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Major Insect Pest Management in Paddy (Oryza sativa L.): A Review

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Abstract
Rice (Oryza sativa L.) is a staple food crop supporting more than half of the global population. However, its productivity is severely constrained by insect pests, which cause significant yield losses at different crop growth stages. More than 100 insect species infest rice, but only about 15–20 species are of economic importance. Major pests include stem borers, planthoppers, leaf folders, gall midge, and gundhi bug. Effective pest management requires an integrated approach combining cultural, biological, mechanical, and chemical methods. This review highlights major insect pests of rice, their damage symptoms, and sustainable management strategies with emphasis on Integrated Pest Management (IPM).

Keywords: *Rice, insect pests, IPM, biological control, sustainable agriculture*

1. Introduction

Rice is one of the most important cereal crops globally and plays a critical role in food security. Insect pests are a major biotic constraint in rice production, ranking second only to weeds in causing yield losses . These pests attack rice at all growth stages—from nursery to storage—resulting in reduced yield and grain quality .The intensification of rice cultivation, excessive nitrogen fertilization, and indiscriminate pesticide use have led to pest outbreaks and resistance development. Therefore, sustainable pest management strategies are essential. Integrated Pest Management (IPM) and Integrated Nutrient Management (INM) are the two pillars of crop management that has direct influence on the yield and quality. Healthier soils produce crops that are less damaged by pests. The interactions among fertilizers, rice cultivars, and pests may have dramatic effects on yield, yet these interactions are poorly understood. Soil fertility practices can affect the susceptibility of crop plants to insect pests directly or indirectly. Soils with high organic matter and active soil biological activity generally exhibit good soil fertility as well as complex food webs and beneficial organisms that prevent pest build up. On the other hand, farming practices that cause nutrition imbalances can lower pest resistance. The resistance or tolerance of plants to insect pests seems to be closely related to various soil properties. A soil's physical condition, level of compaction, water-holding capacity, and drainage, affects soil and plant health. The chemical aspects of soils (pH, salt content, availability of nutrients, etc.) can affect crop health and pest susceptibility. Recent studies have shown that plant resistance to insect and disease pests is linked to optimal physical, chemical, and—perhaps most importantly—biological properties of soil (Altieri and Nicholls, 2003; Zehnder et al., 2007). There are several strategies for improving the soil health like crop rotation, growing of green manures, cover crops, tillage practices, mulches and clean cultivation that also help in reducing the insect pest incidence. This lecture includes major insect pests of rice and impact of fertilizers, organic manures on these pests and strategies to be considered for enhanced soil fertility and effective pest regulation.

1.1 Insect pest scenario in rice – present status

Since the onset of green revolution in rice in the country, there has been a concomitant accentuation and tremendous change in the pest scenario. Among the major pests, yellow stem borer, Scirpophaga incertulas Walker which was not known in areas like Punjab and Haryana has assumed number one pest status, some times inflicting severe losses. Gall midge, Orseolia oryzae Wood-Mason, is now a wide-spread pest causing serious losses in many new areas like U.P., Bihar, N.Eastern state of Manipur etc. in addition to its severe status not only in kharif but also in rabi seasons in coastal areas of A.P. and Kerala. Similarly, planthoppers as well as leaf folder, Cnaphalocrocis medinalis Guenee which were of minor importance, assumed major pest status. Brown planthopper, Nilaparvata lugens Stal and whitebacked planthopper, Sogatella furcifera Horvath are now of serious concern in Punjab, Haryana and parts of U.P. They have been recognised as major pests responsible for significant decline in yield of rice in different cropping system zones and are considered as national pests. Other sporadic pests viz., rice hispa, Dicladispa armigera Olivier occurring in Andhra Pradesh, Himachal Pradesh, Bihar, West Bengal, Orissa and North Eastern region, green leafhopper, Nephotettix virescens Distant prevalent in Bihar, West Bengal, Assam, Orissa, Madhya Pradesh, Andhra Pradesh and Tamil Nadu, gundhi bug, Leptocorisa spp. in upland rice in Uttar Pradesh, Bihar, West Bengal, Orissa, Madhya Pradesh, Manipur and parts of Andhra Pradesh, climbing cutworm, Mythimna separata Walker in upland rice growing areas and swarming caterpillar, Spodoptera mauritia Boisduval in low lying rice in Bihar, West Bengal, Assam and Orissa have been considered regionally significant. Major insect pests of rice along with symptoms of damage were given below:

