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Biology and Management of Key Rice Pest in Asia

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Importance of Rice in Asia

Rice is one of the most important commodities of the world. It is a basic food and principal source of calories and protein in more than half of the world populations. Fifty to eighty percent of daily calorie intake in human comes from rice. In contrast to other cereals, it is consumed almost exclusively by humans. It remains a major staple food for people of the Philippines which account about thirty-five percent of average calorie intakes. Rice is also one of the major staple food in Indonesia. In china, about sixty percent of the population feed on rice. In Sri Lanka, about 18.6 million Sri Lankans people also rely on rice. Rice is also one of the predominant crops in most of the ecological regions in Thailand, providing eighty percent of the carbohydrate and forty percent of the protein intake in their diet.

In the year 2025, the projected demand of rice skyrocketed especially in major Asian countries where rice consumption increases faster than the population growth.

Table 1. Projections of Population in Major Rice Producing and Consuming Countries in Asia, 1995 to 2025

Country	Population (mill.) 1995	Annual Growth Rate (% per year)		Projected Population (mill.) in 2025	Percent Increase 1995-2025
		1995-2000	2020-2025		
China	1199	0.9	0.5	1471	23
India	934	1.7	1.0	1370	47
Indonesia	192	1.4	0.8	265	38
Bangladesh	121	1.8	1.1	182	50
Vietnam	74.1	2.0	1.2	117	58
Thailand	60.5	1.3	0.7	80.8	34
Myanmar	46.8	2.1	1.1	72.9	56
Japan	125	0.3	-0.3	124	-1
Philippines	69.2	2.2	1.2	115	66
Rep. of Korea	44.8	0.8	0.3	52.9	18
Pakistan	130	2.7	1.6	243	87
Asia (excluding China)	2244	1.8	1.1	3389	51

Source: World Bank Population Projections, 1994-95 Edition

The rice consumption in Asia by the year of 2025 over the base year of 1995 will increase by more than fifty-one percent and the current demand of 524 million tons is expected to increase to over 700 million tons. Since the early 1990s, the global rice production has been expanding marginally above the population growth. Developing countries account for ninety-five percent of the total, with China and India alone responsible for over half of the world output. Rice also plays an important role as a “wage” commodity for workers in cash crop or non-agricultural sectors. In the Philippines, rice farming is the source of income and employment of 11.5 million farmers and family members. It is also a source of livelihood in more than 1.8 million farmers in Sri Lanka. The need for world food supplies in rice production has increased dramatically. Arable lands are mostly exploited especially in Asia, where ninety percent of the world’s rice is produced and consumed.

With the increasing demands of rice, the average growth rate in production need to keep the pace with the growth rate of the population. Rice in the world trade markets ranges between 11.8 and 12.7 million tons per annum with Asia remains the major rice importing regions, followed by Africa, Europe and South America. In other words, rice is the most important food for mankind.

Origin and History of rice as a Crop

It is believed that rice has been cultivated for more than 7000 years ago. The first crops were observed in China at the Hemu Du region around 5000 B.C. and in Thailand around 4500 B.C. From there, rice spread and expanded to other parts of Asia including Cambodia, Vietnam, Japan, Indonesia, and some parts of India and Southern India and to other Asian country such as Korea, Japan, Myanmar, Pakistan, Sri Lanka, Philippines and Indonesia. The wet monsoon rains that fall from May to September makes these countries ideal for growing rice

Cultivated rice consists of two species – *Oryza sativa* L. and *Oryza glaberrima*. These plants are native to tropical and subtropical southern Asia and southeastern Africa. The cultivated rice plant (*Oryza sativa* L.) belongs to the grass family; Family Poaceae. About twenty species of the genus Oryza are recognized, but nearly all of the cultivated rice is *Oryza sativa* L. with a small amount of *Oryza glaberrima*, a perennial species grown in Africa.

Because of its long history of cultivation and selection under diverse environments, *Oryza sativa* has acquired a broad range of adaptability and tolerance so that it can be grown in a wide range of water and soil regimens, from deeply flooded land to dry hilly slopes. In Asia, cultivars with resistance to aluminum toxicity and with tolerance to submergence by flood water, high salinity and cool temperatures at the seedling or ripening stage have been developed. In Africa, cultivars with tolerance to iron toxicity and heat constraints have also been developed and cultivated. Rice is now grown in over 100 countries on every continent except Antarctica, extending from 50° north latitudes to 40° south latitudes and from sea level to an altitude of 3000m. It is certain, however, that the domestication of rice ranks as one of the most important developments in history, for rice is the longest, continuously grown cereal crop in the world.

References: 7,9,19,29,31,32,33,39,50,92,95,97.

Rice Cultivation

Rice has been cultivated for a thousand of years and since its domestication, it has been grown in a diverse agroecosystem. It is the most diverse and versatile crop that evolved a high level of adaptability to different habitats, which resulted in tremendous genetic diversity of rice crop around the world. Through this, several methods for planting rice has been developed, each variety are different and thus

each planting method usually depends on the type of rice being planted, climatic condition, soil types and the types of agriculture technology available.

Rice can be planted either thru direct seeding or transplanting.

Direct seeded rice- it is a method in which the seeds are sown directly in the field. Direct seeding usually requires around 60-80 kg of seed per hectare.

Transplanted rice - it is a method in which the rice seedlings are first raised in the seedbed prior to planting in the field. Transplanting rice usually requires 40 kg of seed per hectare with 2 plants per hill.

Based on land and water regime, ricelands are either classified as:

1. Lowland or irrigated rice
2. Upland rice
3. Deep water rice
4. Floating rice

Lowland or Irrigated Rice: rice are being cultivated and grown in relatively flat lands where the water is accumulated for the entire or part of the growing season. Farmers divide the land into paddies and build low mud wall called dikes that surround the fields/paddies to keep the water inside. Generally, the fields are drained during harvest time. Lowland rice system accounts for about seventy-six percent of the global rice production. It is grown in parts of Japan, Thailand, Vietnam, Philippines and China. Lowland rice occupies larger land area than upland rice.

Upland Rice: Not all rice is irrigated; rice can also be grown under dry condition. Upland rice refers to the rice that is grown on either flat and sloping fields that are not bunded, prepared and seeded under dry conditions. Farmers rely on rainfall for moisture and nourishment of the plants. The area planted through upland rice is nearly one-sixth of the world total rice land that even a small increase in yield will substantially influence the total rice production. Asia alone has more than ten million hectares of upland rice.

Deepwater Rice: Rice that is grown in standing water that is more that 50cm for a certain period of time. This type of rice is well adapted to water that it can grow in depths that would kill most of the other crops. Cultivated rice are characterized by the level of water in which they grow; some are grown within depth of 50-100cm; 100-150 cm or more than 150cm. Countries in east India, Bangladesh and Burma have more than eight million hectares of deep water rice. Some parts of south East Asia have grown almost three million hectares of deep water rice.

Floating Rice: this refers to rice that is grown in water in depths of 1 to 6 meters. These varieties are usually grown in countries that experience monsoon rains. In this case, the seeds are planted along the riverbanks when the water level is very low. As water level of the river rises, the rice grows at the same speed so that the panicles, or heads of the plants remain above the water and the ripened rice appears

to be floating on top. Floating rice is mostly grown in part India, Bangladesh, Thailand, Myanmar, Vietnam, Kampuchea and Indonesia.

References:16, 17,19,38,45.

Parts of Rice Plants

Rice plants are long and thin plants that look like tall blade of grass. The head of the plant is called the panicle that grows at the top of the stalk above the long and green leaves. Small flowers called spikelets sprout from the panicle that eventually produce tiny grains of rice. After several months, the spikelet ripens and dries out. When the plants turn golden yellow the plants are ready to be harvested. Depending on the type of rice and the environmental conditions they are in, they can grow for three to seven months and grown between three to six meters tall.

Rice Plant Development

There are three main growth stages of rice plants which include the vegetative stage (germination to panicle initiation), reproductive stage (panicle initiation to flowering), and ripening stage (flowering to grain maturity). Each of these stages has series of developments that may overlap each other. Developmental stages are described in detail below

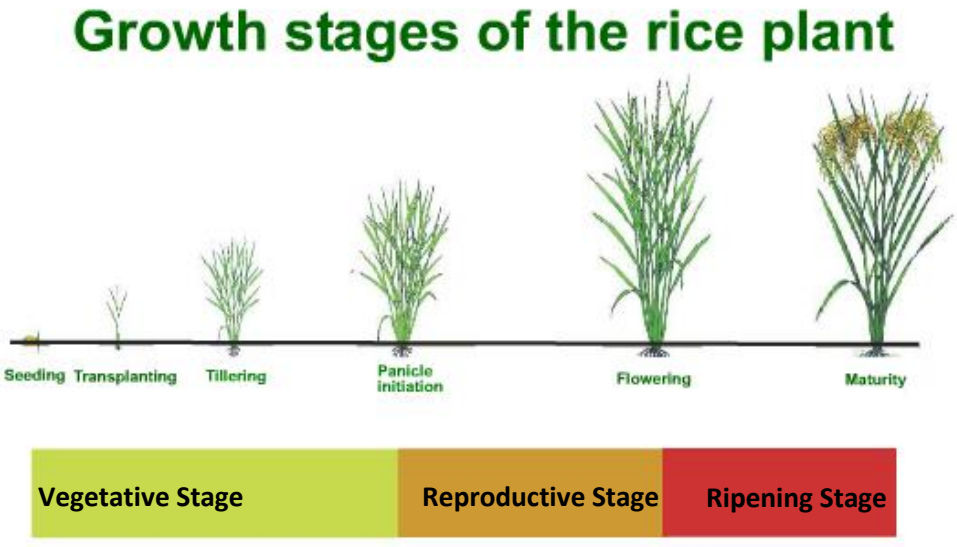


Photo: IRRI- Rice Knowledge Bank

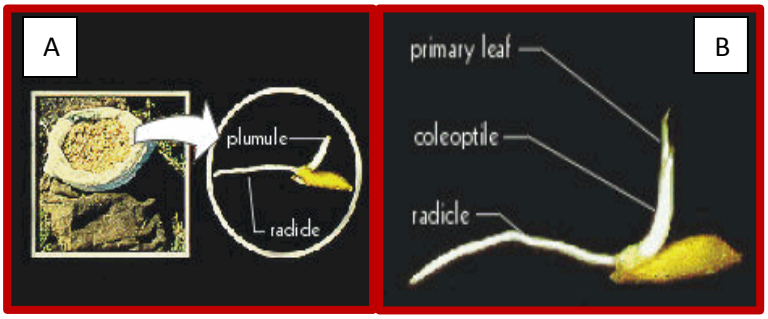
Vegetative Stage (Germination to Panicle Initiation)

Germination to Emergence- Seedling- Tillering- Stem Elongation

The length of the vegetative growth phase primarily determines the growth duration of the cultivars. Some cultivars have shortened vegetative growth stages, while others have both shortened vegetative and reproductive growth stages.

