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Research Article

EVALUATION OF INSECTICIDES AND FUNGICIDES, ALONE AND IN COMBINATION AGAINST YELLOW STEM BORER AND LEAF FOLDER OF RICE

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Abstract A field experiment was carried out to evaluate insecticides and fungicides, alone and in combination against yellow stem borer [*Scirpophaga incertulas* (Walker)] and leaf folder [*Cnaphalocrocis medinalis* (Guenee)] in rice during Kharif 2017 and 2018 at Rice Research Station, Anand Agricultural University, Nawagam, Kheda (Gujarat). All the nine treatments were found significantly superior over control in reducing the infestation of yellow stem borer and leaf folder and also increasing the grain yield comparison. The combination of spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml/10 liter of water was found most effective by recorded 8.89 per cent dead hearts followed by spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml/ 10 litre water (9.37%). The pre harvest observation of yellow stem borer infestation showed that the minimum per cent white ear (15.69%) were recorded in combination of spinetoram 6% + methoxyfenozide 30% + tricyclazole 75% WP at 7.5 + 6.0 g/10 litre water followed by spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml per 10 litre water (16.18%) and spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml per 10 litre water (16.74%). The application of spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml/ 10 litre water was found most effective in reducing the damaged leaves (10.57%) followed by spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml/ 10 litre water (11.17%). The highest grain yield (37.63 q/ha) was observed in spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml per 10 litre water treated plot followed by spinetoram 6% + methoxyfenozide 30% + tricyclazole 75% WP at 7.5 + 6.0 g/10 litre water (37.38 q/ha) and spinetoram 6% + methoxyfenozide 30% at 7.5 ml per 10 litre water (36.16 q/ha).
Keywords: Efficacy, Insecticides and Fungicides, Leaf folder, Pesticide Compatibility, Yellow stem borer.

Introduction

Rice (*Oryza sativa* L.) is one of the world's most important cereal crops, providing a staple food for nearly, half of the global population (Heinrichs *et al.,* 2017). The rice crop can be attacked by more than 100 species of insects and 20 of them can cause serious economic loss (Pathak, 1977; Heinrichs *et al.,* 2017). Total yield loss from insect pests in rice is estimated to be about 30-40% (Henrichs *et al.,* 1979). Though insect pests have been regarded as an important constrain in paddy cultivation through the centuries, occurrence of pest outbreaks have increased with the change of pest complexities, in the last four decades (Ahmed *et al*., 2010).

Among them, the attack of yellow stem borer, [*Scirpophaga incertulas* (Walker)] is quite serious as it can cause 25-30 per cent damage to the crop manifests as "dead hearts" in vegetative stage and white ears with chaffy grains during flowering stage (Rath, 2001 and Sachan *et al.,* 2006). Larvae of yellow stem borers bore into the stems of rice plants after hatching from eggs. Feeding within the stem cuts off supplies of photosynthates and nutrients to the upper parts of the affected stem. Attack by yellow stem borers at the vegetative stage of plant growth produces symptoms called 'dead hearts' while attack at the reproductive stage (at the time of panicle development) produces 'white ear'. The larvae and pupae have overlapping populations in the field, and larvae mostly remain concealed inside the stem and are difficult to control by spraying insecticides. Proper timing of insecticide application is critical to yellow stem borer control (Phil Rice, 2007). The insecticides can be applied only when the yellow stem borer damage reaches the economic threshold (ETL) or economic injury level (EIL). An economic threshold of 5-10% DHs and 5 per cent white ear has been suggested for yellow stem borers (Henrichs *et al.,* 1979).

Paddy leaf folder is another one of the most important insect pests in Gujarat. Out of the eight species

of leaf folder, the most wide spread and important one is leaf folder [*Cnaphalocrocis medinalis* (Guenee)] (Bhatti *et al*., 1995). Second instars leaf folder larvae glues the growing paddy leaves longitudinally for accommodation and feeds on green foliage voraciously which results in papery dry leaves (Khan *et al*., 1989). Feeding often results in stunting, curling or yellowing of plant green foliage (Alvi *et al*., 2003). The leaf folder affected the crop adversely resulting in severe loss in the favorable conditions. The extent of loss may extend up to 63 to 80% depending on agro-ecological situations as reported by Rajendran *et al*. (1986).