Brown planthopper (BPH), Nilaparvata lugens Stal

Both adults and nymphs suck sap from the base of the tillers, resulting in yellowing and drying of the plants. At early stages of attack, round yellowish patches appear which soon turn brownish due to drying up of the plants. The patches of infestation spread in concentric circles within the field and in severe cases the affected field gives a burnt appearance known as 'hopper burn'. The hopper populations can multiply very fast and migrate over long distances causing widespread infestation in short time. Apart from causing direct damage, BPH also acts as a vector of grassy stunt virus.

White backed planthopper (WBPH), Sogatella furcifera Horvath

WBPH is relatively smaller in size compared to BPH with a conspicuous white spot on dorsal thorax. The nature of damage of WBPH is similar to BPH. Both nymphs and adults suck the plant sap from phloem and cause drying up of plants. Unlike BPH, it does not cause sudden and severe hopper burn.

Yellow Stem borer (YSB), Scirpophaga incertulas Walker

The stem borers attack rice crop throughout the growth

Figure 1. BPH nymphs

Figure 2. WBPH nymphs

Figure 3. Hopper burn

Figure 4. YSB adult

Figure 5. Dead heart

period from nursery up to harvest. The damage results in characteristic symptoms of 'dead hearts' or 'white ears' depending on the stage of the crop. During vegetative phase, due to larval feeding, the central leaf whorl does not unfold, turns brownish and dries out although the lower leaves remain green and healthy. The affected tillers do not grow further and eventually dry. The dead heart comes out easily when pulled and emits foul smell. At reproductive phase, the damage is characterized by whitish, erect and chaffy panicles, which are very conspicuous in field and are called 'white ears'.

Leaf folder (LF), Cnaphalocrocis medinalis Guenee

Leaf folder damage was found at all the stages of crop growth. Larva folds the leaf and feeds by scraping the green mesophyll tissue from within the fold. This feeding result in longitudinal white stripes and under severe infestation whole field appears scorched. Usually a single larva was found in each fold. The folding and feeding of leaf folders affects the photosynthetic ability

Figure 6. White ear

Figure 7. Caption

Figure 8. Caption

Figure 9. Caption

Figure 10. Caption

of the leaf resulting in yield reduction. The damage to the flag leaf was a more serious concern as there will be a direct impact on grain yield.

Gall midge, Orseolia oryzae

The maggot of rice gall midge enters inside the young rice plant and starts feeding on growing portions. As a result, the meristematic tissue grows and encloses the feeding insect inside. The meristematic tissue as it grows, turns into a pale green tubular structure called "silver shoot." The larvae pupates inside the silver shoot and emerges as adult from the top portion of silver shoot. The damaged tiller does not bear panicle. The crop under severe infestation is stunted with more numerous tillers.

Influence of fertilizers on insect pests

Nutrition management is one of the most important practices for high production system, but nutrition management may affect response of rice to pests, as well as development pattern of pest populations due to the change of environments. The understanding of impacts of nutrition management on interactions between rice and pests is a basis to stimulate high yield production system. Most pest management methods used by farmers can be considered as soil fertility management strategies and vice versa. Development of fertilizer responsive high yielding varieties has resulted in the indiscriminate use of fertilizers especially nitrogenous fertilizers. Application of these fertilizers has long term effects on the growth of the plant which in turn affects the pest population dynamics in rice ecosystems.

Effect of Nitrogen on insect pests of rice

Nitrogen is the most essential mineral nutrient for plant growth and development and proper nitrogen management is essential in intensive agriculture for plant production. The heavy application of nitrogen fertilizer rarely affects insect directly, however, it can alter or change morphological, biochemical and physiological characters of host plants and improve nutritional conditions for herbivores. More nitrogen application was forced for more occurrence of insect pests and diseases, especially brown plant hopper (BPH), leaf folder (LF), stem borer (SB), blast (Bl) and red-stripped disease (RSD). Many insect species exhibit higher growth rates and decreased development times when their host plant is fertilized at high N levels (e.g., Fisher and Fiedler 2000, Slansky and Feeny 1977, Tabashnik 1982).

