigintiquatuorpunctata L
Meloe xanthomelas Sols
Epithrix pubescens Koch

Order Lepidoptera
Euxoa temera L.
Agrotis segetum Den.et. Schiff
A. exlamationis L.
Dichagyrris flammafra Den.et. Schiff
Discestra trifolii Hfn
Mamestra brassicae L
Spodoptera exigua Hbn
Trichaplusia ni Hb
Autographa gamma L
Order Diptera
Bibio hortulanus L:
B. marci L.
Phytomyza atriiornus Mg

Table 11.14 Quantity of processed samples from potato plants and the soil around their roots where nematodes were present (from Tulaganov 1958). Values indicate the number of sampling sites.

District researched	**Sampling Area**									
	Stalks and leaves			Root			11.1.1.0.1.1.1 Soil			No. of samples
	Total	Nematodes		Total	Nematodes		Total	Nematodes		
		Present	Not present		Present	Not present		Present	Not present	
Kuybisheb	5	5	-	5	5	-	5	5	-	15
Kegeylin	5	5	-	5	5	-	5	5	-	15
Chimbay	5	2	3	5	4	1	5	5	-	15
Shabbaz	5	3	2	5	4	1	5	5	-	15
Turtkul	5	2	3	5	5	-	5	5	-	15
Total sampling sites	25	17	8	25	3	2	25	25	0	75

Table 11.15 Nematodes discovered in potato plants and periroot soil (from Tulaganov 1958)

	Name of nematode species	Kuybishev district			Kegeylin district			Chimbay district			Shabbaz district			Turtkul district			All areas combined			Total
		Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	
1	*Rhabditus brevispina* Osche, 1952	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1
2	*Rhabditis filiformis* Osche, 1952	-	-	-	17	10	-	-	-	-	-	-	-	-	121	-	17	131	-	148
3	*Rhabditus intermedius* Osche, 1952	-	7	26	-	15	-	-	-	-	-	-	-	-	-	-	-	22	26	48
4	*Rhabditus monhystera* Butschli, 1873	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1
5	*Diploscapter rhizophilus* Rham	10	98	-	13	21	22	-	6	-	3	1	-	-	-	-	26	126	22	174
6	*Diplogaster longicauda* Claus,1863	-	-	5	-	-	-	-	-	-	-	-	-	-	4936	-	-	4936	5	4941
7	*Cephalobus cornis* Thorne,1937	-	-	14	-	6	-	-	-	-	-	-	-	1	40	3	1	46	17	64
8	*Cephalobus nanus* de Man,1880	1	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	8	-	8
9	*Cephalobus persegnis* Allgen,1953	-	8	38	3	71	39	1	6	17	-	4	8	-	-	-	4	89	102	195
10	*Eucephalobus elongates* Thorne,1937	-	16	74	10	119	51	3	1	12	2	53	6	-	156	309	15	345	452	812
11	*Eucephalobus filiformis* Schuuemans Stekhoven,1951	-	-	6	8	-	-	-	-	-	-	-	-	-	1	-	8	1	6	15
12	*Eucephalobus oxyuroide* Steiner, 1936	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	9	9
13	*Eucephalobus striatus* Thorne,1937	-	-	-	-	8	-	-	-	-	-	-	4	-	480	-	-	488	4	492
14	*Acrobeloides bűtschlii* Steiner et Buhrer,1933	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
15	*Acrobeloides emarginatus* Scheider, 1939	-	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1	3	4
16	*Chiloplacus lentus* Thorne, 1937	-	-	1	1	9	1	-	-	-	-	-	-	-	-	-	1	9	2	12
17	*Cervidellus insubricus* Thorne, 1937	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1
18	*Acrobeles ciliatus* Linstow,1877	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	12	-	12
19	*Acrobeles* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	3
20	*Tylenchus agricola* Meyl,1961	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1
21	*Tylenchus davainei* Bastian,1865	-	-	18	-	9	13	-	1	1	-	-	-	-	-	-	-	10	32	42
22	*Tylenchus filiformis* Andrassy, 1954	-	-	-	-	2	7	-	-	12	-	-	-	-	-	-	-	2	19	1