A number of chemical insecticides have been reported to be effective against yellow stem borer and leaf folder in different parts of the country but indiscriminate use of insecticides resulted in reduction of natural enemies, caused environmental pollution and residues in seeds and other crop produce etc. Karthikeyan (2015) reported that the tank mix of flubendiamide + buprofezin, triazophos + tricylazole and flubendiamide + buprofezin + hexaconazole recorded lowest incidence of yellow stem borer, leaf folder and also recorded highest grain yield of paddy. The application of chlorantraniliprole 0.4% G and methoxyfenozide 24% SC resulted in the greatest reduction in yellow stem borer infestation (DH and WE) and greatest increase of yield (Rahaman and Stout, 2019). Neelakanth *et al,* (2017) found that lowest per cent of yellow stem borer damage recorded in tricyclazole + chlorpyriphos, azoxystrobin + chlorpyriphos combination and minimum per cent of leaf folder damage in carbendazim + flubendiamide and carbendazim + chlorpyriphos and are found to be best. The flubendiamide + buprofezin 24 SC in combination with hexaconazole 5 SC and tricyclazole 75 WP recorded less DHs and WEs and produced highest yield of paddy (Seni *et al.,* 2017). Farmers can save time, labour and money if they can apply pesticides in combination to tackle multiple insect-pests and diseases. However, it is essential for the farmer to know about the compatibility of chemicals so that there is no adverse effect of the pesticide mixtures in terms of their efficacy in reducing pest incidence in field (Anonymous, 2018). New molecules are now emerging as a viable component of IPM strategies in all crops in view of their good efficacy to insect-pest control and safety to non target organisms. Therefore, the present investigation was undertaken to study evaluation of insecticides and fungicides, alone and in combination against yellow stem borer and leaf folder of rice.

Materials and Method

The experiment was carried out to evaluate the insecticides and fungicides, alone and in combination against yellow stem borer and leaf folder of rice by using variety GR-11 during *Kharif* season 2017 and 2018 at Rice Research Station, Anand Agricultural University, Nawagam, Kheda (Gujarat) in a randomized block design with three replications. The thirty days old seedlings of rice were transplanted to main field with an experimental plot size 5.0 X 3.6 m area and spacing 20 X 10 cm between row and plants, respectively. The crop was raised by following all the recommended agronomical practices except plant protection measures for the insect-pest management. All the insecticides and fungicides were applied with knapsack sprayer during cropping period. The quantity of spray solution used was 500 lit per hectare. The spray was done at 40 days after transplanting of paddy.

The trial consisted of nine treatments consisting of spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml/10 litre water, triflumezopyrim at 4.8 ml/10 litre water, hexaconazole at 20 .0 ml/10 litre water and tricyclazole at 0.6 g/10 litre water applied alone as individual treatments and also in four possible combination treatments. Untreated control without any insecticide or fungicide application was also included for comparison.

Observations on infestation of yellow stem borer were assessed by counting number of dead hearts (DH) in the initial stage of damage and number of white ear (WE) at later stage from five randomly selected plants/hills in each treatment. Similarly, for leaf folder incidence at each observation, total number of leaves and leaf folder damaged leaves were recorded from five randomly selected plants in each treatment. Finally, the per cent damaged leaves (DL), dead heart and white ear were calculated using following formula as described by Singh and Pandey (1997).

$$\text{Per cent DH/WE/DL} = \frac{\text{Total number of DH/WE/DL}}{\text{Number of TT/PBT/TL}} \times 100$$

Whereas,

DH-Dead hearts, WE-White ear, DL- Damage leaves, TT-Total tiller, PBT- Panicle bearing tillers and TL- Total leaves

The crop was harvested at maturity and grain yield was recorded separately from net plot area of each treatment.

Results and Discussion

Effect on stem borer

The pooled data of 2017 and 2018 presented in Table 1 and year wise data (2017 and 2018) descried in Fig. 1 revealed that all the treatments were found effective in controlling yellow stem borer infestation.