The effects of nitrogen fertilization on population dynamics and natural control of rice leaf folder were studied in an irrigated rice area by de Kraker et al (2000). They found that the average density of leaf folder larvae at the highest nitrogen level was eight times more than that at the zero nitrogen level, while the injured leaves ranged from 5% to 35%. The severe increase in larval density was due to the positive effect of nitrogen fertilization on egg recruitment and survival of medium-sized larvae. The rice plants with high nitrogen were preferred to feeding and oviposition by Brown planthopper (BPH). Plants with high nitrogen content had high feeding rates and honeydew excretion, less probing behavior, higher survival rates, fecundity and oocytes production and high tendency for outbreak of BPH (Cheng, 1971; Lu et al, 2004 & 2005). Kanno et al (1977) monitored the feeding activity of BPH using the isotope mark of 32P and found that the feeding amounts, honeydew excretion and nitrogen content in the body of BPH on high nitrogen plants were increased by 3-7, 7 and 2-3 times, respectively. The water content (WC) and relative water content (RWC) significantly increased, while the amount of sap flowed reduced statistically with the increase in nitrogen content of rice plants. However, the RWC in rice treated with high nitrogen fertilizer drastically decreased due to the injury by BPH nymphs, while the reduced survival duration with the increase of nitrogen content was recorded. This might be one of the key factors for enhancing the susceptibility to BPH damage in rice plants supplied with nitrogen fertilizer (Lu et al, 2004). Nitrogen fertilization also significantly increased the populations of WBPH, GLH, and small brown planthopper ((Hu et al, 1986; Ma Lee, 1996). However, Ma and Lee (1996) found that GLH population did not increase with higher nitrogen levels in fields at later transplanting times. The dead hearts and white heads caused by Yellow stem borer (YSB) increased with higher nitrogen levels (Yein Das, 1988). Similar effects of nitrogen on the incidence of Striped stem borer (SSB), Chilo suppressalis had also been observed

(Tan, 1986). The application of nitrogen fertilizer can increase the succulence in stems and leaves, which can lead to greater stem borer attack, higher larval weights and shorter the developmental time. Liu and Qin (1997) reviewed the population of YSB and SSB in China and found that the rates of damage, densities, and the weight and sizes of larval body of SSB increased significantly with the increase in nitrogen, while the nitrogen content of rice plant was a key factor affecting the diapause of YSB larvae. However, whorl maggot and rice thrips incidence was not increased with increase in doses of nitrogen.

Effect of phosphorous on insect pests

Phosphorous fertilizer did not affect rice growth, but improves root development resulting which in turn increases tolerance for root pests, such as root weevil, Echinocnemus oryzae (Tirumala Rao, 1952). There was no difference in plant height, number of tillers / square foot at various P2O5 levels. Only the SPAD index was responded to P2O5 levels, higher dose of phosphorous made the rice leaves greener than as compared to control (no phosphorous application). Application of phosphorous fertilizers (0 – 60 kg/ ha) did not affect the development and outbreak of pests. However, application of 40 kg P2O5 resulted in low stem borer damage as compared to other treatments (chau et al, 2003).

Effect of potassium on insect pests

Lowest leaf folder infestation and white ear incidence was recorded at higher doses of potassium (100 kg/ ha). Similarly ear head bug and blue beetle damage was found low at high dose of K (Kulagod et al, 2011). K applications may suppress pests by lowering plant sugar and aminoacid levels, promoting thicker cell walls and increasing silicon uptake (Baskaran, 1985).