	Name of nematode species	Kuybishev district			Kegeylin district			Chimbay district			Shabbaz district			Turtkul district			All areas combined			Total
		Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	Stalks and leaves	Root system	Soil Depth 0-10	
23	*Tylenchus leptosoma* de Man,1880	-	-	2	-	6	-	-	-	-	-	-	-	-	-	-	-	6	2	8
24	*Tylenchorynchus dudius* Cobb,1913	-	-	-	-	20	1	-	2	12	-	-	-	-	-	-	-	22	12	34
25	*Ditylenchus dipsaci* Filipjev,1936	-	10	17	-	10	28	-	621	5	-	-	-	-	6	6	-	647	46	693
26	*Ditylenchus intermedius* Filipjev,1934	-	1	11	-	8	12	-	-	-	-	-	-	-	-	-	-	9	23	32
27	*Helicotylenchus multicinctus* Golden 1956	-	-	-	-	17	15	-	-	-	-	-	-	-	-	-	-	17	15	32
28	*Potylenchus* sp.	-	-	-	5	31	10	-	-	-	-	-	-	-	-	-	5	31	10	46
29	*Meloidogyne* sp.	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
30	*Paratyinchus* sp.	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	9	-	9
31	*Criconema* sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1
32	*Aphelenchus avenae* Bastian,1865	2	18	82	18	36	73	1	11	5	2	1	4	-	280	202	23	346	366	735
33	*Aphelenchus kuhni* Fisher,1894	-	-	1	-	-	-	-	-	-	-	-	-	-	-	6	-	-	6	6
34	*Aphelenchoides parietinus* Bastian,1865	2	35	09	20	22	-	-	7	-	2	1	-	-	111	-	24	176	109	309
35	*Aphelenchoides zeravschanicus* n.sp.	-	-	-	5	-	-	-	3	2	-	-	-	-	-	-	5	3	2	10
36	*Dorylaimus brachyuris* de Man,1880	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-	3
37	*Dorylaimus labiatus* de Man,1880	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	9	-	9
38	*Dorylaimus monohystera* de Man,1880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	32
39	*Dorylaimus pratensis* de Man,1880	-	-	20	-	-	11	-	-	-	-	-	-	-	-	-	-	-	31	41
40	*Dorylaimus obtusicaudatus* Meyl,1954	-	-	32	-	1	15	-	-	1	-	-	-	-	-	-	-	1	48	9
41	*Dorylaimus samarcandicus* Tulaganov,1949	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1
42	*Dorylaimus skrjabini* Tulaganov,1949	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1
43	*Dorylaimus* sp.	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	1	-	2	3
	Total	15															133	7515	1381	9029

Table 11.16 List of poplar pests

1	*Monosteria inermis* Horw.
2	*Chaitophorus* Mordw.
3	*Pterocomma populea* Kalt.
4	*Pemphigus filaginis* Fonsc.
5	*Pemphigus bursarius* Licht.
6	*Pemphigus lactucarius* Pass.
7	*Pemphigus protospirae* Licht.
8	*Drosicha turkestanica* Arch.
9	*Lecanium rugulosum* Arch.
10	*Lecanium corni* Bouche
11	*Leucaspis kermanensis* Ldgr.
12	*Lepidosaphes ulmi* L. Fern.
13	*Aspidiotus transcaspiensis* Marlott.
14	*Aspidiotus slavonica* Green.
15	*Capnodis miliaris metallica* Ball.
16	*Buprestis picta* Pall.
17	*Anthaxia farimgera* Kr.
18	*Agrilus viridis* L.
19	*Aeolesthes sarta* Solsky
20	*Xylotrechus namanganensis* Heid var. *bucharensis* Sem.
21	*Anaglyptus bicalosus* Kr.
22	*Anaesthetis* sp.
23	*Melasoma populi* L.
24	*Agelastica orientalis* Baly
25	*Phyllocnistis xenia* Hering.
26	*Lithocolletis populifoliella* Tr.
27	*Comeraria obliguefascia* L.
28	*Paranthrena kungessana* Alph.
29	*Stegonopticha neglecta* Dup.
30	*Porthetria dispar* L.
31	Poplar hairy insect (unidentified species)
32	Poplar miner fly (unidentified species)
33	Poplar miner sawfly (unidentified species)
34	Poplar head tick (unidentified species)
35	*Eotetranychus turkestani* Ugar.et Nik.