The result showed that combination of spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml/10 litre of water was significantly reduced the damage of yellow stem borer as dead heart (8.89%) followed by and it was closely followed by spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml/10 litre of water (9.37%) at 10 days after spraying and both were found statistically at par. The next best performance was recorded in combination of spinetoram 6% + methoxyfenozide 30% + tricyclazole 75% WP at 7.5 + 6.0 g/10 litre of water were the dead heart damage was 10.81 per cent followed by hexaconazole 5% SC alone at 20.0 ml/10 litre of water (13.07%), tricyclazole 75% WP alone at 6.0 g/10 litre of water (14.18%), triflumezopyrim 10.6% SC alone at 4.8 ml/10 litre of water (18.42%), triflumezopyrim 10.6% SC + hexaconazole 5% SC in combination at 7.5 + 20.0 ml/10 litre of water (18.63%) and triflumezopyrim 10.6% SC + tricyclazole 75% WP at 4.8 + 6.0 g/10 litre of water (20.22%) in comparison to untreated control where the dead heart was 24.39 per cent.

The similar results were also obtained in case per cent white ear, where it was lowest (15.69%) in combination of spinetoram 6% + methoxyfenozide 30% + tricyclazole 75% WP at 7.5 + 6.0 g/10 litre of water followed by spinetoram 6 % + methoxyfenozide 30% SC at 7.5 ml/10 litre of water (16.18%) and spinetoram 6% + methoxyfenozide 30 % + hexaconazole 5% SC at 7.5 + 20.0 ml/10 litre of water (16.74%) at before the harvesting of the crop. These three treatments were found significantly at par with each other. The per cent white ear damage was 18.04 per cent in tricyclazole 75 % WP at 6.0 g/10 litre of water followed by hexaconazole 5% SC at 20.0 ml/10 litre of water (19.33%), triflumezopyrim 10.6 % SC at 4.8 ml/10 litre of water (23.95%), triflumezopyrim 10.6% SC + hexaconazole 5% SC at 4.8 + 20.0 ml/10 litre of water (25.51%) and triflumezopyrim 10.6% SC + tricyclazole 75% WP at 4.8 + 6.0 g/10 litre of water (25.71%). Whereas, it was 35.29 per cent in the case of control plot.

These findings have close concern with the findings of earlier workers who have reported the least per cent of dead heart in application of tricyclazole + fipronil combination (Prasanna Kumar *et al.,* 2011). Another study by Ram Singh *et al.* (2010) revealed least per cent white ear heads in case of fungicides tricyclazole and iprobenphos. Application of chlorantraniliprole (0.3 ml / lit) in combination with hexaconazole (2 ml / lit) caused less incidence of yellow stem borer (Bhuvaneswari and Raju, 2013). Karthikeyan (2015) revealed that the combination of triazophos + tricylazole recorded lowest incidence of dead hearts and also recorded lowest incidence of white ear. The lowest per cent of dead heart was recorded in tricyclazole + chlorpyriphos combination (Neelakanth, *et al.,* 2017). Flubendiamide (4%) + Buprofezin (20%) 24 SC in combination with hexaconazole 5 SC and tricyclazole 75 WP recorded less dead heart and white ear head and produced highest yield of paddy (Seni *et al.,* 2017).