Effect of balanced use of fertilizers

Gururaj katti et al (2004) reported lowest white ear damage as well as leaf folder damage at recommended levels of N, P and K. Studies in India, China, Indonesia Philippines and Vietnam found lower insect pest incidence in fields with site specific nutrient management as compared to farmers fertilizer practices (Sta cruz et al, 2001; Samiayyan et al, 2000). Minor plant nutrients, such as silicon and zinc, can also contribute to pest suppression. In the proper quantities, silicon can increase the resistance of rice plants to planthoppers, and stem borers (Chang et al 2001, Kim and Heinrichs 1982, Pathak et al 1971, Prakash 1999). Zinc applications reportedly minimize damage by Elasmopalpus, a stem borer of dryland rice (Reddy 1967).

Soil fertility & plant resistance to insect pests

Plant resistance to pests depends on the age and growth of the plant which is associated to the physiology of the plant directly. Thus any factor that affects the physiology of the plant like fertilization has been shown to affect all three categories of resistance viz., non-preference, antibiosis & tolerance. Fertilization also causes changes in growth rates, size of plant parts, prolonged vegetative stage, accelerated or delayed maturity, change in flowering etc which indirectly influences the growth and development of insect pests. Effects of soil fertility practices on pest resistance can be mediated through changes in nutritional content in crops. The responses of BPH to nitrogen differed on rice varieties with different resistance levels. Little differences in honeydew excretion, survival rate and population built-up of BPH were found on resistant rice varieties at 320 kg/ha and 160 kg/ha nitrogen rates. The damages on resistant variety IR26 by BPH were not affected apparently by nitrogen applications, but on susceptible variety Kaoshenyu 12 the damages was obvious. The BPH weights, feeding rates and population growth increased with nitrogen application on IR26, Utri Rajapan and Triveni. Population growth of BPH increased threefold on resistant varieties IR26 and Utri Rajapan, and twofold on moderately resistant variety Triveni, without antibiosis (Heinrichs and Medrano, 1985). At the same rate of nitrogen fertilizer, more BPH adults were located on susceptible varieties than on resistant ones (Wang and Wu, 1991).

Soil nutrient availability not only affects the degree of damage to plants by herbivores but also the ability of plants to recover from such damage. The addition of N stimulates tiller production, which helps rice plants compensate for early stem borer damage (Rubia et al 1996). Similarly, plants with high N content have an improved ability to compensate for planthopper feeding (Rubia Sanchez et al 1999).

Effect of organic manures on insect pests

Use of organic manures, either alone or in combination with fertilizers is increasing day by day in rice production. In addition to improving the soil fertility status, these organic manures may also affect insect pests. The organic manures create a partial nitrogen stress up to certain period without any negative effects on crop growth and thus induce resistance through intrinsic production of defense compounds, which deter the pest attack. The low nitrogen content in plants due to organic manures leads to increased phenols, tannins and lignins that make the leaf toughness and production of more cell wall related structural compounds which are not desirable for herbivores.

The organic crops have been shown to be more tolerant

Table 1. Major Insect Pests of Paddy and Their Management

Pest	Scientific Name	Damage Symptoms	Management Practices
Yellow Stem Borer	Scirpophaga incertulas	Dead hearts, white ear heads	Pheromone traps, Trichogramma release, need-based insecticides
Brown Planthopper	Nilaparvata lugens	Hopper burn, wilting	Resistant varieties, avoid excess nitrogen, imidacloprid spray
Leaf Folder	Cnaphalocrocis medinalis	Leaf folding, reduced photosynthesis	Light traps, biological control, neem spray
Gall Midge	Orseolia oryzae	Silver shoots	Resistant varieties, timely planting
Rice Hispa	Dicladispa armigera	White streaks on leaves	Manual removal, insecticide spray
Gundhi Bug	Leptocorisa acuta	Chaffy grains, bad odor	Netting, malathion spray

