Field problems of rice in Latin America

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CIAT

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This manual is designed to help farmers and technicians identify the most common insect, disease and soil problems of rice in Latin America. All major problems are illustrated and discussed; minor problems that might be confusing have also been dealt with briefly.

CONTENTS

Fungi

Virus

Diseases caused by nematodes

Nonpathogenic diseases

Identification of problems affecting rice production in Latin America

Most of the problems affecting rice production can be identified by knowledge of the varieties attacked, careful observation of the symptoms and their pattern of distribution in the field, and visual association of the affected plants or areas with differences in soils, irrigation or fertilization practices. Information on soil pH and fertility helps identify nutritional problems..

Insect problems

Most insects are large enough to be observed; a few are minute or difficult to detect but can be identified by their feeding habits.

Damage is caused by chewing, sucking and rasping insects, the first two classes being the most important.

Damage to leaves and panicles is easily detected, but damage to roots and stems cannot be determined without pulling up the plant or cutting open the stems.

Many insects inhabit rice fields but not all damage rice; some are beneficial as they feed on other insects. Not only must the insect and the damage caused be recognized, but it must also be determined whether the insect population can cause economic damage. Frequently, the damaging insects are not present in sufficient number to apply insecticides.

It should be pointed out that specific insecticides have not been recommended for the control of the insect pests described for three reasons: (1) New products are continually being developed to replace existing ones; (2) frequently, the availability of specific products varies from one country to another; (3) nomenclature is not standard.

Disease problems

Diseases can attack leaves, stems, panicles and roots; their presence is confirmed by discolored, rotted areas of plant tissue in the affected parts. Some diseases are worsened by high nitrogen fertilization and water stress while in others the presence of the disease signals a fertilizer deficiency. The hoja blanca disease is transmitted by insects whose presence in large numbers may indicate that the disease will soon appear.

Soil problems

Soil problems are usually involved when (1) all plants within the area are affected, (2) insects and fungus diseases are not obvious and (3) the problem is alleviated or intensified by fertilization or by flooding after symptoms have appeared.

Soil problems occur because the plants cannot absorb adequate amounts of a specific nutrient or because some nutrient is absorbed in toxic amounts. The following table shows the most important nutrients and the conditions favoring the nutrient deficiency or toxicity.

Nutrient	Deficiency	Toxicity
Nitrogen	Low organic matter, cold soils	----------
Phosphorus	Strongly acid soil	----------
Potassium	Sandy soils	----------
Iron	Upland, neutral or alkaline soils	Strongly acid, flooded soils
Manganese	Upland permeable, sandy soils	Poorly drained, upland soils
Aluminum	----------	Strongly acid, upland soils
Zinc	Most serious on neutral or alkaline soils. May be caused by land leveling or erosion in any soil	----------
Sulfur	Highly weathered, strongly acid soils in nonindustrial jungle or savanna areas	----------
Salinity	----------	Irrigated soils in arid areas

Ground beetles and white grubs

Photo 1. Larva of **Phyllophaga** sp.

When new land is first put into rice, many insects that have been living in the soil and feeding on the roots of other crops are already present in the fields and can cause severe reduction in the rice stands by eating the rice roots and killing the young plants. Commonly found in these areas are large, thick-bodied whitish worms that are always curled up in a U-shaped form (Photo 1). These are larvae of rather large brown- to black-colored beetles that range in size from 13 to 25 mm. In some cases, the adults also feed on the rice roots. The dead plant illustrated (Photo 2) has had most of its roots destroyed by the insects. These insects attack upland rice roots at any stage of growth but cannot survive in irrigated rice.

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Rice water weevil

Photos 5 and 7. Adult and larva of *Lissorhoptrus oryzophilus*

This insect is a major pest of flooded rice in many countries. The adult weevils (Photo 5) feed on rice leaves leaving white longitudinal scars parallel to the midrib. The adults measure about 3 mm, but in Brazil one species is about 5 to 6 mm in length. Eggs are laid below the water level and the larva feed on the rice roots (Photo 6). The legless white larvae measure about 6 to 12 mm in length (Photo 7).

When a considerable portion of the root system is destroyed, the older leaves become yellow (Photo 8), and the plants may lodge.

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Chinch bug

Photo 9 *Blissus leucopterus*

Chinch bugs are small (3.5 mm) black insects with whitish wings. They are most commonly found in the soil feeding on roots of upland rice but may also attack stems. Adults and nymphs suck plant sap from the roots and stems; and if present in large numbers, they may cause the plants to become yellow and die. This insect may attack and damage grains of developing panicles (Photo 9).

Fall armyworm

Photo 10. Larva of *Spodoptera frugiperda*

This insect is found in all rice-growing areas. The larvae (Photo 10) feed on the leaves of young rice plants (Photo 11). They vary in color from light brown to green, to almost black and have three yellowish lines on the back that extend from the head to the tip of the abdomen. Two of these lines unite to form an inverted "Y" on the front part of the head. The larvae of a few related species feed during the night and hide in the soil during the day.

This is the most serious of the leaf-eating caterpillars as it is generally present in large numbers and can defoliate a rice field in only a few days.

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Leaf rollers

Photos 12 and 13. Adult and larva of **Panoquina** sp.

The adult butterflies are usually brown in color with some yellowish spots on the forewings. The antennas are hooked at the tips (Photo 12). The damaging state is the larva, which is easily recognized by its green color, by the large heart-shaped head, and by the necklike thorax which can be extended or retracted. The tip of the abdomen is also flattened (Photo 13). The larva rolls the leaf margins of one or more leaves together (Photo 14) to provide a protected feeding area.

The insect is not considered to be a serious pest of rice and is rarely found in numbers sufficient to cause economic damage.

