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EFFICACY OF PESTICIDES AGAINST RICE PLANT HOPPERS AND INSECTICIDE AND FUNGICIDE COMPATIBILITY

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ABSTRACT

Insecticides viz., spinetoram (6%)+ methoxyfenozide (30%) 36EC @ 0.75 ml/l, triflumezopyrim 106SC @0.48 ml/l; fungicide, hexaconazole 5SC @ 2.0 ml/l, tricyclazole 75WP @ 0.6 ml/l, and their combinations viz., spinetoram (6%) + methoxyfenozide (30%) + hexaconazole @ 0.75+2.0 ml/l, spinetoram (6%) + methoxyfenozide (30%) + tricyclazole @ 0.75+0.6 ml/l, triflumezopyrim+hexaconazole @ 0.48+2.0g/l and triflumezopyrim+ tricyclazole @ 0.48+0.6 g/l along with an untreated check were evaluated against rice BPH on Pusa Basmati 1121 during kharif 2017 and Pusa Basmati 1637 during 2018. Brown planthopper (BPH), *Nilaparvata lugens* (Stal.) appeared in outbreak numbers in the experiments at 90 days after transplanting (DAT), while incidence of other insect pests and diseases viz., stem borer, leaf folder, sheath blight and blast remained very low. Amongst pesticides, triflumezopyrim+ tricyclazole (2017) and triflumezopyrim (2018) were observed to be the most effective treatment against BPH followed by triflumezopyrim+ hexaconazole. The efficacy of the combination products against BPH depicted that the fungicides did not affect the effectiveness of the insecticide. The fungicides, tricyclozole and hexaconazole were thus compatible with triflumezopyrim.

Key words: Rice, BPH, triflumezopyrim, BPH, pesticides, *Nilaparvata lugens*, rice

Rice (*Oryza sativa* L.*)* is one of the world's most important cereal crop providing a staple food for nearly half of the global population (Seni and Naik, 2017). In India, rice has a productivity of 2550 kg/ha (Anonymous, 2017). The rice alone provides 20% of the world's dietary energy supply (FAO, 2004). However, rice production is hampered by attack of a large number of insect pests and diseases. About nearly 300 species attack rice and among them 23 species cause notable damage (Pasalu and Katti, 2006). Among rice planthoppers, the brown planthopper (BPH), *Nilaparvata lugens (Stal.) is the most important (Krishnaiah et al., 2008)*. Besides this direct feeding damage, it also serves as the vector of rice grassy stunt and ragged stunt viruses (Ling, 1977; Narayana and Muniyappa, 1996; Rubia-Sanchez et al*.,* 2003; Grimshaw and Donaldson, 2007). Widespread outbreaks of the BPH occurred in Northern India in 2008 and 2013 that resulted in substantial yield losses (Chander and Palta, 2010; Chander and Husain, 2018).

Farmers rely heavily on insecticides and almost 50% of the insecticides used in rice are targeted against this pest alone (Reddy et al., 2012). There is a need to continuously evaluate new molecules and their combination. Besides, rice diseases such as sheath blight and blast also inflict significant yield losses and heavy fungicides applications are undertaken. Conventionally, insecticides and fungicides are applied separately which increases the expenditure on pest management activity. Therefore, joint application i.e. of insecticides and fungicides can help in reducing the expenditure on pesticides application, provided pesticides show compatibility with each other. The present study was carried out to explore efficacy of insecticides and fungicides compatibility against rice BPH.