Table 2. Economic Threshold Levels (ETL) of Major Rice Pests

Pest	Stage	ETL
Yellow Stem Borer	Vegetative	5% dead hearts
Yellow Stem Borer	Reproductive	2% white ear heads
Brown Planthopper	All stages	10 insects/hill
Leaf Folder	Vegetative	2 damaged leaves/hill
Gall Midge	Tillering	5% silver shoots
Gundhi Bug	Milky stage	1 bug/panicle

as well as resistant to insect attacks and organic rice is reported to have thicker cell wall and lower levels of free amino acid than conventional rice. Surekha et al (2010) reported that, the white ears and dead hearts in rice were slightly more in inorganic treatments compared to organics. Outbreak of stem borer in rice crop was reported to be low with organics compared to synthetic inorganic fertilizers (Luong and Heong, 2005). Significantly lowest percent of silver shoots was reported when nutrients were met through organics irrespective of plant protection measures. Low incidence of insect pests such as plant hoppers and leaf hoppers was observed in organically farmed rice fields compared to traditional fields (Hidaka; 1997; Kajimura et al., 1993, and Kajimura, 1995). Surekha et al (2010) also reported more populations of natural enemies such as Platygaster oryzae, mirid bugs and spiders in organic treatments compared to inorganics. Hesler et al (1993) and Louis et al (1993) reported significantly abundant populations of predators like giant water bugs, back swimmers and diving beetles in organic fields. The density of immigrants of the rice plant hopper species Sogotella furcifera was significantly lower and the settling rate of female adults and survival rate of immature stages of ensuing generations were generally lower in organic compared to conventional rice field. Luong and Heong, (2005) opined that the organics or manures affected rice plant growth and minimized the outbreak of brown plant hopper. A multi-location study on effect of organic manures on insect pests' under AICRIP entomology program revealed that the leaf folder damage, white ears by stem borer and BPH population were low in vermicompost applied plots followed by FYM applied plots. Neem cake and karanj cake applied plots recorded low pest incidence followed by vermicompost applied plots (AICRIP Progress report 2008 - 2010).

Effect of pesticide applications on soil fertility

There is also evidence that certain pesticides can reduce soil fertility. Different pesticides will increase or decrease ammonification, nitrification, denitrification, and nitrogen fixation. Some insecticides, such as lindane (HCH) and chlorpyriphos, increase extractable ammonium in flooded soils. Malathion and parathion, organic phosphate insecticides, inhibit the activity of soil urease under flooded conditions. The effects of pesticides on nitrogen transformations can be temperature-dependent. HCH applied in combination with carbofuran result nitrification in flooded soils. Certain pesticides inhibit denitrification in irrigated soils. Carbofuran stimuates nitrogen fixation of Nostoc muscorum in liquid culture at low concentrations but inhibits N fixation at high concentrations (Ray and Sethunathan 1988). Application of triazophos resulted in the reduction of N and P contents and increase in K and Zn in rice foliage regardless of cultivars and nutrient levels.

Effect of Soil fertility management practices on insect pests

A number of soil fertility management practices like

Table 3. Recommended Insecticides and Doses for Rice Pests

Pest	Insecticide	Dose	Remarks
Stem Borer	Chlorantraniliprole 18.5 SC	150 ml/ha	Apply at ETL
BPH	Imidacloprid 17.8 SL	100 ml/ha	Avoid repeated use
Leaf Folder	Flubendiamide 20 WG	50 g/ha	Spray at early stage
Hispa	Quinalphos 25 EC	1000 ml/ha	Uniform coverage
Gundhi Bug	Malathion 50 EC	1000 ml/ha	Spray at milky stage

Table 4. Biological Control Agents in Rice Pest Management

Agent	Target Pest	Application
Trichogramma japonicum	Stem borer	Release 50,000/ha weekly
Cyrtorhinus lividipennis	Planthoppers	Conservation biological control
Beauveria bassiana	Various pests	Spray 5 g/litre
Metarhizium anisopliae	Planthoppers	Spray formulation
Neem oil (Azadirachtin)	General pests	3-5 ml/litre spray

crop rotation, cover crops, tillage practices, green manures and application of compost and other organic manures have great impact on insect pests wherein most of these practices breaks their life cycle, creates unfavorable environment for pest multiplication and expose them to natural enemies leading to low pest damage.