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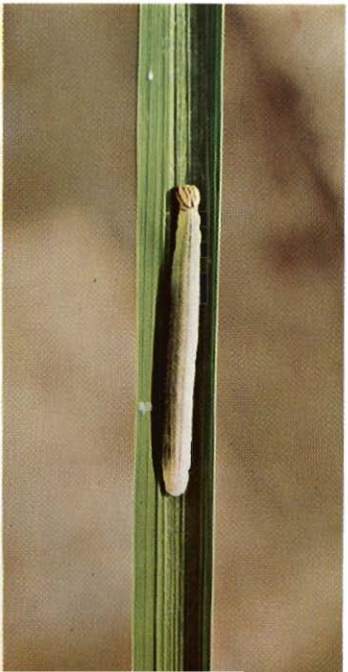

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Rice plant hopper

Photo 15. *Sogatodes oryzicola.* Photo 17. *Sogatodes cubanus*

This small insect has caused tremendous damage to rice fields. It transmits the hoja blanca virus disease and is often present in sufficient number to destroy entire fields as a result of its feeding. Adults and nymphs (Photo 15) suck the sap from rice leaves and stems and from developing panicles during the boot stage. The insects excrete a honey dew substance which attracts fungi, causing sooty black spots on the surface of the leaves and stems (Photo 16). The males are smaller and darker than the females, and the nymphs (immature stage) are wingless and have two black stripes running the entire length of the body. This species is distinguisned from a similar insect, *Sogatodes cubanus*, which has two black spots on the back corresponding to the tips of the front wings (Photo 17). *S. cubanus* is common in rice fields but feeds on grasses and neither transmits the hoja blanca virus to rice nor causes feeding damage.

Protection against attacks from this insect and from the virus is obtained by the use of resistant varieties. The varieties in the center and on the right of Photo 18 are susceptible to mechanical damage by the insect while the variety on the left is resistant.

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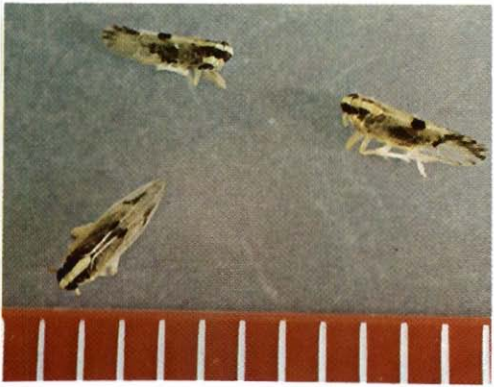

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Leafhoppers

Photo 19. *Draeculacephala clypeata.* Photo 20 *Hortensia similis*

Several species of green leafhoppers, along with the **Sogatodes** plant hoppers, are common in rice fields. Although sometimes found in great numbers, they cause little damage except to very young rice.

The species *Draeculacephala clypeata* (Photo 19) can be distinguished by its long pointed head. The head of the *Hortensia similis* (Photo 20) is rounded and has a characteristic pattern of black spots and designs on the front.

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Leaf (flea) beetles

Photos 21 and 22. Adult and larva of **Disonycha** sp.

These are small, shiny beetles that feed on the rice leaves. They vary in size from 2 to 6 mm, and the color may vary from bright yellow to black. Some have characteristic spots, others may have stripes, while others may be of a solid color. The larvae of some of these insects also attack the roots of upland rice.

The larva and adult (Photos 21, 22) of **Disonycha** sp. are serious rice pests in northern Brazil. Photo 23 illustrates severe damage caused by feeding of the leaf beetle larva.

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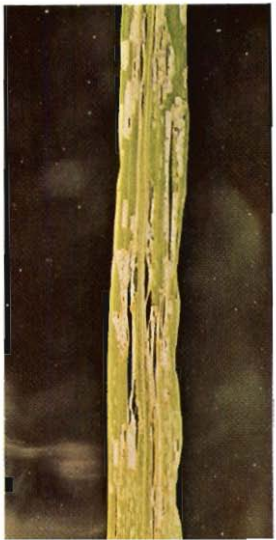

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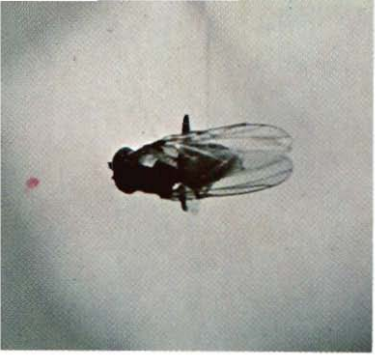
Rice leaf miners

Photo 24. **Hydrellia** sp.

This pest of flooded rice is widespread, and a number of species are known. It usually attacks young flooded rice or newly transplanted rice. The adult is a small fly about 3 mm in length (Photo 24). The adult lays one egg on the newly emerging leaf blade; and upon hatching, the small larva tunnels into the leaf blade, leaving longitudinal white scars (Photo 25). By holding the leaf blade up to the sun, the small larva or pupa may be seen. If the larva penetrates into the whorl of the plant, it produces white, damaged areas that can be seen through the leaf sheaths and causes damaged leaf tips (Photo 26), which resemble the damage caused by the white tip nematode.

When numerous, this insect seriously reduces rice stands. Photos 27 and 28 show typical plant damage.



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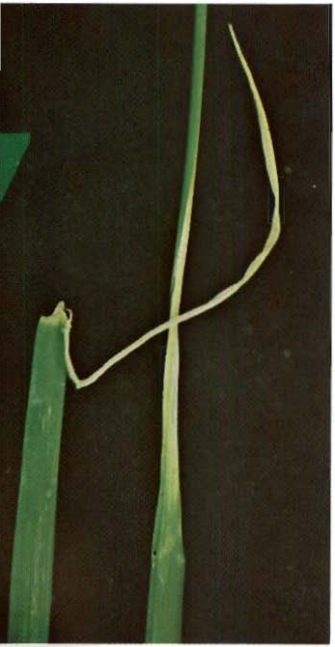

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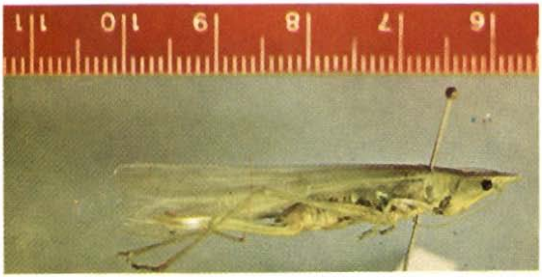
Grasshoppers

Photo 29. *Caulopsis cuspidata.* Photo 32. *Orphulella punctata*

There are a number of both long- and short-antennaed grasshoppers that attack rice. Photo 29 shows a common long-horned grasshopper, *Caulopsis cuspidata.* Long-horned grasshopper adults and nymphs feed on leaves (Photo 30) and stems (Photo 31), producing white heads. Short-horned grasshoppers (Photo 32) may also eat leaves but occasionally feed on the developing grains (Photo 33). In most rice-growing areas, these insects do not cause economic damage; but in Guyana and in the Caribbean area, they can cause significant damage if not controlled.