Table 11.17 Arthropods living in elm in the Khorezm area (from Hudoberganov 1994)

N	Arthropod species	% that settle trees	Significance of arthropods
1.	*Aeolesthes sarta* Solsky	30.3	Very high
2.	*Scolytus orientalis* Egg	11.2	Very high
3.	*Galarucella luteola* Mull Elm leaf-eater	80.2	Moderately high
4.	*Cratomerus intermedias* Obend	0.5	Moderate
5.	*Monosteira discoidalis* Jak Poplar bug	0.5	Moderate
6.	*Parlatorea oleal* Col	0.1	Moderate
7.	*Quadraspidiotus perniciosus* Comct.	0.1	Moderate
8.	*Tetranychus urticae* Koch Red spider mite	71.1	High
9.	*Eriophyes ulmicola brevipunctatus*	0.1	Moderate
10.	*Tinocallis saltans* Nevs Elm aphid	88.2	High
11.	*Eriosoma lanuginosum* Hart. Gall aphid	0.5	Moderate
12.	*Abraxas sylvata* Scop	0.1	Low
13.	*Psylla ulmi* Frst	0.1	Low
14.	*Chrysopa carnea* Steph	50.1	Entomophagous
15.	*Coccinella septempunctata* L.	42.1	Entomophagous
16.	*Stetoris punctillum* Ws.	20.1	Entomophagous
17.	*Scolothrips acariformes*	14.2	Entomophagous
18.	*Deraeocoris pilipes*	10.1	Entomophagous
19.	*Sphaerophoria acripta* L.	26.1	Entomophagous
20.	*Formica subpilosa* Ruzs.	30.1	Entomophagous

Table 11.18 Biological efficiency of insecticides in controlling *Aeolesthes sarta* in elm after two treatments with a tractor OVT-1 (1000 l/ha) (by Hudoberganov 1994) Legend: m.p.: moistened powder, s.c.: suspended concentrate.

N	Preparations	Concentration of preparation (%)	Total of treated trees	Number of trees analyzed	Number of individuals larvae	Decrease in number of pests (%)
1	Cimbush 25 % s.c.	0.1	182	5	12	92.0
2	Decis 2,5 % s.c.	0.05	192	5	10	98.3
3	Mavrik 2E 25 % s.c.	0.15	179	5	17	88.6
4	Sumi-alpha 5 % s.c.	0.1	189	5	18	88.0
5	Talstar 10 % s.c.	0.1	199	5	9	94.0
6	Karate 5 % s.c.	0.05	200	5	8	96.7
7	Chlorophos, 80 % technical. (Standard)	0.2	214	5	30	79.8
8	Dimilin 25 % m.p. (unitary treatment)	0.03	109	5	38	75.0
9	Control (no treatment)	-	-	5	149	-

Table 11.19 Biological efficiency of insecticides in control of *Scolytus orientalis* on elm trees (by Hudoberganov 1994). Legend: s.c.: suspended concentrate

Preparation	Concentration of solution %	Number of treated trees.	Average number of larvae /dm^2, individual		P	Efficiency, %
			Before treatment	After treatment		
Decis. 2.5 % s.c.	0.07	114	1.0	0	-	100
Cimbush, 25 % s.c.	0.05	118	1.0±0.058	0.05±0.003	0.001	96.3
Karate, 5 % s.c.	0.05	106	1.2	0	-	100
Talstar, 10 % s.c.	0.06	92	0.6	0	-	100
Carbophos, 30 % s.c. (Standard)	0.15	79	0.8±0.064	0.05±0.005	0,001	96.3
Control (no treatment)	-	-	1.2±0.098	1.6±0.125	0.001	-

Table 11.20 Biological efficiency of preparations for control of the elm leaf-eater *Galerucella luteola*. Legend: s.c.: suspended concentrate

N	Preparation	Preparation concentration, %	Average quantity of larvae (per branch)				Efficiency, % per day		
			Pre-treatment	After treatment (in days):					
				3	7	14	3	7	14
1	Eym 12%s.c.	0.02	23.0	0.2	0	0.2	98.4	100	98.7
2	Karate 5 % s.c.	0.005	39.7	0.7	0	0.2	97.7	100	99.9
3.	Talstar 10 %	0.005	27.7	0.2	0	0.2	98.7	100	99.2
4.	Trebon 30 % s.c.	0.01	30.2	0.2	0	0.2	99.0	100	98.2
5.	Trebon 10 % FLO	0.03	42.7	0.7	0.2	0.7	97.6	99.0	98.2
6.	Mavric 2U 25 % s.c.	0.005	57.2	1.2	0	0.7	96.9	100	99.4
7.	Sumi-alpha 5 % s.c.	0.005	47.7	0	0	1.2	100	100	97.2
8.	Danitol. 10 % FLO	0.05	39.2	0.2	0	0.2	99.3	100	99.2
9.	Decis 2.5 % s.c.	0.02	46.2	0.2	0.2	0	99.3	99.7	100
10	Antion 25 % s.c. (typically applied)	0.05	62.2	0.2	0	1.2	99.6	100	97.8
11.	Control (no treatment)		35.7	24.3	34	32.4	-	-	-
	P < 0.5								1.2