MATERIALS AND METHODS

Field experiments were conducted with the rice cultivar, Pusa Basmati 1121 during kharif*,* 2017 and Pusa Basmati 1637 during kharif, 2018 at the experimental farm of ICAR- Indian Agricultural Research Institute, New Delhi (28.08 ^{0}N, 77.12 ^{0}E, 228.6 masl). During both years, nursery was sown on 19th June with a seed rate of 20 kg/ha, and raised following recommended agronomic practices without any pesticide application. Plot size was 5 x 4 sq.m. with 15 cm plant and 20 cm row spacing. One-month old seedlings were transplanted on 19th July during 2017 and 2018 crop season. Recommended dosages of nitrogen (N_2), phosphorous (P_2O_5) and potassium (K_2O) fertilizers were applied @ 120:60:40 kgha^{-1}. The N_2 was applied in three equal splits, as basal dose, at tillering and panicle emergence stage, whereas, P_2O_5 and K_2O were applied as basal dose only. Irrigation was done at weekly intervals until 10 days before harvest of the crop. The experiment had nine treatments, that comprised insectcidesviz, spinetoram (6%) + methoxyfenozide (30%) 36EC @ 0.75 ml/l, triflumezopyrim 106SC @ 0.48 ml/l; fungicides, hexaconazole 5SC @ 2.0 ml/l and tricyclazole 75WP @ 0.6 ml/l, and their combinations, spinetoram (6%) + methoxyfenozide (30%) + hexaconazole 5SC @ 0.75+2.0 ml/l, spinetoram (6%) + methoxyfenozide (30%) + tricyclazole75WP @ 0.75+0.6 ml/l, triflumezopyrim106SC + hexaconazole 5SC @ 0.48+2.0g/l and triflumezopyrim106SC +tricyclazole75WP @ 0.48+0.6 g/l and an untreated check. The experiments were conducted in randomized block design (RBD) with three replications.

The pesticides were applied at 23, 53 and 77 days after transplanting (DAT) during 2017 and at16, 54, 67 and 77 DAT during 2018 depending upon the need as dictated by pressure of pest number. Observations on pest incidence were begun at 30 DAT and continued until crop maturity at 10 days interval. In the experiments planthopper population comprising of both BPH and white backed planthopper (WBPH) *Sogatella furcifera* (Horvath) was enumerated on10randomly selected hills in each of the plots. Leaf folder, *Cnaphalocrocis medinalis* (Guenee) damage was assessed as percentage of damaged leaves based on damaged leaves and total number of leaves on 10 randomly selected hills in each of the plots. In case of the stem borer, number of dead hearts/white ears and total number of tillers were enumerated in 10 randomly selected hills in each of the plots and expressed as percent dead heart/white ear damage. Likewise, incidence of sheath blight and blast was also recorded on 10 randomly selected hills. At maturity, crop was harvested and threshed and yield was recorded separately for each of the treatments. Planthopper population data were transformed through square root transformation, while leaf folder as well as

Table 1. Compatibility of insecticides and fungicides against *N. lugens* in rice (kharif 2017)

Treatments	BPH population/10 hills at different days after transplanting (DAT)						Yield (kg/ha)
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	90 DAT	
Spinetoram 6% + methoxyfenozide 30% 36 EC @ 0.75 ml/l	7.30 (2.61)	4.00 (2.14)	8.70a (3.08)	38.00c (6.14)	273.70b (13.97)	592.30b (23.95)	3791abc
Triflumezopyrim 106 SC @ 0.48 ml/l	9.70 (3.23)	6.30 (2.57)	3.70a (2.15)	24.30b (4.87)	70.00a (6.59)	8.70a (2.50)	4833bc
Hexaconazole 5SC @ 237.5ml/l	6.70 (2.29)	4.30 (2.14)	8.70a (2.90)	42.00cd (6.49)	429.70b (14.91)	925.30c (30.36)	3433a
Tricyclazole 75WP @ 0.6 ml/l	5.30 (2.40)	3.30 (1.86)	5.70a (2.57)	19.00a (3.72)	180.00a (5.42)	825.70bc (28.72)	3800abc
Spinetoram 6%+ methoxyfenozide 30%+Hexaconazole SC @0.75+2.0 ml/l	3.00 (1.93)	2.30 (1.75)	3.00a (1.98)	40.00c (6.22)	163.70ab (10.90)	910bc (30.17)	3400a
Spinetoram6%+ methoxyfenozide30%+Tricyclazole SC @ 0.75+0.6 ml/l	9.00 (3.01)	6.30 (1.75)	8.00a (2.90)	33.70bc (5.86)	378.00b (15.23)	768.70bc (27.39)	3666ab
Triflumezopyrim+ hexaconazole SG @ 0.48+2.0 ml/l	5.00 (2.44)	3.00 (2.42)	2.30a (1.74)	11.70a (3.50)	87.70a (7.23)	48.00a (5.72)	4250abc
Triflumezopyrim+ tricyclazoles G @ 0.48+0.6	7.00 (2.82)	3.70 (1.95)	4.30a (2.10)	16.00a (3.87)	87.70a (7.13)	2.30a (1.82)	5066c
Untreated control	9.70 (3.15)	3.30 (2.00)	33.00b (5.38)	52.30d (7.29)	144.30a (6.50)	660.30bc (24.98)	4416abc
SEm (±)	0.81	0.51	0.90	2.30	3.16	2.81	622.2
LSD (P <0.05)	NS	NS	1.92	1.08	6.71	5.96	1319.1