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Stemborers

Photos 34 and 35. *Diatraea saccharalis.*

There are four or five species of stemborers that attack rice in Latin America, but only three are considered to be important.

The most damaging and the most widely distributed is the sugar cane borer. The adult moth (Photo 34) is seldom seen since it is hidden during the day. Eggs are laid on the leaves, and the newly hatched larva may feed on the surface of the leaves for a few days before entering the plant through the leaf sheaths and then boring into the stems. The mature larva (Photo 35) has brown spots on each segment of the abdomen but no stripes are present. When the plant is attacked at an early stage, the growing tip may be destroyed, producing dead hearts (Photo 36). Later attacks produce white heads (Photo 37).

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Photos 38 and 39. *Rupella albinella*

The white rice stemborer is found from Mexico to Peru and across northern South American from Colombia to Surinam. The white moth (Photo 38) is commonly seen on the uppermost leaf tips. The whitish or cream-colored larva (Photo 39) is easily recognized by its small head, tapered abdomen and the absence of spots or stripes on its ribbed body. In upland rice it can be a serious pest attacking at ground level and feeding upward in the stem. This insect is not normally a serious pest in irrigated rice even though present in high populations. Plants attacked by the insect usually show a yellowing of the lower leaves (Photo 40). After the pupa stage is complete, the adult exits through a hole (Photo 41).

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Photo 43. Elasmopalpus lignosellus

The lesser corn stalk borer at times seriously damages upland rice in Central America and in Brazil. The larva attacks the base of the plant often causing death (Photo 42). The adult insect is a slender moth (Photo 43) with grayish brown front wings and white rear wings. In the resting position, the wings are folded over the back. The mature larva is bluish green with brown stripes and measures about 15 mm. The larva remains in the stem only during feeding and is found in the soil at the base of the plant when not feeding. Since the larvae live in the soil, they are controlled by heavy rains.

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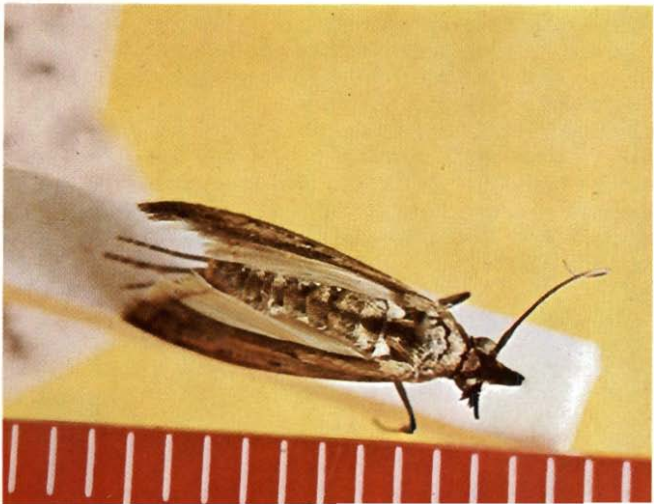

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Stink bugs

Photo 44. *Tibraca limbativentris.*

These insects can be recognized by their shield-shaped bodies and by the disagreeable odor given off when they are caught and mashed. Both adults and nymphs cause damage. The large plant stink bug, *Tibraca limbativentris,* (Photo 44) is present in most rice-growing areas, but is a serious pest of rice in southern Brazil, Argentina and Bolivia. It is identified by its size, brown color and by the two small triangular pits on each side of the front of the scutellum. Early attacks produce dead hearts while late attacks cause white heads (Photo 45) similar to the damage caused by the stemborers. But initial damage is made on the uppermost internode (Photo 46).

Many species of stink bugs attack the developing grains in the milk or dough stage. Most have the typical shield-shaped body but vary in size and color. Early attacks may produce

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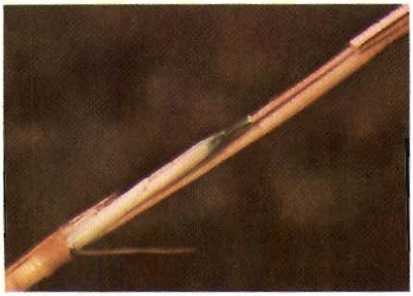

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Photo 49. *Oebalus poecilus* Photo 50. *Alkindus atratus.*

empty grain and significantly reduce yields. Later attacks produce light and chalky grains that break during milling (Photo 47). Stink bug damage to rough rice can be detected by the presence of the brown fungus spots which appear at the point where the grains were pierced by the insect (Photo 48).

The principal stink bug in northern South America and Brazil is *Oebalus poecilus* (Photo 49), which closely resembles other species in Central America and in the Dominican Republic. The small black stink bug is found in Colombia and other parts of Central America. This insect, *Alkindus atratus,* resembles a small black beetle but belongs to another stink bug family (Photo 50).

