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Integrated Pest Management of Basmati Rice

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Indian Basmati rice has been cultivated for centuries in the Himalayan foothills of the Indian subcontinent, a geographical region known for its long-grain, aromatic rice. With its extra-long, slender grains and a distinctive soft and fluffy texture, superior aroma, distinct flavor and has ability to elongate to at least twice its original size when cooked. The Basmati crop is therefore one of the most important cash crops in North India during the kharif season (Anonymous 2024). One of the major biotic constraints on production and quality of these crops is insect-pests. During crop season, high humidity and warmer temperatures are very conducive for their development and rapid multiplication (Atwal and Dhaliwal 2015, Randhawa et al 2023). An early season blanket application of insecticides is performed by farmers instead of based on need. Because of lack of knowledge regarding insect pest identification and damage potential, this occurs. The quality grain production and yield reduction can be checked, according to the information provided about identification, damaging symptoms and integrated management of major insect-pests is given below. A sustainable approach to pest management, IPM combines cultural, biological, chemical and physical tools with the help of pest scouts in a way that minimizes economic, health and environmental risks. IPM relies heavily on knowledge of pests and crop interaction to choose the best combination of locally available pest management tools (Fig. 1). Therefore, IPM is not a single product that can be stored on shelves like pesticide and it does not rely on single method to solve all our pest problems. Pests also co-evolve and adapt very quickly to single control tactics through natural selection and that multiple methods used simultaneously, or an "integrated" approach, is the most effective for long-term, sustainable pest management programs (Dutta 2015). Following is a detailed description of the main insect-pests of basmati rice (Anonymous 2024a) :

Stem Borers

Three species of stem borers attack these crops from July to October. Forewings of yellow stem borer (YSB) females are creamy yellow in colour with a black dot in the center of the wings (Photo 1), whereas, forewings of white stem borer female are slivery white in color (WSB). The female of pink stem borer (PSB) are robust and tan with dark brown markings, from central point in the forewing, a typical radiation of grey-black lines spreads toward the wing tips (Photo 2). Egg masses laid by the YSB and WSB females can be seen near the leaf tips, whereas bead like single eggs are laid inside the leaf sheath by PSB female moths. YSB and WSB borer attack the crop in the early stage of crop growth, whereas, PSB attack the crop in mid and later part of the crop growth. The larvae of all the borers in a similar manner bore into the stems and feed inside the stem tissues causing yellow and dry central shoots called, '*dead hearts*' in vegetative crop stage (Photo 3). These dead hearts can be easily pulled from the plant, whereas damage in the form of 'white ears' in panicle bearing plants are observed which are empty ear heads and remain white, seed less and stand erect. These dead hearts can be easily pulled from the plant, whereas, in older plants, damage symptoms are observed as empty ear heads which remain white and stand erect called 'white ear' s. Such damaged plants can be easily observed in the field from a distance (Kaur et al 2021).

Control Measures

a) Cultural Control: Sowing of nursery and transplanting should be restricted as per recommendations to reduce the population build-up of borers especially on the successive *Basmati* crop. From July 1 to July 15, transplant 25 to 30 days old nursery plants of basmati varieties, except Pusa Bas 1509 (25 days old nursery) and CSR 30 after July 15.

b) Chemical control: Regular monitoring of crop for stem borers damage is necessary. As and when dead heart damage reaches more than 2 % (economic threshold level (ETL) apply any one of the recommended insecticides (Table 1). Further application may be repeated with alternative insecticide, if required.

Leaf Folder

The females are yellow to light brown in colour and forewings have distinct dark brown wavy lines and dark brown bands along outer margin. Female lays translucent, flat and oval eggs singly or in pairs on the underside of leaf blades. The young larvae feed on green leaf tissues without folding them, whereas older larvae feed on green tissues by folding them. The damaged leaves produce white streaks and become

membranous that reduces photosynthetic activities of the crop (Photo 4).

Control measures

a) Cultural control: It is advisable to refrain from planting or transplanting crops in shaded areas under trees or buildings, as these locations can potentially facilitate the proliferation of pests. Additionally, it is recommended to minimize the application of nitrogen-rich fertilizers and excessive irrigation. Strictly follow the sowing/transplanting time for the crop as per recommendations.

b) Mechanical control: Dislodge the larvae by passing 20-30-meter-long coir/jute rope, forward and backward, both ways while touching the crop canopy. This practice should be conducted with caution, ensuring that there is standing water in the crop, and ideally before the flowering stage.

c) Chemical control: Regular monitoring of the crop is necessary, when the leaf damage reaches 10% ETH with more than 1/3rd damage on leaf; apply any of the recommended insecticides (Table 1).