*Data in parentheses square root transformed; **Yield data with same superscript do not differ significantly

Table 2. Compatibility of insecticides and fungicides against *N. lugens* (kharif 2018)

Treatments	BPH population/10 hills at different days after transplanting (DAT)							Yield (kg/ha)
	30 DAT	40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	
Spinetoram 6% + methoxyfenozide 30% 36EC @ 0.75 ml/l	1.00 (1.38)	1.70ab (1.57)	14.70 (3.78)	44.30abc (6.43)	295b (17.17)	1420b (37.66)	2317.30b (48.00)	2141a
Triflumezopyrim 106 SC @0.48 ml/l	0.00 (1.00)	0.70a (1.27)	19.30 (4.64)	8.30a (2.95)	1.70a (1.57)	2.67a (1.66)	0.00a (1.00)	4083b
Hexaconazole 5 SC @ 237.5 ml/ l	0.30 (1.13)	3.00b (1.98)	13.70 (3.76)	66.70bcd (8.15)	209.30b (14.07)	1021.70b (30.43)	2227b (46.36)	2816a
Tricyclazole 75 WP @ 0.6 ml/l	0.30 (1.13)	3.00b (1.97)	12.70 (3.69)	123.30d (10.60)	277b (16.31)	1354.30b (36.00)	2043.70b (44.07)	2925a
Spinetoram 6%+ methoxy- fenozide 30%+ hexaconazole SC @ 0.75+2.0 ml/l	0.00 (1.00)	0.30a (1.13)	13.70 (3.76)	74.70bcd (8.69)	330b (18.18)	1314.70b (35.95)	2719.70b (52.02)	2400a
Spinetoram 6%+ methoxy-fenozide 30%+ tricyclazole SC @ 0.75+0.6 ml/l	1.30 (1.47)	1.30ab (1.47)	18.00 (4.29)	86.30cd (8.93)	263.70b (16.00)	1412b (37.09)	2492.30b (48.63)	2941a
Triflumezopyrim+ hexaconazole SG @ 0.48+2.0 ml/l	0.70 (1.27)	0.30a (1.13)	17.30 (4.26)	14.30a (3.79)	4.30a (2.24)	2.33a (1.72)	0.00a (1.00)	4025b
Triflumezopyrim+ tricyclazole SG @ 0.48+0.6 ml/l	1.00 (1.33)	0.70a (1.27)	13.00 (3.73)	19.30ab (4.43)	2.00a (1.71)	0.00a (1.00)	1.00a (1.33)	4075b
Untreated control	0.00 (1.00)	0.30a (1.13)	14.00 (3.80)	99.70cd (9.75)	277.70b (16.32)	1396.70b (36.43)	2240.70b (46.31)	2641a
SEm (±)	0.26	0.27	0.61	1.96	2.16	5.37	6.14	481
LSD (P <0.05)	NS	0.57	NS	4.15	4.58	11.38	13.03	622.2 1021

*Data in parentheses square root transformed; **Yield data with same superscript do not differ significantly

stem borer damage (%) data were transformed through arc sine transformation. Transformed pest data and yield data were subjected to ANOVA for RBD.