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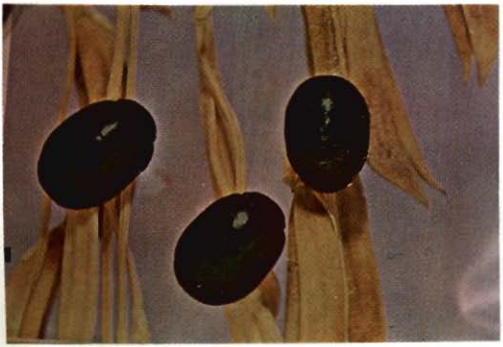

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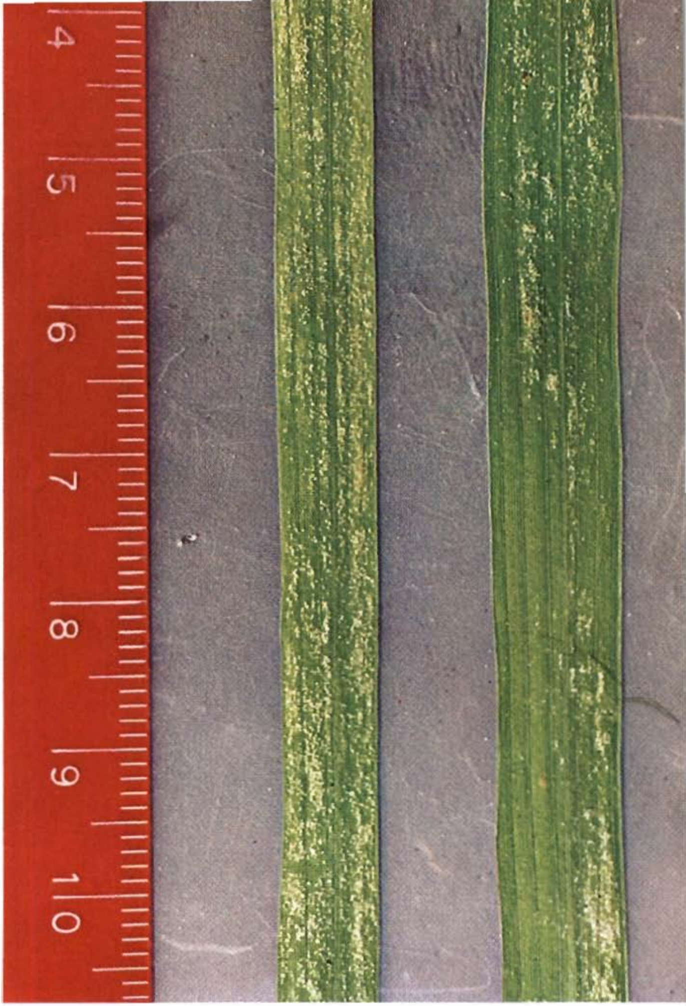
Spider mites

Although these are not true insects, as they have eight legs instead of the six characteristic of insects, the damage caused is similar to the damage caused by the former. The almost microscopic mites feed on the leaf blades (Photo 51). They usually appear during periods with little or no rainfall and can cause considerable damage to leaves if not controlled.



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Rice blast

Pyricularia oryzae

Rice blast is caused by a fungus that attacks all stages of plant growth. It is most damaging in nursery beds for transplanting. It also attacks the leaves of actively tillering plants, the nodes of stems and panicles.

Typical leaf lesions (Photo 52) are diamond shaped (reaching 1.5 cm in length) and the center of the lesion is grayish; whereas early infection and resistant reactions cause small brown spots that are difficult to distinguish from other leaf diseases. Large leaf lesions often coalesce and kill the plants. When nodes are infected (Photo 53), the upper portion of the stem dies. Infection may occur in any part of the panicle or at the base of the panicle, causing neck rot (Photo 54). Severe neck rot causes heavy yield losses as the panicle may produce some grains that are usually light and have poor milling recovery. Blast spots on the glumes of seeds are often confused with **Helminthosporium** and other fungi.

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The disease is disseminated by spores carried by wind. High humidity, prolonged soft rains and cool nights favor disease development. Heavy nitrogen supply and dense populations stimulate the disease. Blast is more damaging on upland than on irrigated rice.

Varietal resistance (Photo 55) is the most economical way to control blast. However, the fungus readily produces new forms that attack resistant varieties after one or two years of planting. Careful water control following establishment of seedlings and split applications of nitrogen reduce leaf blast. Fungicides are frequently used to reduce neck rot losses and to improve milling quality.

55

Brown leaf spot

Cochiobolus miyabeanus (Helminthosporium oryzae)

Brown leaf spot is caused by a fungus that attacks seedlings, leaves and developing grains. Spots on leaves are oval or circular, uniform in size, dark brown and evenly distributed (Photo 56). The spots on glumes are dark and often resemble other diseases. In severe cases, the spots may cover the entire panicle, causing direct grain loss (Photo 57).

The disease is usually found on upland rice in poorly drained areas and on plants suffering nutritional disorders including silica, potassium and late nitrogen deficiency, or the accumulation of toxic substances in strongly reduced soils. Brown spot is not important on nutritionally healthy plants.

Disease control is best accomplished by correcting the soil problem. Fungicide applications and varietal resistance are not practicable.

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Narrow brown leaf spot

Sphaerulina oryzina (Cercospora oryzae)

Narrow brown leaf spot is primarily a leaf disease that occasionally causes minor spotting on glumes. The fungus causes very narrow, linear, brown lesions parallel to the veins of leaf blades (Photo 58). The lesions on susceptible varieties are somewhat wider and lighter brown. The disease is common but rarely important. It can cause numerous lesions and leaf drying on maturing plants of highly susceptible varieties, resulting in some yield loss.

Varietal resistance is the only practicable means of disease control. Most modern varieties are moderately to highly resistant. Highly susceptible varieties should be avoided in high humidity areas where the disease is common.

Leaf scald

Rhynchosporium oryzae

Leaf scald is a fungus disease that attacks the older leaves. The lesions usually begin at the leaf tips and progress down the leaf blade. The lesions commence as water-soaked blotches and develop into large areas encircled by dark brown bands with lighter brown halos (Photo 59). The zonation caused by dark brown margins and lighter inner areas is diagnostic. Lesion enlargement results in the drying and death of severely infected leaves. The fungus may attack grains, causing glume discoloration and sterility.