Stage 0- Seed Germination to Emergence

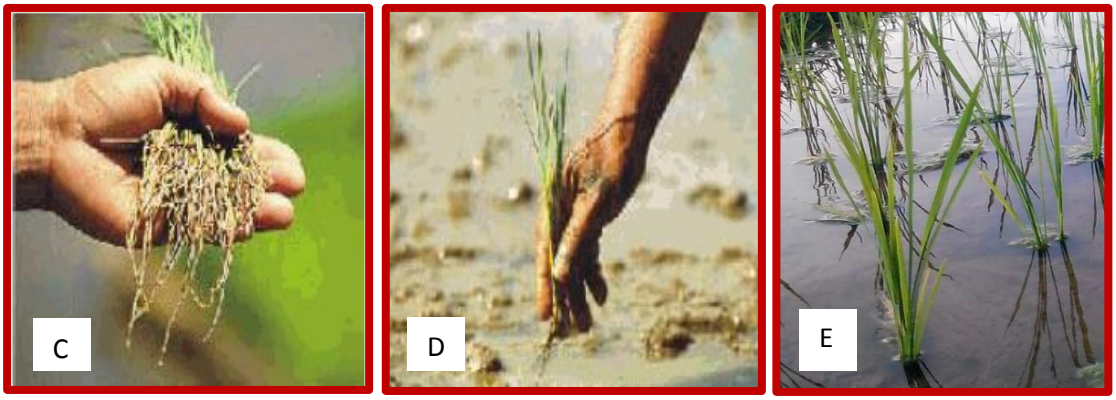
Usually seeds are pregerminated by soaking in water for at least 24hr. Seed germinates when the seed coat has imbibed adequate water to become soft and elastic. After pregermination, the radicle and plumule (A) protrude through the hull. The first leaf breaks through the coleoptile (B) usually after the second or third day of seeding into the seedbed.



The end of stage 0 shows the emerged primary leaf still curled (B) and an elongated radicle. Photo: IRRI-Rice Knowledge Bank

Stage 1- Seedling

The seedling stage starts right after seed emergence and lasts until or just before the first tiller appears. Seedling emergence happens when the first internode (mesocotyl) has elongated and the tip of the rice coleoptile (epiblast) has pushed through the soil surface. The first sheathing leaf (prophyll) that emerges through the coleoptile lacks the leaf blade. Therefore, it is not considered to be a true leaf. True leaf occurs when the first complete leaf pushes through the prophyll, extends fully, and forms a collar, which is called the V1 stage. The V2 growth stage occurs when the second leaf has fully emerged and also forms a collar. The process continues until the desired number n^{th} leaf on the main culm is reached. The complete set of V stages begins with the complete leaf emerging from the prophyll and ends in the formation of collar on the final leaf (the 'flag' leaf) on a culm.



Photos: C, D - 18-day old seedling ready for transplanting. E- Transplanted seedlings

Photo: C & D (IRRI Rice Knowledge Bank), E (Jesson Salo)

Stage 2- Tillering

Tillers are branches that are developed from the leaf axils of the unelongated node of the main shoot or from other tillers during the vegetative growth stage. The tillering stage usually begins when the fifth-leaf stage (V5) of the plant emerges from the main culm and the first leaf of the tiller emerges from the axillary bud of the second leaf culm. Tillering usually starts on the second leaf, so when the sixth leaf emerges from the main culm, the first leaf of the tiller comes from the axillary bud of the third leaf on that culm. Tillering continues in a synchronous manner until the maximum number of tillers is reached.

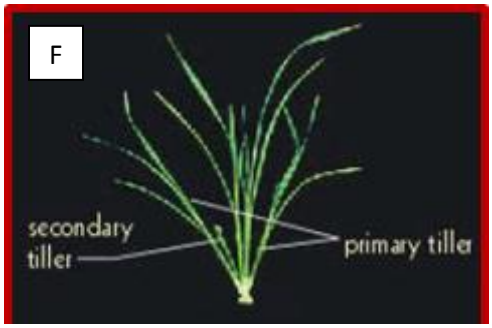
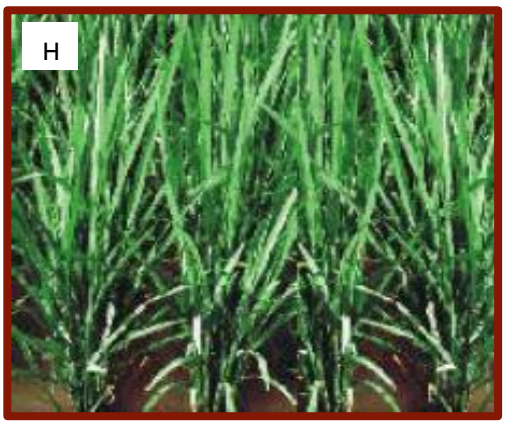


Photo: IRRI-Rice Knowledge Bank

Stage 3- Stem Elongation

This is a process where the stem increases in length, which may begin before panicle initiation or during the latter part of the tillering stage. This process is usually associated with the exsertion of the panicles from the sheath to allow flowering and pollination.



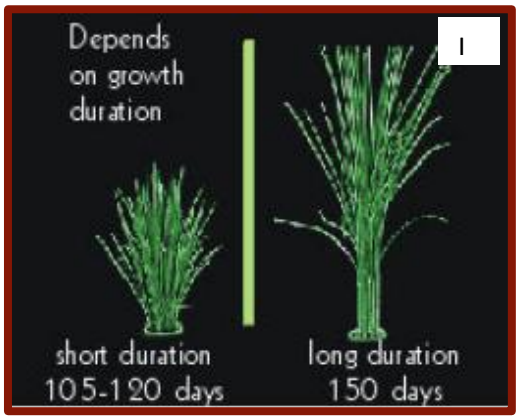


Photo: IRRI-Rice Knowledge Bank

In this stage, the tillers will continue to increase in number and height. Stem elongation usually occurs in varieties with longer growth duration. Long duration varieties mature in about 150 days (I) while the short duration varieties mature between 105-120 days.

Reproductive Stage (Panicle initiation to Heading)

Panicle initiation to Booting- Flowering- Heading

The reproductive phase is characterized by culm, elongation, a decline in number of tillers, booting, emergence of the flag leaf, heading, and flowering. In most cultivars, the reproductive phase usually lasts approximately 30 days.

Stage 4- Panicle initiation to booting

Panicle initiation is the time when the panicle primordia initiate the production of panicle in the uppermost node of the culm. Approximately 10 days after initiation, the panicle primordium usually becomes visible to the naked eyes. As the panicle continues to develop the spikelets (J) become distinguishable. As the panicle increases in size, the flag leaf sheath bulge. The bulging of the flag leaf sheath is called booting (k). Full or late boot occurs when the flag leaf has extended completely.

Photo: IRRI-Rice Knowledge Bank

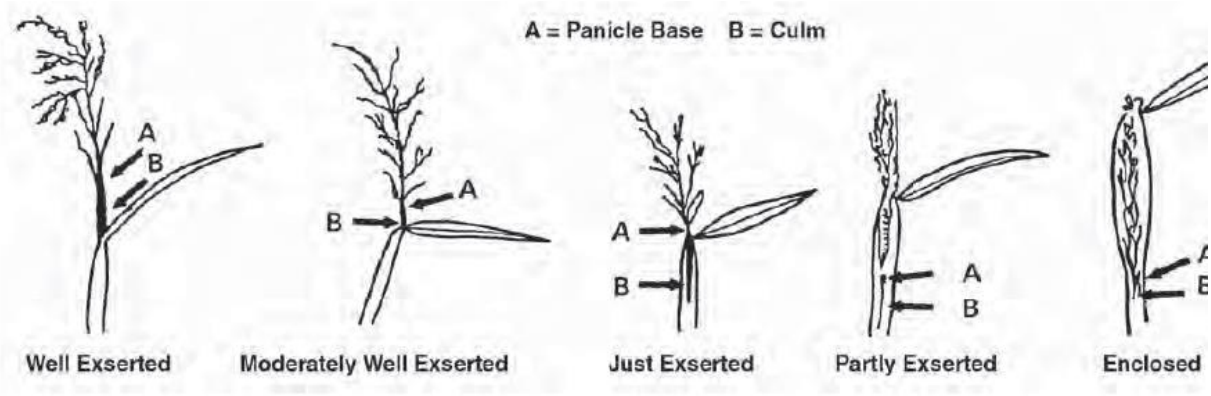
Stage 5- Heading

Heading, also known as the panicle exertion stage, is the time when the panicle begins to exert from the boot (L). This stage may take at least 10-14 days due to the variations within tillers on the same plant and between plants in the field. Depending on the cultivars, panicle exsertion may extend partially out from the boot (Fig.1) while others may extend 3 to 4 inches beyond the panicle base. The panicle continues to emerge until it partially or completely protrudes from the sheath.

Photo: Rolando Ybanez

Fig.1 Common stages of panicle exsertion of rice

Moldenhauer, K & Slaton, N



Stage 6 –Flowering

Anthesis or flowering (M) is the event between the opening and closing of the spikelet (floret) and which fertilization takes place. Flowering usually begins upon panicle exsertion or on the following day and considered synonymous to heading. The pollen grains are viable for approximately five minutes after emerging from the anther while the stigma may be fertilized for 3-7 days.

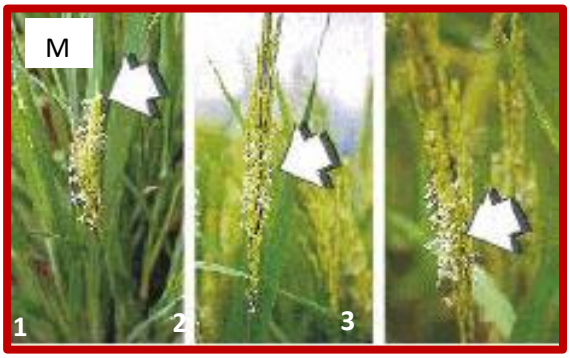


Photo: IRRI-Rice Knowledge Bank

1. Anthesis at the top of the panicle, 1st day after heading
2. 2nd day after heading
3. 3rd day after heading

Ripening Stage (Heading to Maturity)

Milk grain, Dough grain, Mature grain

During this stage, the grain increases in size and weight, the grain changes in color from green to a gold or straw color, and the leaves of the plants begin to senesce.

Photo: Rolando Ybanez

Stage 7- Milk grain stage

At this stage, the grain begins to fill with a white milky liquid starch. The kernel is soft (N) which can be squeezed out by pressing the grain between the fingers.

Stage 8- Dough grain stage

During this stage, the starch in the grain is still soft but begins to become firm (Soft dough stage). Then, the whole grain becomes firm and nearly ready for harvest (Hard dough stage). The grains in the panicle will begin to change from green to yellow, and senescence of leaves and tillers are noticeable. As the panicle turns yellow, the last two remaining leaves of each tiller will begin to dry at the tips.

Photo: Jesson Salo

Stage 9- Mature grain stage

This is the last stage in rice development, in which the whole grain is hard and fully developed. In this stage, individual grains have turned yellow and ready for harvest.

Reference: 34,46,67,93,96,122,137,138.