Effect on leaf folder and grain yield

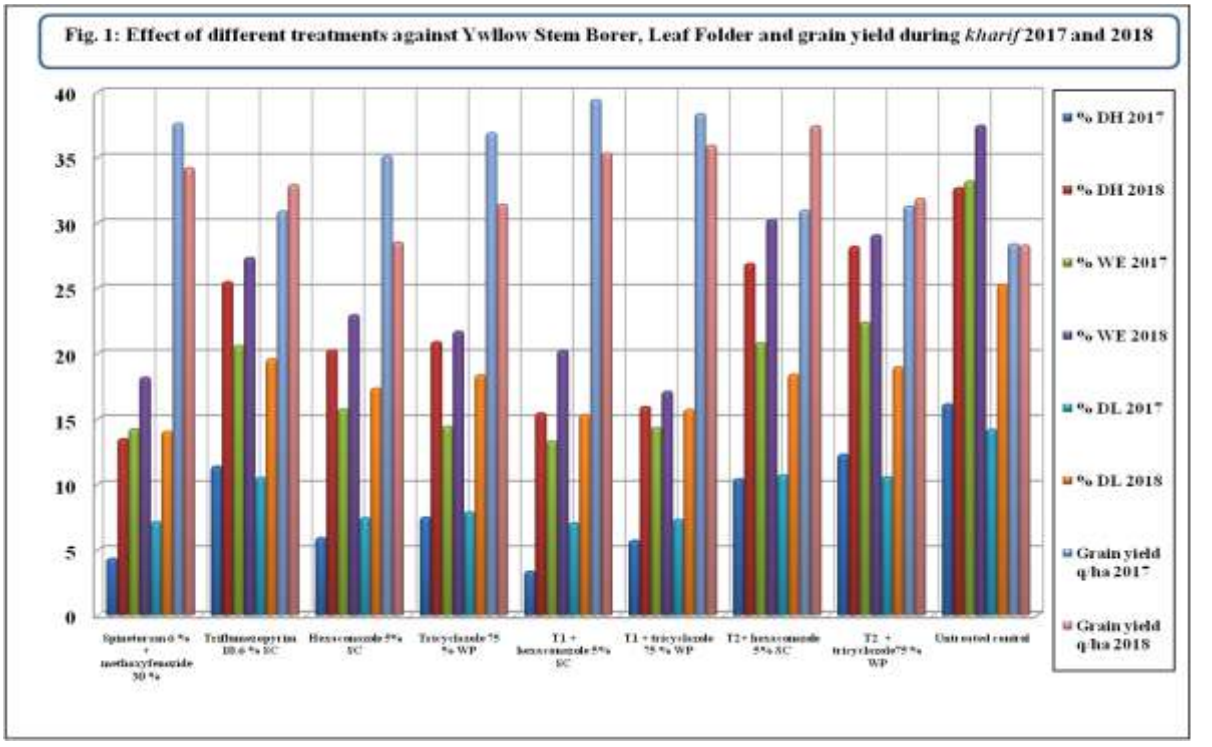
The pooled data of two year were presented in Table 1 and year wise data descried in Fig. 1 showed that in all the treatments minimum per cent damage leaves and increased grain yield were recorded when compare with untreated control.

The mean of pooled data presented in Table 1 and year wise data (2017 and 2018) descried in Fig. 1 revealed that all the treatments were significantly reduced per cent damage leaves as compared to untreated control. The results showed that the combination of spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml per 10 liter of water recorded minimum per cent damage leaves (10.57%) followed by combination of spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml per 10 liter of water (11.17%). The next best performance was recorded in combination of spinetoram 6% + methoxyfenozide 30% + tricyclazole 75 % WP at 7.5 + 6.0 g/10 liter of water 11.48 per cent and followed by hexaconazole 5% SC alone at 20.0 ml per 10 liter of water (12.37%), tricyclazole 75 % WP alone at 6.0 g/10 liter of water (13.10%), triflumezopyrim 10.6% SC + hexaconazole 5% SC in combination at 4.8 + 20.0 ml per 10 liter of water (14.54%), triflumezopyrim 10.6% SC + tricyclazole75% WP at 4.8 + 6.0 g/10 liter of water (14.76%) and triflumezopyrim 10.6% SC alone at 4.8ml per 10 liter of water (15.03%). Whereas, the highest per cent damage laves was recorded in control plot (19.72%). The result of the present investigation are in agreement with the result of anonymous (2017) found that spinetoram 6% + methoxyfenozide 30% treatment performance both the alone and in combination with the fungicides was significantly superior to management of leaf folder incidence. The findings are shows similarity with the findings of Bhuvaneshwari and Raju, (2013) who have reported that the chlorantraniliprole @ 0.3 ml/l

Table1: Effect of different insecticides and fungicides, alone and in combination against yellow stem borer, leaf folder and consequent impact on grain yield during *Kharif* 2017 and 2018 (Pooled data).