The disease is common on upland rice in Central and South America. It is not serious on irrigated rice. Severe attacks of leaf scald may cause yield loss, but it is not generally regarded as economically important outside of Central America.

Heavy nitrogen applications favor disease development. Some varieties are susceptible while others are considered to be tolerant or resistant. No efficient fungicide control programs are known.

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Stackburn disease

Alternaria padwickii, (Trichoconis padwickii)

Stackburn disease, caused by a weak fungal pathogen, is an uncommon leaf and grain problem of minor economic importance. Leaf spots which rarely cause much damage are large and rounded, with dark brown and narrow margins that encircle the pale centers of the spots like a ring (Photo 60). The light straw-colored centers may show numerous small black sclerotia. The leaf spots rarely, if ever, occur in abundance.

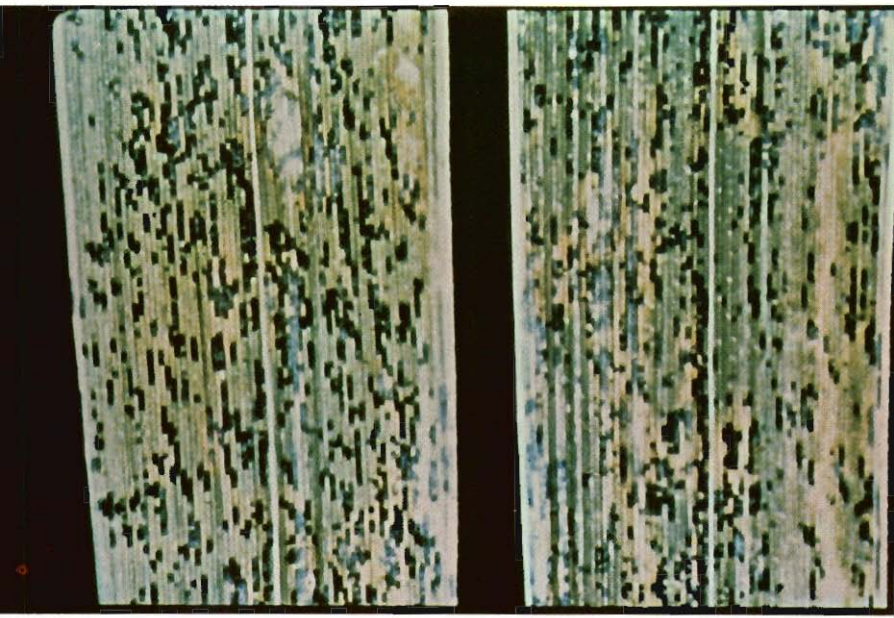
Infected grains show pale spots with black dots in the center surrounded by a dark border. The spots are difficult to distinguish from other diseases. Under favorable conditions the fungus may attack a high percentage of grains in the field, causing seed discoloration. When planted, these grains may result in seedling blight and death of young plants.

Specific control methods are unknown.

Leaf smut

Entyloma oryzae

Leaf smut, caused by a fungus, is a widespread, fairly common disease of little or no economic importance. The fungus causes small, black spots on both sides of the leaves of older plants. The spots are usually linear or rectangular and rarely coalesce (Photo 61). Heavily infected leaves may turn yellow. Each spot is covered by an epidermis that when removed by soaking in water, reveals a black mass of spores. No control measures are known or necessary.



Stem rot

Leptosphaeria salvinii (Helminthosporium sigmoideum, Sclerotium oryzae)

Stem rot is an important disease of rice. Infection of stems begins near the water line through wounds, as a black, irregular lesion that enlarges as the disease advances. The fungus produces sclerotia inside the leaf sheath and eventually penetrates the culm (Photo 62). One or two internodes are rotted, and tissues are covered with numerous, small, black sclerotia that are diagnostic (Photo 63). The upper leaves of infected stems frequently become yellowish and may die (Photo 64). Rotting stems lodge and yield losses can be high.

Sclerotia are distributed in irrigation water. High levels of nitrogen and wounds caused by insects or other agencies favor disease development.

Chemical control of stem rot is not effective. Burning of straw and stubble reduces the level of sclerotia. Large differences in varietal reaction to the pathogen are known, and the use of resistant and/or nonlodging varieties is the most effective control measure.

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Sheath blight

Thanatephorus cucumeris, (Rhizoctonia solani, Corticium sasakii, Pellicularia sasakii)

The fungus causing sheath blight causes lesions on leaf sheaths and occasionally on leaf blades. Infection is observed only on older plants. Typical lesions are irregularly elliptical, about 2 to 3 cm long, and are gray-white, surrounded by brown margins (Photo 65). The lesions may coalesce (Photo 66) and kill the upper leaves. Brown sclerotia are often attached loosely to the lesions. Severe infection causes reduced panicle size, sterility and grain losses. Typical leaf blade lesions are shown in Photo 67.

The disease is favored by warm weather and all factors that give high humidity: heavy density, high tillering and heavy fertilization with nitrogen. The disease appears to be increasing in severity, parallel to the adoption of the modern, short varieties. It can be severe on upland as well as on irrigated rice.

Although no highly resistant varieties are available, many are considerably more tolerant than others. The avoidance of highly susceptible varieties and reduced nitrogen are the most effective means of control.

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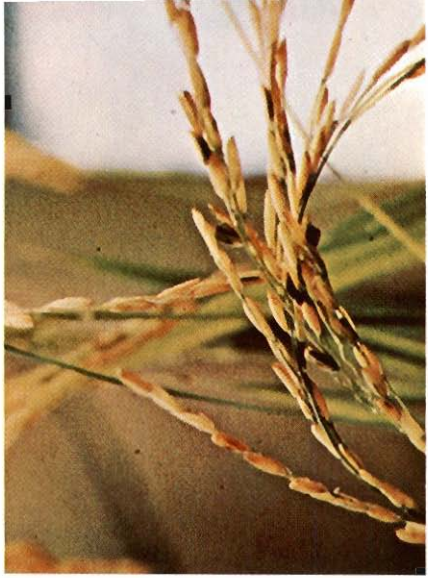
Kernel smut

Tilletia barclayana

Kernel smut, a fungus disease of maturing grains, is commonly observed but has a very low incidence and is not economically important—either as a cause of yield loss or as a source of infected seed. The disease is not systemic--as is the case of many other cereal smuts—and only infects opening flowers individually.