Theory of trophobiosis

Trophobiosis is derived from two Greek roots – trophikos (nourishment) and bio- sis (life): "the relationships between plant and parasite are primarily nutritional" Chaboussou,p.206). According to the trophobiosis theory, it is nutrient deficiencies and imbalances that lead to pest and disease outbreaks, and that synthetic pesticides and fertilizers can cause such deficiencies and imbalances. According to this theory, pests can only survive on plants that have an excessive level of soluble nutrients in their sap or tissues, such as amino acids, sugars, nucleotides, minerals. The excess can be due to inhibition of proteosynthesis, to predominance of proteolysis over proteosynthesis or to excessive production of amino acids. Inhibition can be caused by pesticides or by unbalanced nutrition. Excessive production of amino acids comes from oversupply of nitrogen from soluble fertilizers.

2. Major Insect Pests of Paddy

2.1 Yellow Stem Borer (Scirpophaga incertulas)

- **Damage symptoms:** Dead hearts (vegetative stage), white ear heads (reproductive stage)
- **Nature of damage:** Larvae bore into stems and feed internally

2.2 Brown Planthopper (Nilaparvata lugens)

- **Damage symptoms:** Hopper burn, plant wilting
- **Importance:** Major pest causing severe outbreaks in Asia

2.3 White-backed Planthopper (Sogatella furcifera)

- Causes sap sucking and transmits viral diseases

2.4 Rice Leaf Folder (Cnaphalocrocis medinalis)

- Larvae fold leaves and feed on chlorophyll
- Reduces photosynthetic area

2.5 Rice Gall Midge (Orseolia oryzae)

- Causes “silver shoots” or “onion leaf” symptoms

2.6 Rice Hispa (Dicladispa armigera)

- Scrapes leaf surface leading to white streaks

2.7 Gundhi Bug (Leptocorisa acuta)

- Sucks sap from developing grains
- Causes chaffy grains and bad odor
  These pests are widely reported as economically important across rice-growing regions

3. Yield Losses Due to Insect Pests

Yield losses vary depending on pest species, infestation level, and environmental conditions. In severe cases, losses can reach 30–70%, particularly due to planthoppers and stem borers. Pest population dynamics fluctuate seasonally and geographically .

Cross-Referencing Note

As shown in Figure 1, insect pests undergo complete metamorphosis, which is crucial for timing control measures. Figure 2 illustrates the integrated approach required for sustainable pest management in rice ecosystems. The first borer resistant variety ‘IR-20’ of rice was developed by crossing TKM-6 (highly resistant donor) x TN-1. This variety is moderately resistance to striped rice stem borer (Chilo suppressalis) and yellow stem borer (S. incertulas) of rice, besides possessing resistance to green leafhopper (Nephotettix spp.),

Table 5. Economic Threshold Levels (ETL) of Major Rice Pests

Pest	Stage	ETL
Yellow Stem Borer	Vegetative	5% dead hearts
Yellow Stem Borer	Reproductive	2% white ear heads
Brown Planthopper	All stages	10 insects/hill
Leaf Folder	Vegetative	2 damaged leaves/hill
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Hispa	Quinalphos 25 EC	1000 ml/ha	Uniform coverage
Gundhi Bug	Malathion 50 EC	1000 ml/ha	Spray at milky stage

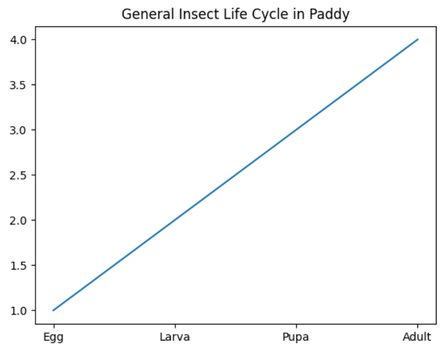

Figure 11. Generalized life cycle of major insect pests in paddy showing egg, larva, pupa, and adult stages.