Rice Pests

Rice is grown in different habitats from arid to wet environments and temperate to tropical climate. In each geographical area where rice is grown, it harbors different insects and insect pests associated with the rice cultivation and practices to that area.

The growth and development of rice is often associated with the different types of insect's species that attacks and damage rice as they grow. These insects inflict damage by chewing leaves, sucking the sap, boring or tunneling on stems, grains, seeds or either by attacking roots and underground stems. In this manual, rice pest is categorize based on the growth and developmental stages of rice in which they attack.

Pest Information

The following information is provided for each pest in a uniform format. Pest that is more common or more economically important may be provided with more information. Deviations may occur in some format for pests that that are not of economically importance.

Scientific Classification: The scientific name formed by combining the generic (genus) and specific (species) name of an insect, followed by the order and family names (Family names and order in parenthesis).

Distribution: This indicates the place an insect was known and its approximate distribution in Asia. However, insects with wide geographical distribution are not indicated.

Pest Occurrence: Describes when an insect is more abundant to create economic damage (seasonal and different water /planting regime) of rice fields.

Symptoms and Injury: Indicates the signs and symptoms cause by the pest and the type of injury they inflict to a plant.

Description and Life Cycle: Details about the life cycle of an insect and its development. It also describes key features or characteristics for easy identification.

Management: Includes all potential and practical approach for management of the pest. This includes cultural, mechanical, chemical, biological and other control approaches that will help control pest damage.

Selected References: Number of selected references at the end of the section will refer reader to the list of references at the back of this manual.

Reference: 52, 84.

Vegetative Stage

Rice Stem Borers: Generally considered to be the most serious pests of rice worldwide which damages plants from seedling stage to maturity regardless of geographical area, continents, ecosystem or the type of crop culture. Several species of stem borers that infest rice similarly shows the same symptoms and injury to the plants. For this reason, symptoms/injury to plants and management controls are explained generally or otherwise explained for each insect. Nevertheless, the occurrence, life cycle, and distribution of pests are described in detail.

Seasonal Occurrence/Abundance: Generally stem borers are polyvoltine but the number of generations in a year depends upon the environmental factors such as temperature and availability of hosts or crops. Areas that have a short optimum environmental condition may only have one generation while two or more in areas in warmer environment.

Photo: Rice Knowledge Bank-IRRI

Symptoms/Injury: Stem borer larvae feed initially on the leaf sheath causing broad longitudinal whitish discoloration of the feeding sites. This initial feeding rarely results in wilting or drying of the leaf blades; however, it is about a week after the larvae hatched that they bore into the stem, feeding excessively on the pith and the inner surface of the leaf blades. Excessive feeding during the vegetative stage of the plants causes the central tillers to turn brownish, wilt and eventually dry. This condition is commonly known as “dead heart”. Severe feeding during panicle initiation results in drying of panicles which may not emerge at all and those that already emerged does not produce grains. Damaged tillers have empty grains and look whitish which also called as ‘’white heads”.

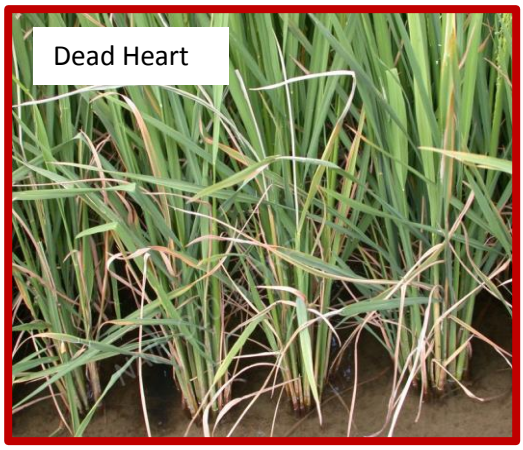


Photo: CRIDA and NAIP

Management: To confirm stem borer damage, visually check rice crop for dead hearts in the vegetative stages and whiteheads in reproductive stages. Stems can also be pulled and dissected for larvae and pupae to verify stem borer damage.

A. Avoid excessive nitrogen application. Rice fields with higher rates of Nitrogenous fertilizers are favored by stemborer moths for oviposition and plants that have a higher level of nitrogen are suitable for larval growth.
B. Cultural controls such synchronous plantings of early-maturing varieties; destruction of ratoon and stubble that remains in the field that can harbor stem borer larvae or pupae will help minimize stem borer population.
C. At seedbed and transplanting, handpick and destroy egg masses and before transplanting to reduce carry over of eggs from the seedbed to the field. Raising irrigation level of water periodically to submerge the eggs deposited on the lower parts of the plants.
D. Use biological control agents such as braconid or trichogrammatid wasps, ants, lady beetles etc. will maintain stem borer population at lower level.
E. Timing of insecticide application to control stem bores is very important since the larvae are only expose for a few hours before they enter or tunnel the plant behind the leaf sheath. Granular formulations such as gamma BHC and diazinon give maximum control than foliar sprays or dust particularly in high rainfall environments. Granules broadcast into the irrigation water are also effective in preventing dead hearts of younger plants. A systemic granule is also effective since the chemical can enter the plant even with low water levels.
F. Use of resistant varieties.

Yellow Stem Borer (YSB), Paddy stem borer

Scientific Classification:
Scirpophaga incertulas (Lepidoptera: Pyralidae)

Distribution: Afghanistan, Bangladesh, Burma, Cambodia, China, HongKong, India, Indonesia, Japan, Laos, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam.

Photo: Merle Shepard

Pest Occurrence: The yellow stem borer larvae feed only in rice; it is a pest of deep-water rice and can be found in aquatic environments where they attacked throughout the growing period of the crops.

Symptoms/Injury: It is the larvae that cause damage to the plants. The newly hatched larvae will bore into the leaf sheath causing yellowish-white patches on the feeding site. The larvae then bore into the stem, where they stay in the pith and feed on the inner surface of the stem, making a tunnel from one node to another. The larvae migrate to another plant by using body leaf wrappings. The larvae cut the tip of a leaf that naturally rolls into a tube, securing with silk to form a tubular leaf case. The larvae then incase itself into the tube and cut off the leaf to fall on the water. The case protects the larvae while in the water, with its head and thorax protruding, the larvae swims until it reaches into another plant and attaches the case perpendicularly to a tiller above the water level and bores into the plant. When the crop is at the heading stage, boring occurs at the peduncle node which causes whiteheads. A slight larval feeding can cause maximum damage to the plants. Yellow stem borers are unique because of the ability of the larvae to seal off both the entrance and exit holes with silk, making the tiller waterproof. Both larvae and pupa can survive below the water line making them a major problem in deep-water rice.

Photo: CRIDA and NAIP

Photo: Merle Shepard

Description/Life Cycle: The moth usually lives for approximately 4-5 days. Female moths are bigger than the male. The forewings are bright yellowish brown with a single dark spot towards the center of the forewings, whereas the male moth has pale yellow or light brown forewings with two rows of small spots at the tip of each forewing. The female laid eggs near the tip of the leaf blade in patches of 80-150 eggs, covered with a brown mass of hairs from the anal tuft of the female. The eggs are creamy white, flattened, oval, scale like and turned into darker to purplish tinge before they hatched. There are six larval stages; the fully grown larvae are up to 20 mm long, white or yellowish white with a well divided prothoracic shield. Only one larva can be found per tiller. Pupation occurs within the stem mostly on the lowest node of the plant or just above the water level. The entire developmental period can last up to 51-71 days.

Management:

A. Since the eggs of YSB are laid near the tip of the leaf blade, clippings of seedling tip before transplanting reduce the carry-over of eggs from the seedbed to the transplanted fields.
B. Harvesting at ground level removes YSB larvae. Since stubbles are the major source for overwintering, flooding or plowing the fields greatly reduces stem bore population.
C. The use of natural enemies such as the long horned grasshopper *Conocephalus longipennis* feeds voraciously on eggs YSB. Carabid beetles such as the *Ophionea* spp. *Mesovelia vittigera* also preyed young larvae that falls into the water.
D. Eggs parasitoids also played an important role in maintaining YSB populations; some of these parasitoids are *Telenomus* spp., *Tetrastichus* spp., and *Trichogramma* spp.
E. Since the YSB stem borer cannot survive in cut straw, they go down to the stubble to pupate and spend their time between crops. Thus, close cutting of straws during harvest is detrimental to YBS.

Reference:25,36,54,55,59,61,74,75,79,91,149,150.

White stemborer, White rice borer

Photo: Rice Knowledge Bank -IRRI

Scientific Classification:
Scirpophaga innotata (*Lepidoptera*: Pyralidae)

Distribution: Australia, India, Indonesia, Malaysia, Pakistan, Philippines, Taiwan, Vietnam.

Pest Occurrence: White stemborer is an important pest of rain-fed wetland rice. Since they only feed in rice, they can occur all year round in a multi-rice crops irrigated areas.

Description/Life Cycle: Both male and female moths are bright white in color without any black spot on its forewing. It has as distinctive tuft of long hairs on the thorax. The male is smaller than the female; they live for approximately 4-5 days. The eggs are disc shape and are laid near the tip of the leaf blade in batches of about 100 eggs covered with light brown hairs from the anal tuft of the female.

The larvae are milky white, with a well divided prothoracic shield. The larvae pupate in the stem. The pupae are soft bodied, pale and about 12-15mm long. Pupation is completed in 7-11 days. It has also been reported that *S. innotata* larvae move into the roots and constructs a tunnel up to 4 inches deep to pupate.

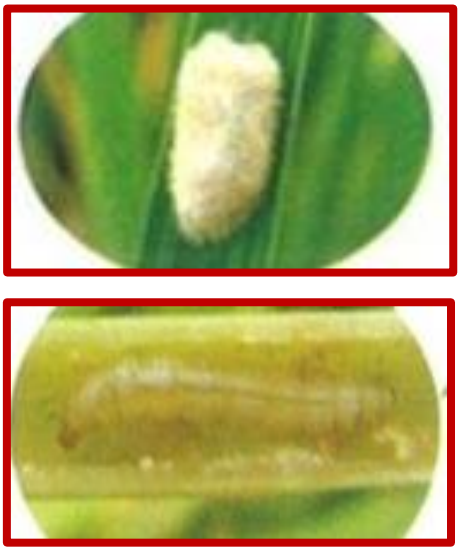


Photo: Rice Knowledge Bank -IRRI

Management:

A. White stemborer is a monophagous pest, destruction of stubble and the establishment of a rice free period during the off season greatly affects white stem borer population.
B. When harvesting, cut the stubble very low to destroy larvae before they have the chance to move into the lower part of the plants to pupate.
C. It was reported that 40-85% of larvae have already reached the lower part of the plants at harvest time. Ploughing the stubble directly after harvest will destroy larvae.
D. Clean surroundings and do not leave vegetation behind, leaving a greater amount of vegetation behind is responsible for the carry-over of borers to the next crop.
E. Use biological control such as parasitoids and predators.

Reference:18,51,59,64,79,80,91,94.

Pink Stem borer

Scientific Name:
Sesamia inferens (Lepidoptera: Noctuidae)

Distribution: China, India, Japan, Korea, Malaysia, Pakistan, Philippines.