RESULTS AND DISCUSSION

During both the years, planthopper population mainly comprised BPH while, WBPH was also there but in very low numbers. There was a substantial increase in BPH population during 2017 at 70 DAT and it varied from 70-378 hoppers/10 hills (Table 1). However, in treatments involving triflumezopyrim it remained low, between 70-87.7 hopper/10 hills and was thus less than the pest ETL i.e., 10 hoppers/ hill. On the other hand, in other treatments including untreated check, it ranged between 144.3- 429.7 hopper/10 hills. There was drastic increase in population at 90 DAT during 2017, it varied from 2.3- 925.3 hoppers/10 hills in various treatments. The population was recorded to be low in triflumezopyrim (2.3-48 hopper/ 10 hills), while in others it ranged from 592.3 to 925.3 hoppers/10 hills. Triflumezopyrim treatments viz., triflumezopyrim+ tricyclazole, triflumezopyrim, triflumezopyrim+ hexaconazole thus proved effective in that order. The yield was found to be maximum in triflumezopyrim+ tricyclazole followed by triflumezopyrim and triflumezopyrim+ hexaconazole (Table 1).

During kharif 2018, planthopper population at 60 DAT ranged from 8.3-123.3 hopper/ 10 hills (Table 2). With triflumezopyrim it ranged between 8.3-19.3 hoppers/10 hills. The population though increased substantially at 70 DAT during 2018 but it was recorded to be 1.7- 4.3 hoppers/ 10 hills in triflumezopyrim compared to 209.3-330 hopper/ 10 hills in other treatments. Further, there was drastic increase between 80-90 DAT (2240.7 hoppers/ 10 hills in untreated check). However, in triflumezopyrim, it ranged between 0-1 hopper/10 hills as compared to 2227-2492.3 hopper/ 10 hills in other treatments at 90 DAT. The yield was maximum with triflumezopyrim followed by triflumezopyrim+ tricyclazole and triflumezopyrim+ hexaconazole (Table 2).

The efficacy of triflumezopyrim did not seem to be affected by fungicides, hexaconazole and tricyclozole as triflumezopyrim+ tricyclazole and triflumezopyrim+ hexaconazole proved effective. The fungicides thus did not affect efficiency of triflumezopyrim when compared to application of triflumezopyrim alone. Efficacy of other insecticide, spinetoram+ methoxyfenozide against tissue consumers and their compatibility with fungicides could not be assessed. The leaf folder incidence ranged from 1.0-1.7% over the two years in different treatments which was well below its' economic injury level of 4.0% damaged leaves. Likewise, stem borer damage also remained less than 1% white ears in different treatments over two years. Besides, spinetoram+ methoxyfenozide did not show any efficacy because these are basically recommended against tissue consumers.

Triflumezopyrim has earlier been reported to be superior over other recommended insecticides against BPH and thus projected as a good candidate for insecticide resistance management (Gurulingapp et al*.,* 2016). This unique class of mesoionic insecticide target the nicotinic acetylcholine receptor, inducing a physiological action which is distinct from that of neonicotinoids (Holyoke et al*.,* 2015). Insecticides can suppress planthopper populations, but their indiscriminate use has resulted in development of insecticide resistance and mortality of natural enemies that triggered pest outbreaks and resurgences. BPH has been reported to have developed resistance to organophosphate (OP) insecticides in late 1990s and even too imidacloprid (Karunaratne et al*.,* 1999; Matsumura et al*.,* 2008). In view of development of insecticides resistance in BPH against OPs, triflumezopyrim might provide an alternative for use against planthopper to ward off insecticide resistance problem.

The present study concluded that triflumezopyrim+ tricyclazole and triflumezopyrim are the most effective against BPH followed by triflumezopyrim+ hexaconazole with maximum yield. The efficacy of the combination products depicted that the fungicides did not affect the effectiveness of the insecticide. The fungicides, tricyclozole and hexaconazole were thus found compatible with triflumezopyrim.

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