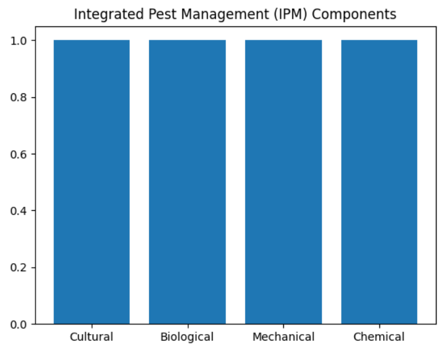

Figure 12. Components of Integrated Pest Management (IPM) in rice including cultural, biological, mechanical, and chemical approaches.

tungro virus, bacterial leaf blight and several races of blast. Co-4 variety of cowpea having characters of pod formation in wider cluster, wider angle between the pods and peduncle and thick pod wall was found to be highly resistant to spotted pod borer (Maruca testulalis). Sugarcane varieties like Co-62207, with a high spine density on the lower leaf surface or mid-rib were found to be less susceptible to attack by the sugarcane top borer (S. nivella). Rice varieties containing high deposits of silica showed tolerance to some borer species (Scirpophaga spp. and Chilo spp.) of the crop as these worn out mandible of the insects.

4. Conclusion

Insect pests remain a major challenge in rice production, significantly affecting yield and quality. Sustainable management through IPM is the most effective approach to mitigate pest damage while ensuring environmental safety. Future strategies should focus on integrating advanced technologies with traditional practices to achieve long-term pest control and food security. To date, the application of the science of pest nutrient interactions on rice consists of simple recommendations to split nitrogen applications, plow straw into the soil to increase silicon uptake, apply K during planthopper outbreaks, or apply N to promote recovery following stem borer and defoliator damage, to give a few examples (Litsinger 1994, Peng 1993). While useful, these sorts of unquantified recommendations fall short of giving farmers the tools necessary to manipulate pest populations through nutrient management. Furthermore, the literature is full of contradictory implications for the manipulation of soil nutrients to manage rice pests. N applications cause at least some rice cultivars to release oryzanone, which makes them more attractive to stem borers (Seko and Kato 1950). On the other hand, the addition of N stimulates tiller production, which helps rice plants compensate for early stem borer damage (Rubia et al 1996). Planthopper incidence is increased by N applications (Cook and Denno 1994, Uthamasamy et al 1983), but plants with high N content have an improved ability to compensate for planthopper feeding (RubiaSanchez et al 1999). These apparent contradictions result from several factors: most of the studies are conducted on one or a few cultivars, soil properties are rarely considered,

Table 7. Biological Control Agents in Rice Pest Management

Agent	Target Pest	Application
Trichogramma japonicum	Stem borer	Release 50,000/ha weekly
Cyrtorhinus lividipennis	Planthoppers	Conservation biological control
Beauveria bassiana	Various pests	Spray 5 g/litre
Metarhizium anisopliae	Planthoppers	Spray formulation
Neem oil (Azadirachtin)	General pests	3-5 ml/litre spray

Table 8. Resistant cultivars developed/identified for different crops in India.

Crop	Insect-pest	Cultivars
1. Maize	(a) Stem borer (Chilo partellus)	Deccan 101 & 103; Ganga 4, 5, 7 & 9; Ganga safed-2 etc.
2. Rice	(a) Brown plant hopper (Nilaparvata lugens)	Manasarowar, Bhadra, Joyti, CO-42 etc.
	(b) Gall midge (Orseolia oryzae)	IR-36, Surekha, Lakshmi, Kunti, Shakti, Rajendradhan, CAUS-1 etc.
	(c) Green leaf hopper (Nephotettix virescens)	IR-20, IET 7301, IET 7302, IET 7303, Vani etc.
	(d) Yellow stem borer (Scirpophaga incertulas)	Ratna, IET-3093, IET-2845, IET-2812, Soket etc.
	(e) Multiple resistant lines (stem borer, leaf folder, thrips, blue beetle etc.)	PTB 12, PTB 20, PT 321, H-4 etc.

and most of the research is done under artificial conditions in which natural enemies and other contributing variables cannot affect the results. There is a need to describe the combinations of soil nutrient management and cultivar choices that encourage or discourage yield loss from damage by key rice pests. It is also essential to develop nutrient management recommendations that promote better compensation for and better host plant resistance against pest damage in new and popular rice cultivars. Now, the time has come for integrating pest and nutrient management strategies by improving the match between INM and IPM recommendations for rice so that farmers can strike a balance between applying enough fertilizer to increase yields without increasing pest damage.

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