Pest Occurrence: The pink stem borer is a pest of upland rice.

Photo: TNAU Agritech Portal

Damage/Injury: The larvae will penetrate the tillers and feed on the pith or inner surface of the stem walls, interrupting the movement of water and nutrients. Tunneling of larvae weakens the stem which causes to break the stem easily.

Description/Life Cycle: The pink stem borer is an extremely polyphagous species that attacks various graminaceous crops. Adult moth is brown in color. Unlike other species of stem borers, the pink stem borer laid bare eggs. The bead-like eggs are laid in rows in between the leaf sheath and the stem, usually from 30-100 eggs per batch. The larvae generally bore into the stem or a leaf sheath without coming to the surface of the plant. The larvae when fully grown can reach up to 35 mm in length. The total life cycle can last up to 46-83 days.

Photo: TNAU Agritech Portal

Management: Refer to general management of stem borers.

Reference: 36,58,59,60,64,79,115.

Dark-headed Striped Stem Borer

Scientific Classification:
Chilo polychrysus (Lepidoptera: Pyralidae)

Distribution: Burma, India, Laos, Malaysia, Philippines, Sabah, Thailand, Vietnam.

Description/Life Cycle: One the most important rice pest in Malaysia and is sometimes referred to as the paddy borer of Malaya. The adult moth is yellow in color with 6-7 tiny black dots at the center of its forewing.

Photo: NBAIR

The hindwings are yellowish white and they usually live for 2-5 days. Eggs are scale –like in appearance and are laid in batches of 20-150 eggs on the lower surface of the leaf blade. Mature larvae ranges from 18-24mm long.

Photo: Merle Shepard

Reference: 36,58,104.

Asiatic Rice Borer, Striped Stem Borer, Pale- Headed Striped Rice Borer

Scientific Classification:
Chilo suppresallis (Lepidoptera: Pyralidae)

Photo: International Rice Research Institute, Bugwood.org

Distribution: Bangladesh, China, India, Indonesia, Japan, Korea, Malaysia, Nepal, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam.

Pest Occurrence: Important pest of deep water rice.

Symptoms/Injury: The newly hatched larvae bore into the stem and feed. As the larvae grow and the plants wither, the larvae gradually disperse into neighboring stems by hanging itself on a silken thread which is blown by the wind. It has been reported that the larvae from an egg mass move in a group and bore into the stem.

Several larvae feed on a single internode leaving a moist pulp of chewed plant debris and frass. Commonly the first generation larvae cause's dead hearts and the second generation larvae cause white heads.

Description/Life Cycle: The moth is about 12mm long from the tip of the head to the tip of the abdomen with a wingspan of 26mm. The male is light brown in color, silvery scales and usually has brown to dark brown specks scattered irregularly in the middle of the forewings. The female is larger than male with paler forewings and fewer dark flecks. Female moths lay eggs in batches of varying numbers up to 300 eggs on the stems or at the basal half of the leaves. The eggs look like a fish scale translucent white to dark yellow as the mature.

Fully grown larvae has yellowish brown head capsule with five brownish longitudinal stripes on the dorsal surface of the body. It has been reported that Stripes stem borer is highly tolerant to low temperature. Full grown larvae exposed to -14c for 1-3hr does not exhibit significant mortality. Depending on the moisture and environmental conditions, mature larvae can pupate in the middle of the stalks or at basal internode. Pupation periods vary from 5 to 10 days. The entire lifecycle reaches between 41-70 days and the threshold temperature for development is 10-12c.

Photo: International Rice Research Institute, Bugwood.org

Management: Refer to General Management of stem borers.

Reference:21,23,33,37,58,100.

Rice gall midge (RGM), Maleng bug

Scientific Classification:
Orseolia oryzae (Diptera: Cecidomyiidae)

Pest Occurrence: The rice gall midge can be found in irrigated or rain-fed wetland rice fields during the crop's tillering stage, they are also common in upland and deep-water rice.

Photo: Rice Knowledge Bank -IRRI

Symptoms/Injury: Rice gall midge starts infesting the plants in the seedbed until the booting stage. They form a tubular gall at the base of the infested tillers, causing elongation of leaf sheaths called onion leaf, silver shoot or elephant tusk. The gall formed is a silvery white hollow tube about 1 cm wide and 10–30 cm long. The affected tiller become stunted, silvery, thickened and dry off without bearing panicles.

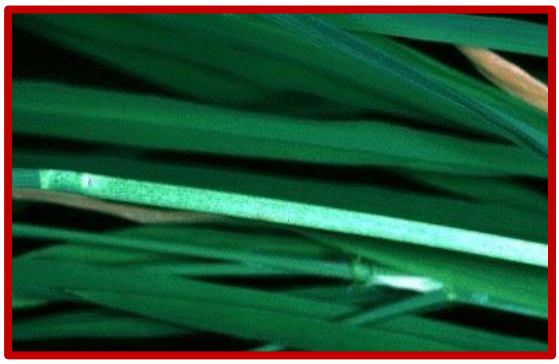


Photo: Merle Shepard (Rice Gall)

Early infestation of the plants can cause profuse tillering but the new tillers may or may not bear panicles. Rice is susceptible during the vegetative phase and continues until the tillering stops and formation of the panicle (booting stage) begins. Because the larvae cannot develop in the panicle primordia, they cannot survive on a crop beyond the vegetative stage.

Description/Life Cycle: Adult RGM flies are about the size of a mosquito. They are nocturnal and phototropic. The male is about 3 mm long with a yellowish brown body while the female is about 4mm long with a bright red abdomen. The antennae of the male are longer (23 segments) than the female (13 segments). Female lives for 48 to 78hr, whereas the males survive for 23 to 30hr. A female fly is capable of laying between 100-300 eggs that are laid singly or in groups at the base of the plants, ligules or on the undersurface of the leaf blade. The eggs are elongate, tubular and the color varies from shiny white pinkish or pink to red or yellow shading that turns shining amber before hatching. The newly hatched larvae can live in the water for several days without harmful effects on them. They will creep down the leaf sheath, to the growing points of the tillers and reach the interior of the bud where they lacerate the tissue and feed. Their feeding stimulates the tillers to grow into a tubular gall that resembles an onion leaf. The full grown larvae are about 3 mm long, pale red with a pointed anterior end. Pupation occurs inside the gall near the base of the plant. The pupae possess several rows of sub-equal abdominal spines pointed backwards which enable the pupae to wriggle their way out to the tip of the gall.

Since the eggs and larvae require high relative humidity, upland rice does not suffer higher infestation. However, lowland rice that grown during the monsoon season where the rain is frequent, cloudy skies and higher temperature usually suffer severe attacks due to the rapid increase of RGM populations.

Management: It is recommended that rice should be planted as early as possible in relation to the rains so that when the pest moves from wild host into the rice, the plants are already advanced in their growth.

A. Cultural control such as removal of grassy weeds or wild rice alternate hosts from surrounding areas and plowing fields after harvest and keeping fallow land free of off-season alternate host plants reduces pest's population.
B. Removal of alternate hosts during the off season interrupts the life cycle of RGM. Avoid staggered planting and multiple cropping's because these will provide continuous development of RGM.
C. Synchronous planting on an area wide basis will prevent continuous development of RGM.
D. Delaying wet season planting of photoperiod-sensitive varieties helps reduce infestation because plants at the vegetative stage are more susceptible to gall midge attack.
E. Planting of photoperiod-insensitive varieties as early as possible after the beginning of wet season allows the crop to complete the vegetative stage before the gall midge population transfers from alternate hosts.
F. Dense stands of rice and applications of higher amounts of nitrogen will create a thick canopy and a moist, humid environment that is suitable for RGM development, thus it is recommended to apply lower amount of nitrogen.
G. Numerous biological controls such as parasitoids and predators attacks different life stages of rice gall midges. The predatory phytoseiid mite *Amblyseius imbricatus* and *Amblyseius rimando* attacks the eggs while the platygasterid wasps *Oryzae cameron* are gregarious larval parasitoids.
H. Timing of application of insecticides is important when chemical control is needed. The target is to kill the adults or the first instar larvae before they reached the site of the gall help reduce gall midge population.
I. Granular insecticides such as carbofuran, phorate, diazinon, chlorpyrifos and quinalfos applied to flooded paddies during the vegetative stage also control RGM. In areas where RGM is a serious pest, prophylactic application to seeding beds, root application of granular products or soaking of seedling in an insecticide also help reduce RGM infestation.

Reference:6,11,24,40,54, 58,124,125.

Rice Hispa

Photo: Guido Bohne

Scientific Classification
Dicladispa armigera (Coleoptera: Chrysomelidae)

Distribution: Bangladesh, China (including Taiwan), India, Indonesia, Japan, Myanmar, Nepal, Pakistan, West Malaysia, Southern Thailand.

Pest Occurrence: Frequently causes extensive damage to lowland rice crops.

Symptoms/Injury: Both adults and grubs damage rice plants. The adults feed on the upper surface of the leaf blade leaving only the lower epidermis. The damaged areas appear as white streaks parallel to the midrib. The grubs enter and mines the leaf between the epidermal tissue making irregular patches. Severe infestation causes the leaves to turn whitish and eventually wither and die.

Photo: Rice Knowledge Bank-IRRI

Description/Life Cycle: Adult hispa is small about 5.5mm long, shiny, metallic blue or green black. It has five lateral spines on either side of the thorax and a series of long and short lateral spines on the elytra.

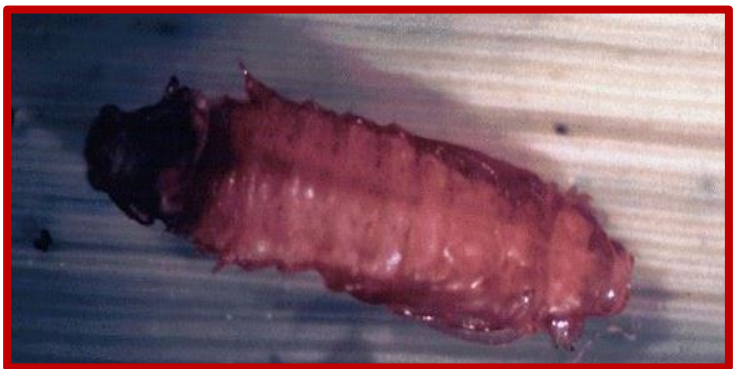


Photo: James Litsinger

The females lay eggs singly near the tip of the leaf blade that are covered with a dark substance secreted by the female beetle. A single female can lay as much as 100 eggs and incubation period usually takes about 4-5 days under natural field condition.

The grub is pale yellow and dorsoventrally flattened. After hatching the larvae will burrow into the leaf blades and feed on the green tissue. The pupae are flattened, brown and exarate. Both larvae and pupa completes its developmental stages without moving into another leaf. The adult beetles cut their way out of the leaf and begin to lay eggs 3 or 4 days after emergence.