Plant Hoppers

The white backed plant hopper (WBPH) (Photo 5) and brown plant hopper (BPH) (Photo 6) are two common species of plant hoppers that can cause damage to rice crops. The WBPH adult hopper is characterized by a narrow white streak on the thorax and a black dot on each forewing. In contrast, BPH adults are typically light to dark brown in color. Both species lay eggs in leaf sheath tissues and both nymphs and adults feed on sap from the base of the tillers, particularly from the leaf-sheath portion, between July and October. The symptoms of plant-hopper infestation include dry brown leaves starting from the tip and spreading downwards, leading to a condition known as "hopper burn" (Photo 7). Infested plants may appear as dry patches in the field. As the plants dry out, the hoppers migrate to nearby green plants, causing rusty patches to appear. Additionally, the hoppers excrete honeydew, which can lead to the development of sooty mold on the leaves, hindering photosynthetic activities. During *kharif* 2022, a new problem of dwarf/stunted plants was observed in the crop in North India due to new virus disease, 'Southern Rice Black-streaked Dwarf Virus (SRBSDV)', (Photo 8) the vector of this disease is WBPH nymphs and adults.

Control Measures

a) Cultural control: To monitor hopper population, it is recommended to regularly alternate between wetting and drying the fields. When hopper population shows its presence, drain the water from the field for 3-4 days, depending on the soil type. It is important to prevent the development of cracks in the fields during this process.

b) Chemical control: Do regular monitoring for hopper population. About one month after transplanting, a few plants in the field should be slightly tilted and tapped 2-3 times at the base at weekly interval and count the number of hoppers falling on the water, if a minimum of 5 hoppers per hill (ETL) are seen floating on the water, then the crop should be sprayed with recommended insecticides (Table 1). Further application of any alternate insecticide may be repeated if hopper population again reaches at ETL. For better and effective results, direct the spray towards the base of the plants. If damage is noticed at hopper burn stage, treat the affected spots/patches along with 3–4-meter periphery immediately as these spots harbor high population of planthoppers.

Grasshoppers: Adults are green, larger with transverse black lines on pronotum. It lays eggs in soil at a depth of 5 cm. Both nymphs and adults cause enormous loss to the crop by chewing and cutting various plant portion *viz.*, leaves, flowers and grains. They completely defoliate the plants leaving only the mid ribs and the plant growth is affected.

Management

- Expose the eggs to be picked up by birds after ploughing and trimming the bunds during the hot months.
- The surrounding crops area should free from all kinds of weeds.
- Insecticides recommended for the control of plant hoppers are also effective against grasshoppers.

Rice Hispa

The glossy bluish-black adult beetles, also known as "kandian waali bhundii," possess numerous short spines on their bodies. The female beetles deposit their eggs within the epidermal layers on the underside of the apical portion of leaves. The adult beetles are external feeders, while grubs feed by tunneling into the leaves and causes damage by producing bold, white streaks on the leaves that reduces photosynthetic activities.

Management

- The hispa pest is more prone in waterlogged and low-lying area, so drain out excessive water from infested fields.
- If attack starts in the nursery, clip-off and destroy the leaf tips before transplanting.

- In transplanted crop, spray the crop with any of the recommended insecticides (Table 1).

Gundhi Bug: Both nymphs and adults suck the sap from individual grains at milky stage. Affected grains become chaffy with black spots at the site of feeding puncture. The foul smell observed from basmati fields during the insect infestation.

Management

- Fix light traps to reduce the adult population of the pest.
- Sweep nets also help for collection of adult population.
- Monitor the pest's population and apply any insecticides as recommended against rice hispa**.**

Measures for insect-pest management (Randhawa et al 2024 & Anonymous 2024)

- During *kharif* 2022, a new virus-related disease SRBSDV (Photo 8) was observed in some area of the north India in early transplanted crop, for which WBPH nymphs and adults (Photo 5) acts as a spreading vector. Prepare the fields well by incorporating previous crop residues before crop season and keep the water channels/bunds free from weeds/grasses.
- In nursery and early crop stage, WBPH population can be monitor by installing light traps near nursery and crop area. If WBPH population appear in light trap use recommended insecticides (Table 1).
- If the stunted rice plants are seen in nursery/main field, uproot these plants and bury deep in the soil.
- Laser leveling is necessary to avoid excessive irrigations.
- Apply only recommended dosage of nitrogenous fertilizers on soil test basis or by use of PAU-Leaf Colour Chart. Do not apply nitrogenous fertilizer after green manuring.
- In rice ecosystem there are many species of natural enemies like spiders (Photo 9), coccinellids, dragon flies (Photo 10), damsel fly and these are very effective against basmati insect-pests. So, care should be taken to do need-based insecticidal application only.
- To monitor the WBPH population in the nursery and early crop stages, light traps can be installed near these areas. If WBPH populations are detected in the traps, it is recommended to use insecticides as listed in Table 1.
- If stunted rice plants are observed in the nursery or main field, they should be uprooted and buried deep in the soil. Laser leveling is essential to prevent excessive irrigation, and only the recommended dosage of nitrogenous fertilizers should be applied based on soil tests or by using the PAU-Leaf Colour Chart.
- For basmati rice, nitrogenous fertilizers should not be applied after green manuring. In the rice ecosystem, natural enemies such as spiders (Photo 9), coccinellids, dragonflies (Photo 10), and damselflies play a crucial role in controlling rice insect pests. Therefore, it is important to apply insecticides only when necessary and in a targeted manner.