Sr. No.	Chemical treatment	Dose g/ml/ 10 liter water	Incidence of yellow stem borer		Per cent damage of leaf folder/5 hills			Grain yield (q/ha)
			Per cent DH/ 5 hills at 10 DAS	Per cent WE / 5 hills at pre harvest	5 DAS	20 DAS	Mean	
T_1	Spinetoram 6 % + methoxyfenozide 30 % SC	7.5	8.89 (17.25)*	16.18 (23.72)	10.76 (19.15)	10.37 (18.78)	10.57 (18.97)	36.16
T_2	Triflumezopyrim 10.6 % SC	4.8	18.42 (25.42)	23.95 (29.30)	15.60 (23.26)	14.46 (22.35)	15.03 (22.81)	32.10
T_3	Hexaconazole 5% SC	20.0	13.07 (21.18)	19.33 (26.08)	12.39 (20.61)	12.35 (20.58)	12.37 (20.59)	32.04
T_4	Tricyclazole 75 % WP	6.0	14.18 (22.11)	18.04 (25.13)	13.62 (21.66)	12.58 (20.76)	13.10 (21.21)	34.39
T_5	Spinetoram 6 % + methoxyfenozide 30 % + hexaconazole 5% SC	7.5+20.0	9.37 (17.82)	16.74 (24.15)	11.32 (19.66)	11.01 (19.38)	11.17 (19.52)	37.63
T_6	Spinetoram 6 % + methoxyfenozide 30 % SC + tricyclazole 75 % WP	7.5 + 6.0	10.81 (19.18)	15.69 (23.33)	11.18 (19.53)	11.78 (20.07)	11.48 (19.81)	37.38
T_7	Triflumezopyrim 10.6 % + hexaconazole 5 % SC	4.8 + 20.0	18.63 (25.57)	25.51 (30.33)	14.89 (22.70)	14.19 (22.13)	14.54 (22.42)	34.38
T_8	Triflumezopyrim 10.6 % SC + tricyclazole 75 % WP	4.8 + 6.0	20.22 (26.72)	25.71 (30.46)	14.87 (22.68)	14.66 (22.51)	14.76 (22.59)	31.76
T_9	Untreated control	Water spray	24.39 (29.59)	35.29 (36.43)	18.39 (25.39)	21.06 (27.32)	19.72 (26.37)	28.51
	C. D. at 5%		1.82	1.62	0.88	0.91	0.57	4.46

* Figures in parenthesis are Arc sine transform value, DH- Dead Hearts, WE- White ear, DAS- Days after spraying



in combination with hexaconazole @ 2 ml/l recorded minimum per cent damaged by leaf folder. These studies also corroborates with Prajapati *et al,* (2005) who reported that triazophos in compatible with carbendazim and tricyclazole was found effective against leaf folder. Karthikeyan (2015) recorded per cent damaged leaves was very low in combination of triazophos + tricyclazole, flubendiamide + buprofezin + hexaconazole and triazophos + hexaconazole treated plots.

The pooled data of two year on grain yield (q/ha) also showed that all the treatments were significantly increased the grain yield as compared to untreated control. The maximum grain yield (37.63 q/ha) was recorded from spinetoram 6% + methoxyfenozide 30% + hexaconazole 5% SC at 7.5 + 20.0 ml per 10 liter of water followed by spinetoram 6% + methoxyfenozide 30% + tricyclazole 75% WP at 7.5 + 6.0 g/10 liter of water (37.38 q/ha), spinetoram 6% + methoxyfenozide 30% SC at 7.5 ml per 10 liter of water (36.16 q/ha), tricyclazole 75% WP at 6.0 g/10 liter of water (34.39 q/ha) and triflumezopyrim 10.6% + hexaconazole 5% SC at 4.8 + 20.0 ml/10 liter of water (37.38 q/ha) . all the treatments were found significantly at par. Among the different treatment the lowest grain yield was recorded in triflumezopyrim 10.6% SC + tricyclazole 75% WP at 4.8 + 6.0 g/10 liter of water (31.76 q/ha). Whereas, it was 28.51 q/ha in untreated control. Similarly, Karthikeyan (2015) recorded per cent damaged leaves was very low and higher grain yield in combination of triazophos + tricyclazole, flubendiamide + buprofezin + hexaconazole and triazophos + hexaconazole treated plots. Anonymous (2018) reported that insecticides and fungicides combination were given significantly higher yield.

Conclusion

A number of chemical insecticides have been reported to be effective against yellow stem borer and leaf folder in different parts of the country but indiscriminate use of insecticides resulted in reduction of natural enemies, environmental pollution and residues in seeds and other crop produce etc. All the tested insecticides and fungicides combination significantly reduced damage caused by yellow stem borer and leaf folder. The newer combination of insecticides and fungicides, spinetoram 6% plus methoxyfenozide 30% SC alone at 7.5 ml per 10 litre of water and combination with hexaconazole 5% SC at 20 ml per 10 litre of water and tricyclazole 75 % WP at 6 g/10 liter of water were recorded highly effective for reducing yellow stem borer and leaf folder infestations and given higher grain yield in rice. There were no significant difference in the performance of combination of spinetoram 6% plus methoxyfenozide 30% SC in their proven efficacy when applied alone or in combination with fungicides.

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