Management:

A. Vicinities should free from grassy weeds that may serve as alternate hosts to maintain beetle population.
B. Avoid too close plant spacing, close plant spacing will result in greater leaf densities and can tolerate Hispa numbers.
C. Stubble should be uprooted after harvest to avoid ratooning. Clip off leaf tips before transplanting to eliminate early stages of the pest.
D. Several biological control agents such as braconid wasps Campyloneurus sp., and Macrocentrus sp., ichneumonid wasp Isotima sp. are known to parasitize the larvae.
E. Chemical control also plays an important role in controlling rice hispa. Since adults are more expose, they are susceptible to insecticide than larvae, which they are protected in leaf mines. Systemic insecticides give longer residual protection and more effective against larvae.

Reference:7,15,58,127,128.

Rice Leaf Folder, Rice Leaf Roller

Scientific Classification:
Cnaphalocrocis medinalis (Lepidoptera: Pyralidae)

Distribution: India, Indonesia, Korea, Malaysia, Pakistan, Philippines.

Pest Occurrence: Rice leaf folders are usually most abundant during the rainy season. It is a pest of both lowland and upland rice fields.

Photo: IRRI-Rice Knowledge Bank

Symptoms/Injury: The larvae infest the leaves and secrete a series of threads that they use to connect the two margins of the leaf blades, rolling them longitudinally. They remain within the leaf blade and feed on the leaves by scraping the leaf surface causing longitudinal, white, transparent streaks on the leaf blade. Feeding reduces the general vigor and photosynthetic ability of an infested rice plant. Heavily infested plants appear scorched and sickly. Damaged leaves also serve as points of entry for fungal and bacterial infections.

Description/Life Cycle: Adult moths are nocturnal. Therefore, they hide during the day and emerge at night. The moths are light brown with shiny brownish-yellow wings with two to three vertical stripes and a dark brown to grey band margins. The moths are about 10-12 mm long. Female moths lay up to 50-300 eggs. The eggs are laid and arranged linearly in batches of 10-12 along the midrib of either surface of the leaf. The eggs are oval-shaped, translucent, and yellowish-white with a slightly convex surface. The newly hatched larvae have shiny translucent bodies and dark brown heads. As soon as they start feeding, their body turns green.

Photo: Rice Knowledge Bank -IRRI

Only the larvae from the late second instars onward can cause the leaves to fold. Full-grown larva is about 20-25 mm long and 1.5-2 mm wide. Pupation occurs inside the rolled leaf. The life cycle usually takes about 25-35 days.

Management:

A. Cultural control such as keeping the rice fields and surrounding area free from weeds will minimize the buildup of rice leaf folders on alternate hosts.
B. Use the recommended dose of N-fertilizer and monitor crop regularly for presence of eggs, larvae, pupae and or adult.
C. Several natural enemies can be used to alter pest population; several species of Hymenoptera *(Goniozus* spp., *Trichogramma* spp., *Apanteles* spp., and *Braconid spp.),* Coleoptera *(Chlaenius* spp. and *Coccinella* spp.) has been reported as parasites and predators of leaf folders.
D. Plant varieties resistant to leaf folders.
E. Apply insecticides only when the infestation is heavy. Some recommended insecticides are Carbaryl, Malathion, Dimethoate, Cartap etc.

Reference: 54,58,69,129.

Rice Armyworm, Rice Swarming Caterpillar

Scientific Classification
Spodoptera Mauritia (Lepidoptera: Noctuidae)

Photo: Buck Richardson

Distribution: Africa, Australia, Malaysia, India, Philippines, Indonesia, Pakistan, Sri Lanka, Thailand.

Pest Occurrence: This pest can be found during the early part of rainy season each year from June to August. They multiply and devastate upland rice seedlings in seedbed or fields.

Symptom/Injury: The rice swarming caterpillar causes severe damage to rice plants either in nursery beds, seedbeds, or in the fields. They appear in masses and move like an army, grazing on the leaves and moving from field to field. Feeding by newly hatched larvae causes the plants to look sickly with withered tips. As the larvae grow older, they become voracious and can defoliate a whole field within a short period of time. These pests are essentially a seedling pest and rarely infest crops more than 6-7 weeks after transplanting. Although mostly young seedlings are affected, older plants, up to the ear emergence stage, have also been attacked.

Description/Life Cycle: The adults are about 25-30mm. The long greyish-black moth has a white blotch on its forewings, which are irregularly waved. The hindwings are whitish in color. Seedlings that are 4-20 days old in flood seedbeds or in direct sown fields with standing water are the preferred oviposition sites of the female. A single moth can lay five to six batches of eggs, each containing about 150-200 eggs on the lower surface of rice plants and other grass leaves. The eggs are spherical with a ridged surface that covered with greyish hairs from the anal tuft of the female.

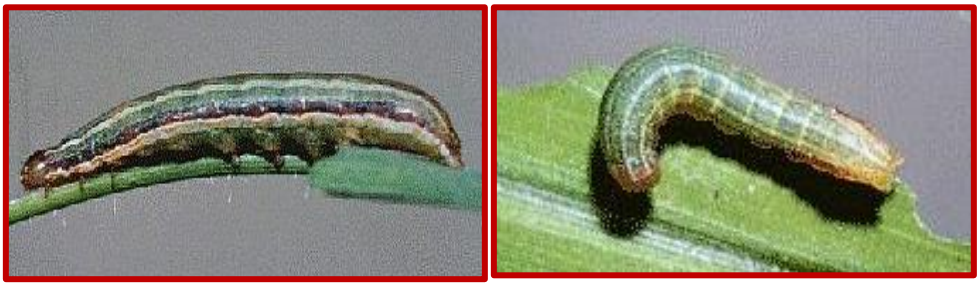


Photo: Don Herbison-Evans

The larvae are smooth-skinned and their color varies from dark to pale green. Three longitudinal stripes are running down its back. Just above the stripes are very distinct semi-lunar or crescent black spots. When disturbed, they curl into a crescent shape. The larvae undergo five instars. Pupation takes place in an earthen cell below the ground.

Management:

A. Monitor the presence of moth armyworms using a light trap.
B. Flooding of rice fields and removal of grasses and other alternate hosts help reduce pest population.
C. Use natural enemies to help reduce pest population and planting of trap crops such as sunflower or castor plants to attract adults to lay their eggs helps minimize damage to rice plants. Trap crops need to be inspected regularly to remove eggs of larvae.

Reference:47, 58,61,89,116,117.

Rice Whorl Maggots

Photo: Rice Knowledge Bank-IRRI

Scientific Classification
Hydrellia philippina (Diptera: Ephydridae)

Distribution: Philippines.

Pest Occurrence: The rice whorl maggot is semi-aquatic and usually common in irrigated fields. It also prefers ponds, streams, and lakes or places with abundant calm water and lush vegetation.

Symptoms/Injury: The Rice whorl maggot feed on the margins of the leaf causing yellow spots, white or transparent patches, and pinholes. The larvae or maggots tunnel the tillers and feed on the developing leaves. Damage becomes visible as the leaf grows. Generally, damage usually occurs from seedling stage to maximum tillering. Heavy infestation can cause severe stunting, fewer tillers, and delayed panicle initiation and maturity. In the Philippines, this pest occurs on rice throughout the year, but is most prevalent from September to November.

Plant damage usually ceases when the plants reach the booting stage which may be due to the lack of suitable habitats for the maggots.

Photo: Rice Knowledge Bank-IRRI

Description/Life Cycle:

The adults are dull grey, and the males are smaller than females. Adults prefer places with abundant calm water and lush vegetation. The eggs are white, cylindrical, and laid singly on either surface of the leaves.

When the eggs are freshly laid, the egg yolk mass is opaque, and as the eggs develop, the anterior half shows the black cephalopharyngeal skeleton of the developing embryo. A single female can lay an average of 20 eggs. Newly hatched maggots are transparent to light cream in color and later turn yellowish after they start feeding. They migrate into the whorl where the entire larval period is completed.

Photo: Rice Knowledge Bank-IRRI

Full-grown larvae are cylindrical, with the posterior end tapering to a pair of pointed spiracles. Pupation occurs into the feeding stalk. The cycle from egg to adult usually takes about 25-28 days.

Management:

A. The plant usually compensates for the damage caused by rice whorl maggot, and the symptoms disappear during the maximum tillering stage of the crop.
B. Use biological control insects such as wasps that will parasitize the eggs and the maggots.

Reference:47,54, 75,132.

Rice Caseworm

Scientific Classification
Nymphula depunctatis (Lepidoptera: Pyralidae)

Distribution: Bangladesh, Bhutan, Brazil, Burma, India, Indonesia, Laos, Malaysia, Philippines, Sri-Lanka, Taiwan, Vietnam.

Occurrence: The rice caseworm is an important pest of irrigated and rain-fed wetland rice.

Photo: Rice Knowledge Bank

Symptoms/Injury: Rice caseworm larvae start feeding on the green tissue by scraping the leaf surface of the plants. Several larvae can attack the same rice plant. The larvae move to the upper part of the leaf at about 1-3cm below the tip, cut off the tip, and roll it into a tubular case. The inside of the tubular case is lined with silk to hold a thin film of water for respiration and to avoid desiccation. The leaf case floats to carry the larvae from one plant to another. Defoliation commonly occurs at seedling stage and before the maximum tillering stage of rice. The larvae scrape the leaf tissue, leaving only the papery upper epidermis.

Description/Life Cycle: Rice caseworm moths are nocturnal. They are delicate and white in color, with fuscous markings and black specks on their forewings. Females are larger than the males. The female lays about 10-20 eggs each batch in rows on the underside of the leaves or on the leaf sheath near the water surface. A single female can lay an average of 60 eggs in its lifetime. The eggs are smooth, spherical, light yellow when freshly laid, and are a darker yellow once they mature.
Larvae are transparent green in color with light brownish-orange heads. They are semi-aquatic with lateral, slender, and filamentous gills, and they measure about 20mm long when fully grown. The larval stage can last up to 15-30 days. The pupa is cream colored when freshly formed and turns silvery white prior to moth emergence.

Management:

A. Cultural control such as water management is effective in controlling larvae. Since larvae are highly dependent on water for oxygen, draining of water in fields for at least 3 days will kill most of the larvae.
B. Use biological control agents such as parasitoids and predators to minimize rice caseworm larvae population.
C. A parasitoid such as the *Trichogramma minutum* is effective in searching rice caseworm eggs. Others, such as the braconid wasp *Dacnusa* sp. and tabanid fly *Tabanus* sp. also parasitizes larvae.
D. Rice caseworm larvae are very sensitive to insecticidal treatment. They can be controlled using foliar sprays or granule application in the water. If using foliar sprays, insecticide application should be carried out no later than one week after transplanting.

Reference:25,53,54,80 120.

Other Pests of Rice- Vegetative Stage

Rice Mealybugs

Scientific Classification
Heterococcus rehi (Homoptera Pseudococcidae)

Adults and nymphs are destructive by sucking the sap from the stem of the rice plants, resulting in yellowing, abnormal tillering, and stunted growth.

Grasshoppers (Short-horned)

Scientific Classification
Oxyla hyla intricata

Short horned grasshoppers cut out areas on leaves and cut off panicles. They also feed on leaf margins.