Rarely are more than a few grains affected in a panicle (Photo 68). Some grains have the seed totally replaced by a mass of black spores while in others only a part of the seed is affected (Photo 69). Infected grains show a dull color before the glumes are separated by the spore mass.

No control measures are practiced or necessary, and seed treatment is of no value.



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False smut

Ustilaginoidea virens

False smut is caused by a fungus that causes conspicuous symptoms. The disease is frequently observed but has little or no economic importance.

Symptoms are seen only in maturing panicles. Infection occurs in young panicles; and few (occasionally several) grains are affected per panicle (Photo 70). Individual grains are transformed into greenish yellow spore balls that eventually turn dark. The spore masses may reach 1 cm or more in diameter.

Humid weather favors disease development. Some varieties of rice appear to be more resistant than others, but special control measures are not necessary.

Hoja Blanca

Hoja blanca, the only rice virus disease in Latin America, is cyclical in nature, causing severe economic losses for several years followed by a period of relative unimportance.

The easily identified field symptoms include long yellowish white stripes and mottling on leaves (Photo 71 and 72), stunting of the plant (Photo 73), and small, deformed, highly sterile panicles with discolored spikelets. The disease rarely appears before plants are about two months old and begins in isolated patches that rapidly spread to cover the field.

The only important vector of the virus is *Sogatodes oryzicola.* The disease is not transmitted by seed, soil or other agents. Fertilizer, density and water have little effect on disease development and spread.

Hoja blanca is controlled at present through plant resistance to the insect vector. A few varieties are also highly resistant to the virus. Insecticide control of the vector does not satisfactorily control hoja blanca.

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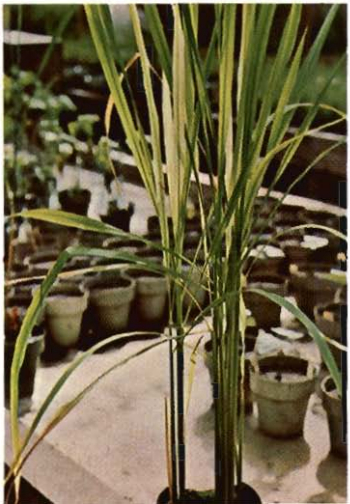

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Nematode diseases

White tip, caused by a seed-borne nematode, *Aphelenchoides besseyi*, is identified by chlorotic or white leaf tips of older plants (Photo 74). Flag leaves may be twisted, causing incomplete panicle emergence (Photo 75). Affected panicles are small, highly sterile and show distorted glumes.

The nematode survives well on infected seed and in soil and spreads in the field from infected to healthy plants. Heavily infested fields suffer considerable yield reduction.

The disease may be controlled through (1) varietal resistance, long-grain varieties being more resistant than short-grain types; (2) hot water treatment of seed at 54°C for 15 minutes; (3) seed treatment with any of several chemicals; and (4) seeding in water with pregerminated seed.

A minor disease caused by a root-knot nematode (Photo 76), *Meloidogyne javanica*, incites leaf discoloration and death and plant stunting in upland rice in Argentina and Brazil.

Upland rice in Brazil following successive crops shows yellowish leaves, retarded growth, reduced tillering and yield reduction. The nematode involved has been identified as *Pratylenchus brachyurus*. Crop rotation or land fallowing results in normal yields.

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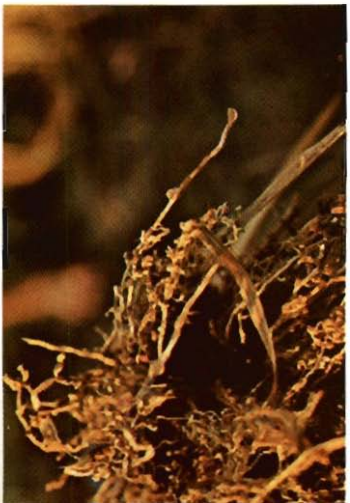


Straighthead

Straighthead is a physiological disease of unknown cause associated with flooded soils. It does not occur on upland rice. The disease is most severe and can cause drastic yield reduction on undrained, sandy soils containing a great deal of organic matter.

Affected panicles are highly sterile and remain erect (Photos 77, 78). The hulls are distorted and the glumes may be reduced in size or absent. Severely affected plants show incomplete panicle development and emergence or remain in the vegetative stage and occasionally produce tillers from stem nodes.

Resistant varieties and thorough draining and drying of the soil for a few days when the rice is about 50 days old successfully control straighthead.

77

78

Herbicide damage

Some herbicides cause leaf spotting that is frequently confused with blast, brown spot and other foliage diseases. Herbicide damage (Photos 79, 80) is usually confined to the borders of fields, the spots are iregularly shaped, and the spotting does not spread from affected to healthy areas in the field or from older, damaged leaves to newly formed leaves.

79

80

Rodent damage

Rodents cause serious damage in the field, and some plantings may be totally destroyed. Rodents attack plants at all stages but cause the greatest damage at seeding and after panicles are initiated. They most commonly cut off the stem (Photo 81) and feed on the developing panicle; the plants give the appearance of having been lodged (Photo 82).

No form of control is completely effective. Constant trapping, poisoning, and killing of rodents in their burrows in levees over large areas is helpful. Control measures in small areas are rarely practicable because the animals migrate from untreated fields into treated areas.