Natural enemies: There are many species of natural enemies in rice and basmati crop ecosystem (spiders, coccinellids, dragon fly, damsel fly and *Trichogramma*). These arthropods are very effective against insect-pests of both crops. So, the farmers are suggested to apply need-based insecticides only (Dutta 2015).

Caution

- Do not perform early season blanket application of insecticides, particularly synthetic pyrethroids as they result in an increase in the population of insect-pests, especially plant hoppers.
- Apply only the recommended dose of insecticides by using 100 litres of water per acre with Knapsack sprayer having fixed type hollow cone nozzle. In *basmati*, granular insecticides should be applied in standing water after wearing gloves.
- Do not use these insecticides banned by the Punjab Government on *basmati* to avoid the residue problem of these chemicals in the produce namely, acephate, buprofezin, chlorpyriphos, methamidophos, thiamethoxam and profenofos.

* Chemicals belong to green chemistry category. Prefer Ecotin or PAU Homemade Neem Extract at pest initiation stage. Use gloves while applying granular insecticides.

Method of preparation of PAU Homemade Neem Extract

Boil 4.0 kg terminal parts (including leaves, green branches and fruits) of neem trees in 10 liter of water for 30 minutes. Then filter this material through muslin cloth and use the filterate for spraying at the recommended dose. **Note**: Fame 480 SC or Takumi 20 WG or Coragen 18.5 SC or Mortar 75 SG or Fipronil 80 WG or Ferterra 0.4 GR or Vibrant 4 GR or

Padan/Kritap/Caldan/Sanvex/Nidan/Marktap/Miftap/Faltap-G/Katsu 4G or Regent/Mortel/Mifpro-G/Mahaveer GR/Shinzen 0.3G also control leaf folder.

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Table 1. Recommended insecticides against different insect-pests of the crop

Insect-pest	Brand(s)	Insecticide	Dose/ acre	Method of application
Stem borers	Ecotin	azadirachtin 5%	80 ml	Spray
	Achook/Neem Kavach	azadirachtin 0.15%	1 litre	
	Fame 480 SC	flubendiamide39.35%*	20 ml	
	Takumi 20WG	flubendiamide 20%*	50 g	
	Coragen 18.5 SC	chlorantraniliprole*	60 ml	
	Mortar 75 SG	cartap hydrochloride	170 g	
	Fipronil 80 WG	fipronil	15 g	
	Ferterra/ Marktera 0.4 GR	chlorantraniliprole*	4 kg	Granules by broad-casting in standing water
	Vibrant 4 GR	thiocyclam hydrogen oxalate	4 kg	
	Regent/Mortel/Mifpro-G/Mahaveer GR/ Shinzen 0.3G	fipronil	6 kg	
	Padan/Caldan/Kritap/Sanvex/ Nidan/Marktap/ Miftap/ Faltap-G/Katsu 4G	cartap hydrochloride	10 kg	
Leaf folder	Coragen 18.5 SC	chlorantraniliprole*	60 ml	Spray
	Fame 480 SC	flubendiamide 39.35%*	20 ml	
	Takumi 20WG	flubendiamide 20%*	50 g	
	Mortar 75 SG	cartap hydrochloride	170 g	
	Ecotin	azadirachtin 5%	80 ml	
Plant hoppers and Grass hoppers	Ulala 50 WG	flonicamid	60 g	Spray
	Pexalon 10 SC	triflumezopyrim	94 ml	
	Osheen/ Token/ Dominant 20 SG	dinotefuran	80 g	
	Chess 50 WG	pymetrozine	120 g	
	Orchestra 10 SC	benzpyrimoxan	400 ml	
	Imagine 10 SC	flupyrimin	300 ml	
	Ekalux/Quinguard/Quinalmass 25 EC	quinalphos	800 ml	
	Ecotin	azadirachtin 5%	80 ml	
	PAU Homemade Neem Extract	PAU Homemade Neem Extract	4 litre	
Rice hispa/Gundhi Bug	Ekalux 25 EC	quinalphos	800 ml	Spray

Table 2: Insect-pests, their damaging symptoms and natural enemies

Photo No.	Insect-pest/damaging symptom	Identification	Photo No.	Insect-pest/damaging symptom	Identification
1	Yellow stem borer adult		6	Brown planthopper adults and nymphs	
2	Pink stem borer adult		7	Hopper burn by plant hoppers	
3	Dead heart		8	Dwarf/stunted plants due to SRBSDV disease	
4	Leaf folder incidence		9	Spider	
5	White backed plant hopper adults and nymphs		10	Dragonfly	

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