Photo: Rice Knowledge Bank-IRRI

Rice Stem Maggot

Scientific Classification

Chlorops oryzae (Diptera: Chloropidae)

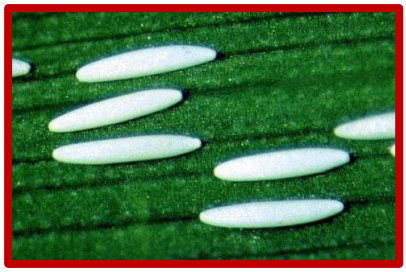


Photo: Mitsayoshi Takeda

Rice Thrips

Scientific Classification
Stenchaetothrips biformis (Thysanoptera: Thripidae)

Rice thrips are small soft-bodied insects that rasp leaf tissue of both lowland and upland rice. Damage includes the inward rolling of leaves, wilting, drying, and stunting.

Oriental Migratory Locust

Scientific Classification
Locusta migratoria manilensis (Orthoptera: Acrididae)

Feeding damage caused by oriental migratory locusts can be devastating to a crop. They swarm through rice fields, feed on leaves, and cut off panicles.

Photo: Matsumomushi

Black Bug

A. Common Black Bug- *Scotinophara coartata* (Hemiptera: Pentatomidae)
B. Malayan Black Bug-*Scotinophara lurida* (Hemiptera: Pentatomidae)

Photo: Rice Knowledge Bank-IRRI

Photo: Natasha Wright

Both nymphs and adults feed on the plant sap. Heavy infestation causes the plants to wilt and dry, also known as bug burn. Severe infestations during the tillering stage kills the central shoots. Plants become stunted, yellow, have chlorotic lesions, and bear few tillers. Infestation that occurs during the booting stage results in no panicles or incomplete exerted panicles and unfilled spikelets.

Green Stink Bug, Southern Green Stink Bug

Scientific Classification
Nezara viridula (Hemiptera: Pentatomidae)

Damage to rice is caused by both nymphs and adults feeding on the endosperm of the developing grains. Panicles are shriveled and contain unfilled grains. Infestation during the dough stage causes discoloration of mature grains and weakened kernels.

References: 54,77,102,105,111,112,130,131,135,146.

Photo: Hanno Schaefer (Azorean Biodiversity Group, CITA-A)

Reproductive Stage

Several species of insects from different orders attack rice during the reproductive stage. Leafhoppers and plant hoppers are just a few amongst the pests that are of great economic importance. These pests either damage the rice directly by sucking the sap and injecting toxins into the rice plant or indirectly by transmitting viruses and diseases.

Photo: IRRI-Rice Knowledge Bank

Brown Planthopper (BPH)

Distribution: China, Fiji, Indonesia, Malaysia, New Guinea, Philippines, Sri Lanka, Taiwan, Thailand, Pakistan, India, Nepal, Bhutan, Bangladesh, Laos, Vietnam, Japan, China, North Korea, and South Korea.

Pest Occurrence: Planthopper is a pest of rain-fed and irrigated wetland environments.

Symptoms/ Injury: BPH inflicts damage to plants either by direct or indirect feeding. Direct feeding of leaves removes excessive amounts of phloem sap, which causes the foliage to dry. Affected leaves turn a yellowish-orange shade before turning into brown, eventually killing the plant. This condition is called Hopperburn, which in physiological terms is caused by the disruption of the photosynthate flow to the root system causing leaf senescence. Plants are most sensitive to the attack 26-39 days after transplanting. BPH is also one of the causative agents of grassy stunt and ragged stunt diseases. Symptoms of grassy stunt are severely stunted plants with many tillers that produce few panicles. The ragged stunt results in ragged leaves during the early growth stages of the plants. It also causes stunting, vein swelling, more panicles, and fewer filled grains. Plants infested during the vegetative phase of development produce fewer panicles and grains per panicle, while later infestations reduce the percentage of fully developed grains.

Description/Life Cycle: BPH adults are about 3mm in body length and either light or dark brown in color. The eggs are crescent shaped, whitish or transparent in color, and laid out in batches inside the leaf sheath or on the midrib of the leaf blade. They have five nymphal stages. The newly hatched nymphs are white in color and later turn brown during the fifth and final molt. Nymphs and adults can be found feeding near the base of the plants.

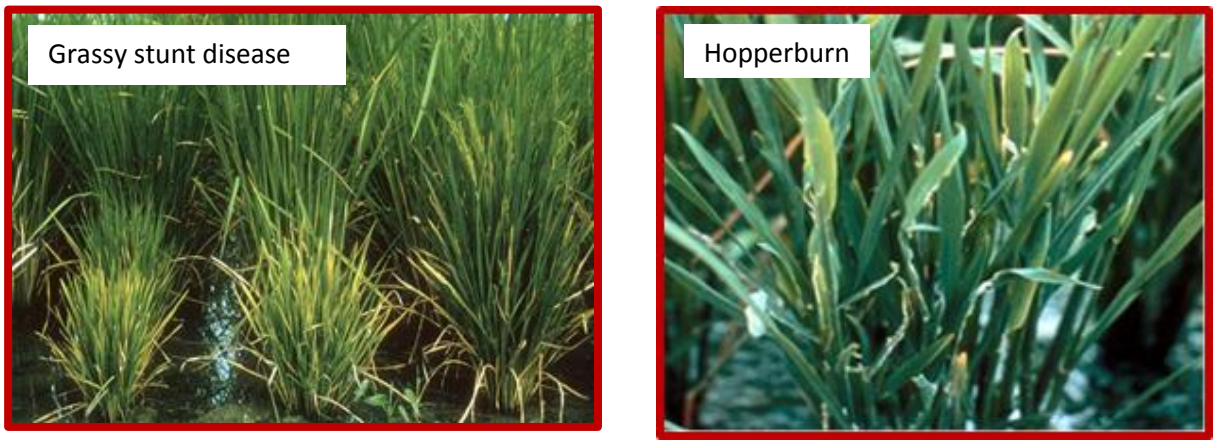


Photo: IRRI- Rice Knowledge Bank

Management: BPH is a serious pest over a wide range of environments. In temperate areas, Hopperburn generally occurs during the reproductive phase, and it occurs at any time in the tropics. A threshold of 10 BPH per hill is widely accepted.

A. Remove or destroy weeds and other alternative hosts by ploughing in stubble to bury infected plants.
B. Scout for BPH in seedbeds or in the field. Also check on stems and the surface of the water. For older rice plants, grasp the plant, bend it over slightly, and gently tap it near the base to see if planthopper fall onto the water surface. There is no need to scout for BPH beyond the milk stage.
C. Avoid indiscriminate use of insecticide; Overuse of insecticide destroys natural enemies which leads to BPH outbreaks.
D. Close and dense canopy. Excessive use of nitrogen and early season insecticide spraying also favors insect development.
E. Use resistant variety.
F. When insecticide is used, it is important to apply the proper dosage to conserve natural enemies and prevent BPH resurgence. Certain insecticides such as carbofuran and decamethrin, when applied as foliar sprays, stimulate egg production in BPH, resulting in much higher infestations. Since BPH feeds below the rice canopy, spraying of insecticides should be directed toward the base of the plants. Selective insecticides that do not promote resurgence, such as Buprofezin, show excellent activity against *N. lugens,* and they do not upset the natural enemy balance or induce resurgence.

Reference: 25,39,40,54,58,63,101.

Whitebacked Planthopper (WBPH)

Photo: Merle Shepard

Scientific Classification

Sogatella furcifera (Hemiptera: Delphacidae)

Distribution: China, Fiji, Indonesia, Japan, Korea, Malaysia, Philippines, Sri Lanka, Taiwan, USSR, Vietnam.

Pest Occurrence: The Whitebacked planthopper is a pest of both upland and wetland rice environments.

Symptoms/Injury: Whitebacked planthopper prefer younger crops and attack seedlings in nursery beds. Both adults and nymphs sucks the sap of the rice plants, primarily at the base which leads to yellowing of the leaves, reduce vigor, and stunting. Severely attacked seedlings do not grow. Instead, they wilt and eventually die.

An infestation that occurs during the panicle initiation stage decreases the number of grains and panicle length. If the infestation occurs during the maturation period, grains do not fill fully and ripening is delayed. During late crop growth, WBPH can be seen infesting the flag leaf and panicles. Gravid females also cause additional damage by making oviposition punctures on the leaf sheaths. Feeding points and wounds caused by egg-laying may later become potential sites for the invasion of bacteria and fungi. The honeydew produced by the WBPH hoppers also promotes mold growth.

Description/Life Cycle: The adult Whitebacked is about 3.5-4.0mm long. The forewings are almost uniformly subhyaline with dark veins and a prominent white band between the junctures of the wings. There is a prominent black dot at the middle of the posterior margin of each forewing which meets when the forewings come together. The body is creamy white, and the abdomen is black dorsally. The eggs are laid in masses in the rice stem or on the leaf sheath. The nymphs are pale to light brown.

Photo: Merle Shepard

Females are either long-winged (Macropterous) or short-winged (Brachypterous) while all males are long-winged. The planthopper, especially adults, prefer to stay at the upper portion of the rice stems. Adults are positively phototropic; hence they are attracted to light traps.

Management:

A. Use early maturing varieties and plant no more than two crops per year in order to help control planthopper population.
B. When heavy infestation occurs, draining the fields for 3-4 days at 8-9 leaf stage helps minimize hopper populations and increases the population of natural enemies.
C. Hoppers can be maintained at low levels by using biological control agents. Most egg parasitoids parasitized delphacids hosts.
D. Use resistant varieties.
E. Use insecticides. Several have been found to be effective, including Dimethoate, DDT, Aldrin, Dieldrin, Disulfoton, and Monocrotophos.

Reference:25,57,58,78,80,147.

Green Leafhoppers (GLH)

Scientific Classification:
Nephotettix virescens (Hemiptera: Cicadellidae)

Distribution: Bangladesh, Burma, Cambodia, Philippines, Laos, Indonesia, Malaysia, Taiwan, Thailand, Vietnam, China, Pakistan, India.

Pest Occurrence: The Green leafhopper is destructive of rain-fed and irrigated wetland environments.

Symptoms/Injury: Green leafhoppers are the most common leafhoppers in rice fields. They are primarily important because they are the vector of viral diseases called tungro, yellow dwarf, yellow-orange leaf, and transitory yellowing diseases. Both nymphs and adults feed by extracting the plant sap with their needle-shaped mouthparts. They prefer to feed on the dorsal surface of the leaf blades and on the lateral leaves. Feeding by GLH and their ovipositional marks predispose plants to fungal and bacterial infection. The honeydew also encourages sooty molds.

Photo: IRRI-Rice Knowledge Bank

Description/Life Cycle: Adults leafhoppers are bout 3.2-5.3mm long, green with black spots on the middle and at the tips of each of their forewings. They are capable of long distance movement. Adults mostly found on the top portion of the rice plant. The females lacerate the midrib of the leaf blade and laid eggs in batches on the leaf sheaths or midribs of foliage near the base of the plants. There are five nymphal stages. In the tropics, a single generation requires about 30 days, while in temperate regions, longer time is needed to complete a life cycle.