81

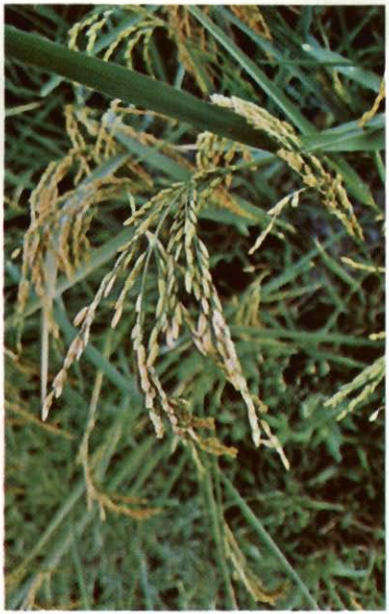
82

Bird damage

Many species of birds cause damage to rice. Ducks and other waterfowl uproot and destroy seedlings in irrigated fields. Many seed eaters, especially migratory species, cause heavy losses by feeding on grain in the milk stage (Photo 83) and on mature seeds. Damaged panicles in the milk stage show a typical whitish discoloration of the glumes (Photo 84).

The best control is to schedule planting to avoid heading during migratory flights. Varieties show clear differences in panicle damage. All older, tall varieties having their panicles above the flag leaves are susceptible to bird damage. Short, modern varieties having long flag leaves extending over the panicles escape extensive damage so long as they remain erect and do not lodge.

83



84

Nitrogen deficiency

Nitrogen deficiency is the most common nutrient problem in rice fields. The leaves may vary from pale green to yellow (Photo 85), and tillering and growth are poor (Photo 86).

The problem is more serious in upland rice, in fields with poor water control, and in cold or light soils. Nitrogen does not persist in the soil for more than a few weeks and should be applied two to three times during the growing period to maintain good leaf color and vigor.

85

86

Phosphorus deficiency

Phosphorus deficiency is common on the more acid soils of Latin America. It is generally more severe on upland soils since flooding increases phosphorus availability.

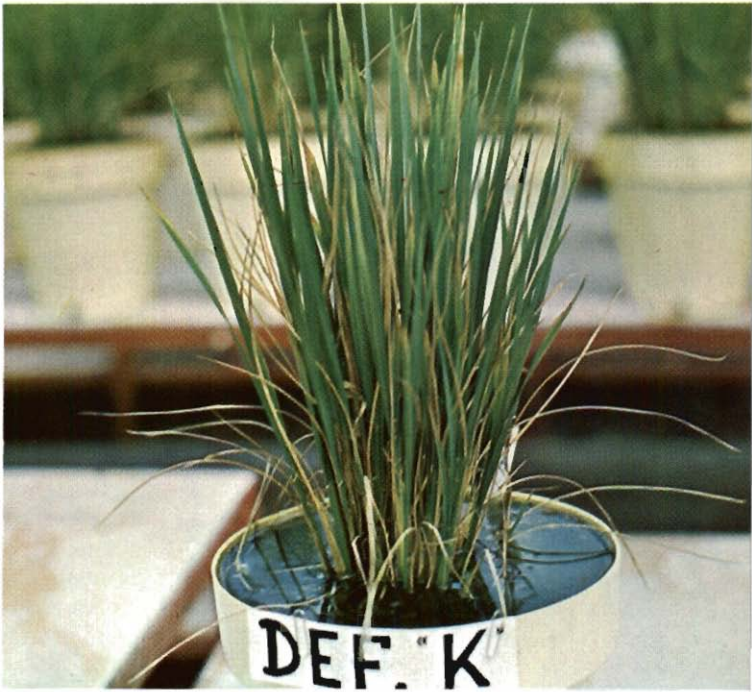
Phosphorus is important for root development, growth and tillering; when phosphorus is deficient, the rice will not respond to the application of nitrogen or potassium fertilizer. An experimental plot which received nitrogen and potassium but no phosphorus is shown in Photo 87 and is compared to one receiving complete fertilizer (Photo 88). Phosphorus should be applied before or shortly after planting.

87

88

Potassium deficiency

Potassium deficiency is difficult to diagnose in young rice since the only symptom is a difference in the color of the lower leaves. Plants may be moderately stunted, but tillering is only slightly reduced. As the plants become older, the lower leaves become yellowish green, starting from the tips, and begin to droop (Photo 89). With increasing age, the lower leaves turn brown; and the yellowish coloration extends to the upper leaves. In some cases brown spots occur on the dark green leaves. Applications of potassium should be made to the soil shortly before or after seeding.



89

Iron deficiency

Iron deficiency is a common seedling disease on neutral or alkaline upland soils (Photo 90), but can also occur on acid soils during periods with little or no rainfall. The deficiency may persist after flooding alkaline soil (Photo 91). Mildly affected seedlings often grow out of the problem with little damage to yield.

Many abandoned banana plantations show iron deficiency symptoms when planted to rice (Photo 92). This is due to copper toxicity caused by the application of Bordeaux mixture over many years. The excess copper inhibits the absorption of iron and produces iron deficiency symptoms.

Iron deficiency on alkaline soils can be avoided by transplanting healthy rice seedlings into a flooded field or by applying sulfur to lower the pH of the soil.

Pregerminated rice may be sown into water if the field has been preflooded for a period of four weeks and if the soil is not allowed to dry during the seedling establishment period.

90

91

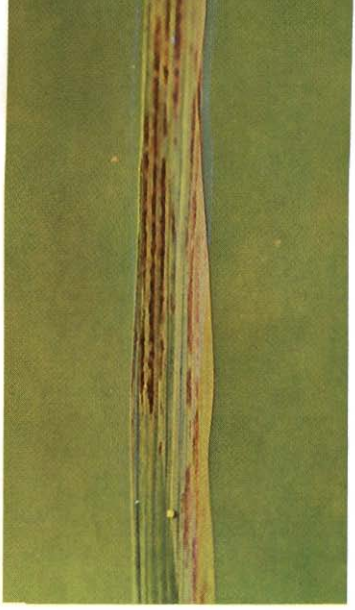
92

Manganese deficiency

Mangenese deficiency is not common on the soils currently being planted to rice in Latin America. It occurs on sandy, highly permeable, upland soils where the rapid percolation of rain water leaches the available manganese. Damage does not occur on impermeable, flooded soils.