Management:

A. GLH prefer rice plants that have been fertilized with large amounts of nitrogen.
B. Staggered planting encourages population growth of GLH.
C. Use GLH-resistant and tungro-resistant varieties.
D. Use trap crops to control Green leafhoppers. Trap crops need to be planted with at least one-fourth of the total crop area and at least 20 days prior to planting rice.
E. To control tungro virus, systemic granules are recommended to incorporate into the soil before sowing the seedbed. Soil-incorporated granules are more efficient than broadcast granules or sprays in the seedbed. Soaking of seedlings in insecticide solution for 6-12 hours before transplanting gives protection for at least 20 days, whereas soil incorporation or broadcasting of systemic granules protects the crops for 40 days.
F. Control weeds in the field, and remove alternative hosts of GLH.
G. Use biological control agents like parasitoid wasps and other natural enemies that parasitizes the eggs, nymphs, and adults.

Reference:22,39,56,104.

Zig-zagged Leafhopper

Scientific Classification:
Recilia dorsalis (Hemiptera: Cicadellidae)

Distribution: India, Japan, Malaysia, Philippines, Sri Lanka, Taiwan, Thailand.

Pest Occurrence: Zig-zagged leafhopper pests occur in all rice environments, but they only transmit the virus diseases to wetland rice. They are particularly abundant during the early rainy season.

Photo: IRRI-Rice Knowledge bank

Symptoms/Injury: Both nymphs and adults damage the plants by sucking the sap out of the leaves and the leaf sheath. They transmit gall dwarf, tungro, and orange leaf virus. Damaged plants have dried leaf tips and leaf margins. Feeding shows orange discoloration and eventually causes the leaf margins to curl. When young seedlings are attack in large numbers, the plants wilt and eventually die.

Description/Life Cycle: Zig-zagged leafhoppers are highly mobile and are abundant during the early growth stages of rice. The adult is about 3.5-4.0mm in length and has white forewings with brown bands that look like a "W", giving the wing a zig-zagged pattern. The female lays its eggs individually in rows within the leaf sheath. Each female can lay as much as 100-200 eggs in its lifetime. There are five nymphal stages. The nymphs are yellowish-brown in color and are usually found in the upper parts of the rice plants and on the tillers near the base.

Management:

A. Control weeds in the field, and remove alternative hosts.
B. Use biological control agents like parasitoid wasps and other natural enemies that parasitizes the eggs, nymphs, and adults.
C. Plant resistant varieties.

Reference:56,58,63,80, 151.

Other Pests of Rice – Reproductive Stage

Small Brown Planthopper

Scientific Classification
Laodelphax striatellus (Hemiptera: Delphacidae)

Small BPH is a temperate species. They transmit the stripe and black streaked dwarf virus diseases.

Photo: James K. Lindsey

Reference: 18,78,145.

Rice Skippers

Scientific Classification

Pelopidas mathias

Parnara guttata

Photo: Rice Knowledge Bank

Symptoms/Injury: Larvae defoliate and feed on margins and tips of the leaves, removing large sections of leaf tissue.

Photo: James Litsinger

Pupa-The pupae which is called chrysalis is light green in color. They attach the pointed end of the chrysalis onto a leaf by a silk.

Reference: 72,133,134.

Ripening Stage

There are several insects that feed on the sap of the rice plant, causing the plants to become weak leading to poor grain formation. Generally, grain that is soft and milky is vulnerable to the attack. These insects feed on the developing grain, brown spots occur on infested or grain that have been feed. As a result, panicles may bear partially or empty grains.

Several species of true bugs in the genus *Leptocorisa*, commonly called rice bugs feed on developing grains. They belong to the order Hemiptera, Family Alydidae. These species are discussed together because their appearance, biology and the damage they cause are similar.

Rice Bugs

Leptocorisa acuta
Photo: Krishna Mohan

Scientific Classification

Leptocorisa acuta (Hemiptera: Alydidae)
Leptocorisa oratorius (Hemiptera: Alydidae)
Leptocorisa chinensis (Hemiptera: Alydidae)
Leptocorisa costalis (Hemiptera: Alydidae)
Leptocorisa tagalica (Hemiptera: Alydidae)

Pest Occurrence: Rice bugs are found in all rice environments, but they are more prevalent in rainfed wetland or upland rice.

Symptoms/Injury: Nymphs and adults sucks plant sap but they prefer to feed on the endosperm of rice grains. They prefer rice at milk stage but also feed on soft and hard dough rice grains. Removal of the liquid endosperm results in a smaller grain.

Leptocorisa oratorius
Photo: NBAIR

Description/Life Cycle: Rice bugs adults are slender; they have long legs and long antennae with brown green bodies. They are active when the monsoonal rains begin. They give off an offensive odor from the scent gland on their abdomens when they are disturbed. Usually, during the dry season the adults move to the wooded areas where they remain dormant.

Each female deposits several hundreds of eggs during a lifetime of 2-3 months. The eggs are dark red brown, disc shaped and laid in batches of 10-20 in 2-3 straight rows along the midrib on the upper surface of a leaf. Some factors that cause high rice bug population are nearby woodlands, extensive weedy areas near rice fields and staggered rice planting.

Management:

A. Cultural control- Eliminate grassy weeds from rice field, levees and surrounding areas to prevent multiplications of rice bugs.
B. Scout the fields a week before the milk stage and continue twice weekly until hard dough stage.
C. Avoid staggered planting of fields in an area.
D. Use biological control agents such as small scelionid wasps, meadow grasshopper that parasitize the eggs and preys on rice bug adults.

Reference:58,63,65,118,119.

Slender rice bug, paddy ears

Scientific Classification
Cletus trigonus (Hemiptera: Coreidae)

Distribution: North Borneo, India, Japan, Malaysia, Philippines, Sri Lanka, Taiwan.

Symptoms/Injury: These insects are seen feeding on younger rice grains, causing discolored spots known as pecky.

Cletus trigonus
Photo: Kwan (DSC01096)

Life Cycle: The adults are about 8mm long, brownish yellow in color with conspicuous brown punctures on its body. The eggs are deposited singly and the first nymphs emerge within 7 days. It has five nymphal stages.

Management:

A. Eliminate grassy weeds from rice field and surrounding areas that may harbor rice bugs.
B. Scout the fields a week before the milk stage and continue twice weekly until hard dough stage.
C. Use biological control agents such as small scelionid wasps, meadow grasshopper that parasitize the eggs and preys on rice bug adults.

Reference:58,63,144.

Green Stink Bug

Photo: Larvalbug

Scientific Classification
Nezara viridula (Hemiptera: Pentatomidae)

Pest Occurrence: Stink bugs are found in all rice environments.

Symptoms/Injury: Adults and nymphs feed on the developing grains of rice in the milk and dough stage which results in partially or entirely unfilled grains. They feed by inserting their proboscis at the points where palea and lemma meet and suck the grain sap. Heavy infested panicles remain erect but contain many shriveled and unfilled grains.

Description/Life cycle: The adults are about 13-17 mm long. They have a good dispersal ability migrating and infesting from one field to another. Eggs are laid in masses of 10-130 in five to eight parallel rows on the lower surface of the leaves. The eggs turn red before hatching. Generally, the first instar nymphs congregate around the egg shells and start feeding gregariously on grains as soon as they reached second instar. There are five nymphal stages that may last between 35-45 days.

Management/Control:

A. Several cultural and mechanical control measures are being adopted and implemented to control stink bugs. This includes weed sanitation and eradication of weeds and alternate host from the rice fields and surrounding areas to prevent harborage of stink bugs.
B. Delayed but synchronous planting and the use of early maturing varieties is suggested to minimize damage of late planting varieties.
C. Monitoring, scouting and hand picking of nymphs, adults and the use of sticky traps is also suggested to minimize stink bug population.
D. Use biological control and resistant varieties.

Reference: 52,58,106.

Soil Inhabiting Pests

Ants

Photo: IRRI-Rice Knowledge Bank

Scientific Classification

Solenopsis geminata (Hymenoptera: Formicidae)
Munomorium pharaonic (Hymenoptera: Formicidae)
Pheidologeton diversus (Hymenoptera: Formicidae)
Pheidole sp. (Hymenoptera: Formicidae)

Occurrence: Commonly occurs in upland rice environments, dry seeded rice fields and rainfed wetlands.

Symptoms/Injury: They damage plants by feeding on the un-germinated rice seeds. Damage is characterized by reduced, patchy plants stand.

Description/Life Cycle: Ants can be easily distinguished form other insects by the presence of a pedicel- a stalk like structure that serves to support the thorax and the abdomen.

Management/Controls:

A. To help compensate plant loss, increase seedling rate.

Reference:54,64,98.

Mole Crickets

Photo: IRRI-Rice Knowledge Bank

Scientific Classification
Gryllotalpa orientalis (Orthoptera: Gryllotalpidae)

Occurrence: Occurs in upland rice fields.

Symptoms/Injury: Mole cricket uses its modified front legs to burrow into the soils where they feed on the tender roots of the growing plants.

Description/Life cycle: Mole crickets are plump insects; they are brownish in color and measures about 2-3 mm long. They have short antennae and their front legs are modified for digging soils. They can dig as deep as 8-10 cm below the soil surface. The female lays 30-50 eggs in a hardened cells or chamber made of soil. The newly hatched nymphs feed directly on the roots that causes less or patchy plants. Nymphal period usually lasts between 3-4 months.

Reference: 1,46,54,113.

Root Aphids

Photo: IRRI Rice Knowledge Bank

Scientific Classification
Tetraneura nigriabdominalis (Hemiptera: Aphidoidea)

Occurrence: Occurs in well drained of both upland and rainfed rice.

Symptoms/Injury: Root aphids infest rice plants during the tillering stage. Both adults and nymphs suck plants sap which causes yellowing of leaves and stunting.

Description/Life Cycle: Rice roots aphids are small, greenish or brownish white in color. They look plump with an oval body. They can be seen in clusters on the roots of the plants. Rice root aphids have two forms- the winged and wingless forms. They have four nymphal stages. The adults may live between 15-20 days. Each female can produce between 35-45 nymphs in each lifetime.

Management/Controls:

1. Use biological agents such as braconid wasps, lady beetles, nematodes that parasitize and prey nymphs and adults.

Reference: 54,58,88,140.

Root/White grubs

Scientific Classification

Leucopholis irrorata (Coleoptera: Scarabaeoidea)

Description/Life Cycle: The adults are grey, tan, dark brown or black. Female beetles laid its eggs singly in moist soil close to the plants. The eggs are ovoid and creamy white with a leather-like shell. The grub or larvae is white in color with light to dark brown head. They pupate in the soil.

Photo: IRRI- Rice Knowledge Bank

Management/Control:

A. Clean out fields and remove possible host with fibrous root system.
B. Use biological control such as scolid wasps that can parasitize grub in the soils.
C. Use granular insecticides in crop furrows or hills at sowing helps minimize damage.

Root grub-damaged plant has yellow orange leaves
Photo: IRRI-Rice Knowledge Bank

Reference:20, 63,76,141.

Storage Rice Pests

Rice can be stored in many forms, and the variation of storage may affect the degree of susceptibility to some biological factors that affect the deterioration of rice during storage. Stored product insects damage rice and other commodities during storage, processing, and production. Below are insect species that are injurious to stored rice products. These pests occur worldwide, especially in tropical and temperate regions.

The general management practices to control stored product pest are listed as basis when controlling each pest, otherwise discussed in each insect category.

General Management Practices/Controls:

A. Sanitation is an effective way of minimizing the impacts of storage insect pests. Sanitation is the most economical and widely applicable method of pest control. It deprives other pests such as rodents, birds, and other insects from shelter and harborage. Sanitation includes cleaning of all storage bins, floors, window sills, and machinery, as well as removal of all trash grains, grain dust, and farinaceous debris form storage premises that may harbor insect pests.
B. Warehouses and other structures infested with rice moths and other insect pests should be cleaned thoroughly, and any materials which contain or have contained infested rice should be heat treated or fumigated.
C. Secondhand bags should not be used without disinfecting them first, and bags that have been used for transportation should be examined for the presence of insects.
D. Chemical control is used as supplemental measures. The use of insecticidal sprays, formulated as water emulsifiable liquids or powders, are applied as residual treatments on exposed surfaces of empty storage bins, warehouses, and other equipment prior to the arrival of new commodities.
E. The use of Malathion as a 'Protectants' insecticide, by applying it directly to bulk rice a before final storage to prevent infestation, has been widely used for decades and is widely successful.
F. Insecticides should be applied as aerosol treatment to control flying insects, particularly moths. Aerosols consist of very small droplets of solutions suspended in the air. These are mists, fogs, or vapors blown into a building with specialized equipment using special formulations of insecticides. An example of an effective aerosol is Dichlorvos.

G. Fumigants are gases that act as individual molecules that enter the respiratory system of the insects. Fumigation is a preferred method in eliminating established infestations. This is a process in which mills and warehouses are properly sealed and fumigated to clean up indigenous populations of insects that were not eliminated by sanitation procedures. An example of a fumigant is Methyl bromide.

Reference:10,12, 13,14.

Angoumois Grain Moth

Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Scientific Classification
Sitotroga cerealella (Lepidoptera: Gelechiidae)

Symptoms/Injury: It is the larvae that cause injury to grains. Angoumois grain moth infestation is difficult to detect in its early stages of infestation because the larvae bore their way inside the grain when they are small. A smaller larva bores smaller entry holes making it difficult to see without the aid of a magnifying lens/glass.

Once inside, the larvae will spin a silken web to cover the opening, making it difficult to locate the entrance hole. The larvae will then feed and consume the endosperm as they grow.

Description/Life Cycle: The moths vary in color from buff to grayish- or yellowish-brown. Each forewing has tiny dark spots, and the apical tip of each hindwing is narrow and pointed. The hindwings are grayish-white with heavily margined long hairs. Each female moth can lay up to 30-150 eggs in clusters or singly near or on the surface of the grain. Newly laid eggs are white in color and later turn into a red color before the eggs hatch. The larvae are white with yellowish-brown heads which bore into the rice grain and feed the endosperm where they continue to develop. Prior to pupation, the larvae cut a circular “window” to the outside of the grain, covered with their webbings. The newly emerged adult pushes the window aside, emerging from the grain, leaving a round hole in the hull. Development from egg to adult maybe completed in 5-6 weeks or may take as long as 12-13 weeks when exposed to lower temperatures.

Management/Control:

A. To prevent or minimize pest invasion, cleanliness is very important. Clean all storage places, bins, and granary areas. Do not let dust, dirt, or other refuse materials to accumulate in the granary; accumulation of this material will harbor insects and pests.
B. The moth dies at temperatures below 10^{o}C, and the eggs and larvae die when temperatures exceed 60^{o}C.
C. Eggs, larvae, pupae, and adults usually are killed if infested grain is heated to a temperature of 120^{o}F. Eggs exposed to 1^{o}F for at least 24 hours also prevents egg hatching.
D. The use of naphthalene balls as a repellent is also recommended for use in bins and other enclosures. Adult moths usually are susceptible to the smell of naphthalene balls; it deters adult moths from depositing eggs on the grain.

Reference: 2,3,43,70,87,97.

Rice Weevil

Scientific Classification
Sitophilus oryzae (Coleoptera: Curculionidae)

Photo: M.S. Caterino/SBMNH
(Bugguide.net)

Symptoms/Injury: The damage is done by both grubs and adults by breaking and hollowing the grains. In cases of severe infestation, only fragments of the pericarp are left behind.

Description/Life Cycle: Rice weevil adults can be easily distinguished from other stored grain insects by looking at their head capsule which prolongs into a slender snout called the rostrum. On the tip of the rostrum is the tiny but powerful chewing mandible. The adults are about 3mm long, though their size depends on the kernel/grain size. The elytra bear four prominent yellowish-brown or light red patches, and the thorax is fitted with round depression. Adult females can deposit up to 400 eggs in their lifetime. The eggs are laid singly. They can live for as long as 5-8 months. The eggs, larvae, and pupae are generally spent inside the kernels that protect the weevil from other insects. Full grown larvae are about 5mm long, plump, fleshy, and legless with a white body and yellowish-brown head. There is only one larva that feeds and develops per seed. Rice weevil prefers cooler temperatures and higher grain moisture.

Reference: 5,48,71,82,139.

Lesser Grain Borer

Photo: John Rosenfeld (Bugguide.net)

Scientific Classification
Phyzopertha dominica (Coleoptera: Bostrychidae)

Symptoms/Injury: Both grubs and adults cause damage by feeding inside the grain, causing many irregular holes.

Description/Life cycle: The lesser grain borer adults are small, cylindrical, approximately 3mm long, and 1mm wide. They are dark reddish-brown in color. Their heads are bent downward and concealed. The tip of the abdomen is tapered, and the end of the elytra is curved gradually. They have well-developed wings, are strong fliers, and can migrate easily spreading the infestation from isolated populations to newly harvested grains. They are long lived; they feed and reproduce for several months. They can develop in a large population and destroy many kilograms of rice before their presence becomes noticeable. A female can deposit about 300-500 eggs singly or in clusters glued to the grains or on bags, cracks, and crevices. The larvae are scarabaeiform with fully developed legs that bore into individual kernels. One of its unique characteristics is that they leave dust and frass behind which can pack into the rice, thus restricting airflow during aeration. Both larvae and beetles produce a large number of fecal pellets. The pellets have a sweetish, musty odor that can easily be identified as a lesser grain borer infestation. In heavy infestations, the grains are completely consumed that only the bran covering remains. Pupal stage is completed in the grain or in the grain dust and lasts for about 7-10 days. Males live longer than females.

Reference:4,5,12,14,62,70,108.

Rust Red Flour Beetles or Bran Bug

Photo: MJ Hatfield (Bugguide.net)

Scientific Classification
Tribolium castaneaum (Coleoptera: Tenebrionidae)

Symptoms/Injury: Both adults and larvae are serious pests of milled rice.

The larvae are negatively phototactic and are always found hidden in the grain. During heavy infestation, the insects give off a yellow color on the grain that becomes moldy with excreta of larvae and adults. This gives the grains a pungent odor, making it unfit for human consumption.

Description/Life Cycle: One of the distinguishing features of the adult red flour beetle is its flat body with a broader pronotum and parallel-sided abdomen. The adults are strong fliers, dark reddish-brown in color, about 3-4mm long and 1mm wide. They are a cosmopolitan species and are abundant in rough rice stored on farms, mills, and warehouses. Both adults and larvae feed on the bran coat, loose flakes of bran, germs, or on grain dust. They damage stored products by not only consuming them, but also by contaminating them with their dead bodies, cast-off skins, and fecal pellets that contain uric acid. Each female can deposit about 300-500 eggs outside the grains. The larvae have a prominent head with three pairs of thoracic legs. Their body is elongated and cylindrical, white in color, and tinged with yellow. They complete their development in about 4-6 weeks but may decrease to 20 days under optimum conditions.

Reference:13,43,70,142.

Sawtoothed Grain Beetle

Scientific Classification

Oryzaephilus surinamensis (Coleoptera: Silvanidae)

Symptom/ Injury: Both adults and larvae prefer the germ portion of the grain. They cause roughening of the grain surface and an off odor in the grain.

Description/Life Cycle: The sawtoothed grain beetles are general feeders. They are small insects, about 2.5mm long, flat and reddish-brown in color.

Photo: Matthew Roth (Bugguide.net)

Their thorax has three ridges, and the lateral margin is serrated with six toothed-like spines on each side. The wings are present but rarely used. The adults feed outside the kernels, whereas the larvae penetrate and feed on the germ area. Female beetles can deposit about 300 eggs in cracks, crevices, or storage receptacles or godown. The eggs usually hatch between 3-5 days in the summer. Depending on the temperature, the larval period can last anywhere from 14 days to as many as 7-10 weeks. Total development under favorable conditions can be completed in 22 days.

References: 5,13,70,84,143.

Long Headed Flour Beetle

Photo: Canadian Grain Commission

Scientific Classification
Latheticus oryzae (Coleoptera: Tenebrionidae)

Symptoms/Injury: Infestation is secondary in nature. Adults and larvae present in excessive numbers which induces heating.

Description/Life Cycle: The long headed flour beetle adult varies from yellow to brown in color. They are slender and flattened, reaching about 3mm in length.

One of its distinguishing features is that the adults have a comparatively large head with short antennae. Both larvae and adults feed on the grain. Larvae are pale yellow to cream in color, with a dark head capsule and an even darker urogomphi.

Reference:5,13,85,110.

Black Fungus Beetle

Photo: Natasha Wright

Scientific Classification
Alphitobius laevigatus (Coleoptera: Tenebrionidae)

Description/Life Cycle: The black fungus beetle is a cosmopolitan species. The adults are dark reddish-brown to black in color and measure about 5.5-7.0mm in length. They can be distinguished from the lesser mealworm based on the appearance of the lateral view of the eye. The black fungus beetle's eyes are only one facet wide at their narrowest point. The larvae are cylindrical and yellowish-brown in color.

Reference:2,5,13, 100.

Rice Moth

Photo: NRI/MAFF

Scientific Classification
Corcyra cephalonica (Lepidoptera: Pyralidae)

Symptoms/Injury: The rice moth is one of the major pests attacking broken grains and flours, especially the milled products of rice, sorghum, and maize. Only the larvae cause damage on broken grains.

As the larvae mature, they become capable of consuming the entire grain. Heavy infestation causes the entire stock of grains to convert into webbed mass. Foul odors develop, causing the grains to become unfit for human consumption.

Description/Life Cycle: The wings of rice moth adults are uniformly dark gray and sometimes streaked with darker lines along its veins. The head is snoutlike, inconspicuous and blunt in males, while long and pointed in females. Females deposit 100-200 eggs singly on rough surfaces. The eggs are pearly white and later turn yellow as they develop. The larvae are creamy white when newly hatched, and then they gradually darken to a dirty white with a reddish-brown head capsule. They go through 7-8 instars. Larval development is completed within 40 days of optimal temperatures.

Reference:2,5,10,86,136.

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