The symptoms are diagnostic and appear as reddish brown streaks in the leaf blades (Photos 93, 94).

Probably the most practical control is the use of foliar applications of manganese. Soil applications of 50-75 kg/ha of manganese sulfate can also be used during the land preparation.



93

94

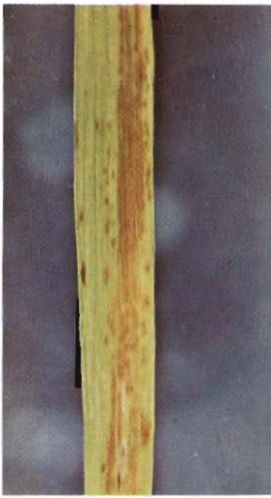
Sulfur deficiency

Sulfur deficiency is rare but may become more important as new savanna or forested land is brought under cultivation.

The symptoms (Photo 98) are identical to those of nitrogen deficiency, and it is not possible to distinguish visually between the two problems. Sulfur-deficient plants are yellow to pale green in color and are generally weak and slow growing.

The application of 30 to 50 kg/ha of sulfur when preparing the fields usually meets the requirements of the rice plants. Sulfate of ammonia is superior to urea as a source of nitrogen fertilizer.

95



96

97

Iron toxicity

Iron toxicity is a serious problem that occurs only in strongly acid, flooded soils with a pH generally below 5.5. Iron toxicity is not a problem on upland rice. Two types of iron toxicity –indirect and direct–are recognized and can result in severe damage. In the indirect or yellow type, the roots (Photo 99) are inactivated by a coating of iron oxide, and the older leaves (Photo 100) become yellowish or orangish in color. The problem is associated with phosphorus deficiency and insufficient development of new roots. In this case, the leaves have not absorbed excessive amounts of iron. Varietal resistance is being observed under field conditions (Photo 101).

Direct iron toxicity occurs when the leaves absorb excessive amounts of iron. The first symptom is the appearance of many small rust-colored spots on the tips of the lower leaves. These spots enlarge and progress down the leaf in rows between the veins of the blade (Photo 102). The mid-vein usually remains green and unaffected for several weeks after the appearance of the problem. Iron toxicity can seriously affect plant growth (Photo 103).

Iron toxicity is usually controlled by the application of lime to increase the pH, by preflooding for four to five weeks prior to planting, or by draining off the flood water without allowing the soil to dry excessively whenever the symptoms begin to appear.

99

102

100

101

103

Aluminum toxicity

Generally,aluminum toxicity is not a serious problem in rice in the western hemisphere. It may be severe in strongly acid (below pH 5.0), upland rice soils; but usually after failures with experimental plantings in new unknown areas, farmers do not replant upland rice.

Root growth is greatly reduced and the leaves become yellow with dead leaf tips (Photo 104). These symptoms may be confused with cold temperature damage in temperate climates.

The problem is corrected by liming to raise the pH or by flooding prior to planting. However, on such strongly acid soils, iron toxicity usually occurs as a result of flooding.

Salinity

Salinity usually occurs in arid irrigated regions during periods of low rainfall. During these periods, water flow in the rivers is inadequate to replace evaporation losses and to dilute the saline drainage water which continually enters the rivers. When the soil dries, a white crust of evaporated salts is deposited on the surface due to movement upward from the highly saline water table.

Symptoms usually occur in the lower parts of the field where there is a greater amount of water to evaporate. Leaf tips turn whitish and die (Photo 105). If the rice is nearing maturity, white and empty panicles may emerge at heading time.

PHOTOGRAPHS

Co-author Robert L. Cheaney contributed the majority of the photographs. The other photographs were taken by: Centro Internacional de Agricultura Tropical, Nos. 34, 35, 38, 46, 95, 97 and 101; V. Arnold Dyck, No. 28; Federación Nacional de Arroceros (Colombia), Nos. 5, 7, 9 and 50; R.A. Fredericksen, Nos. 68 and 69; International Rice Research Institute, Nos. 4, 36, 37, 53, 54, 70, 81, 91, 94 and 101; National Institute of Agricultural Science (Japan), No. 74; Diego Navas (Universidad de Panamá), No. 1; S.H. Ou (IRRI), No. 63; Ramiro Pazos (ICTA, Guatemala), No. 92; H. David Thurston (Cornell University), No. 61; and J.C.H. Wang (IRI, Brazil), No. 98.

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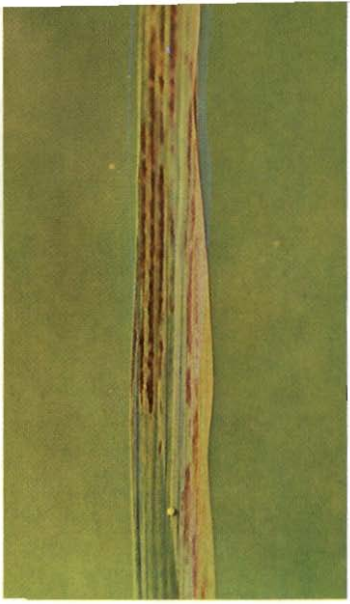

93

94

Zinc deficiency

Zinc is found in the organic matter section in soils. If this layer is removed by land leveling or by erosion, then zinc deficiency may occur.

Zinc deficiency occurs throughout the hemisphere but is most common on alkaline, calcareous soils. The high calcium carbonate content of these soils inhibits zinc uptake by the rice plants.

Zinc-deficient plants are stunted (Photo 95) although tillering may be normal. A rusty discoloration (Photo 96) begins on the leaf blade a few inches below the leaf tips, affecting both the veins and interveinal areas. When zinc deficiency is mild, the only observable symptom may be a failure to respond to nitrogen fertilization and irrigation. Zinc-deficiency symptoms are more severe after heavy nitrogen and phosphorus applications, and in severe cases affected plants may die (Photo 97).

The condition can be corrected by applying zinc oxide or zinc sulfate to the field before planting. Foliar applications of zinc are less satisfactory.