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Dear Sir,

This is to acknowledge receipt of your letter No. ______

dated ______ enclosing an article entitled " Compatibility of Selective Insecticides With Fungicide Propiconazole For Management of Foliar Aphid, Rhopalosiphum Maidis (Fitch) and Yellow Rust in by Poonam Jasrotia, Subhash Katare has been accepted which for publication in the *Indian Journal of Entomology/Bulletin of Entomology;* a decision regarding it, will be communicated to you as soon as possible.

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26/4/18

COMPATIBILITY OF MIXING SELECTIVE INSECTICIDES WITH FUNGICIDE PROPICONAZOLE FOR MANAGEMENT OF FOLIAR APHID, *RHOPALOSIPHUM MAIDIS* (FITCH) AND YELLOW RUST IN WHEAT

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ABSTRACT

The concurrent occurrence of foliar aphid infestation and yellow rust infection is often observed in North-Western Plains Zone (NWPZ) growing areas of wheat. Farmers usually apply insecticide and fungicides separately for their respective management. As the cost of cultivation is increasing day by day, combined application of pesticides can be practiced to save cost, time and labour. On similar lines, a study was conducted during 2014-15 and 2015-16 to evaluate the effect of application of two insecticides, imidacloprid @ 100 ml/ha and thiomethoxam @ 50 ml/ha, and one fungicide, propiconazole @ 500ml/ha alone and in combination against foliar aphids and strip rust management in wheat. The combination treatments included mixing of both the insecticides, imidacloprid @ 100 ml/ha and thiomethoxam @ 50 ml/ha with fungicide, propiconazole @ 500ml/ha in 250 and 500 litres of water. The studies indicated that mixing of broad spectrum fungicide, propiconazole did not influence the efficacy of two insecticides against foliar aphid. However, the efficacy of combination treatments was reduced when the pesticides were mixed in 500 litres of water but at the same time, less reduction in coccinellid population was recorded in these treatments. The information generated will be helpful in reducing the pesticide application cost in wheat crop.

Key Words: Wheat, insecticides, fungicide, insect-pests, rust, compatibility, pest management

Wheat crop is a host of more than 100 species of arthropods that reduce its grain quality and yield and increase production costs (Hatchett et al., 1987). Among the different insect-pest attacking wheat crop, cereal aphids are considered to be major pests of wheat (Singh, 1983). More than 11 aphid species attack wheat crop in India, but only four species, *Rhopalosiphum maidis* (Fitch), *Rhopalosiphum padi* L. *Sitobion miscanthi* and *Sitobion avenae* (Fabricius) are reported to be predominant and constitute foliar aphid complex (Jarosik et al., 2003). Both adults and nymphs of aphids cause damage by sucking cell sap which reduces the vitality of the plants. The infested leaves turn pale, wilt and wear a silky appearance. The pest can cause yield losses either directly by sucking the sap of the plants to the tune of 3-21 % or indirectly around 20-80% damage by transmitting viral and fungal diseases (Singh et al., 2003). In addition, aphids also secrete honeydew on which black sooty mould develops which hinders the photosynthesis (Aslam et al., 2005). Economic threshold level for wheat aphids was established as five aphids/earhead or ten aphids/ tiller during vegetative stage, which being a low population level reflected their economic importance (Singh et al., 2003).

Besides insect-pests, wheat is infected by the three rusts-leaf rust, stripe rust and stem rust; Karnal bunt, foliar blights and loose smut. Leaf or brown rust, caused by *Puccinia recondita* is distributed throughout the country and is the major concern in crop health programme. Yellow or stripe rust, caused by *P. striiformis* is important in the hills as well as the NWPZ (North Western Plain Zone), especially the states of Punjab, Haryana, foot hills of H.P., J&K. and parts of northern Rajasthan and also the Nilgiri hills in the South. Stem or black rust (*P. graminis* tritici) is important in the peninsular and Central India.

Incidence of yellow rust alongwith aphid infestation is concurrently observed in wheat fields of North-Western Plains Zone (NWPZ) from December to March. Farmers apply separate plant protection chemicals for managing them individually as they do not any option of pesticide combinations when such situations encountered in fields. Mixing of plant protection chemicals is usually not advisable but the practice can reduce the input cost. Fungicides and insecticides are can be combined in one sprayer without any harm but exceptions may apply. It is very important to read their labels before mixing them and other considerations include possible phytotoxicity to plants, chemical compatibility, damage to the sprayer and application timing. Several spray compatibility charts were prepared in the past and many revealed difference of opinions. Gray (1914) proposed compatibility chart based physical, chemical and therapeutic properties while Cox (1941) pointed out that compatibility is loosely used to employ suitability of pest control materials for their simultaneous or successive application on same plant. Baicu (1980) suggested that pesticide compatibility should be studied in different stages including field test of effectiveness, phyto-toxicity and yield after treatments. In wheat, only few studies on combined application of fungicides and insecticides for simultaneous control of disease and insect-pests are available. With this perspective, the present investigation was planned to determine field efficacy and compatibility of few selected insecticides with broad spectrum fungicide propiconazole. The findings of the study will provide the information about the pesticide combination for concurrent management of aphids and yellow rust in wheat.

MATERIALS AND METHODS

Field trials were conducted at the Research Farm of ICAR-Indian Institute of Wheat and Barley, Karnal (29° 41' N, 76° 59' E and 250 m above mean sea level) during 2014-15 and 2015- 16 crop seasons. The experiments were carried out under irrigated conditions and variety HD 2967 was chosen for the study. It was sown in the first week of November by following recommended standard package of practices (Kumar *et al*., 2001 and Anonymous, 2014) except the pesticide usage in trials was done as per planned treatments. The two recommended pesticides viz., Imidacloprid (Confidor 17.8 SL, Bayer Crop Sciences Ltd.,) and Thiamethoxam (Actara, 25WG, Syngenta India Ltd.) and one fungicide propiconazole (Tilt 25EC, Syngenta India Ltd.) were selected for the trial. The treatments included application of these pesticides i.e. imidacloprid @ 100 ml/ha, thiamethoxam @ 50 ml/ha, propiconazole @ 500ml/ha singly and, combination of two insecticides, imidacloprid @ 100 ml/ha, and thiamethoxam @ 50 ml/ha with fungicide, propiconazole @ 500ml/ha in 250 and 500 litres of water alongwith with an untreated control treatment. In total, there were eight different treatments replicated thrice in randomized complete block design with a plots size of $6 \times 1.5\ m^2 = 9.0\ m^2$. To create sufficient aphid population load in the experiment plots, aphids were transferred to these plots by detached leaf method (Verma *et al.*, 2011) during the month of January. To have uniform coverage strip rust disease in the plots, the inoculum of *Puccinia striformis* fsp. *tritici* was sprayed in the first fortnight of January. The insecticides application was done with knapsack sprayer at heading stage when average population of aphids was 15- 20 aphids per tiller alongwith the incidence of strip rust. Evening hours were preferred for spraying because of low wind velocity and to keep spray drift to the minimum in the field.

Observation of aphid counts were recorded on five randomly selected shoots from each treatment. Pre-spray aphid counts were taken one day prior to application and post-spray counts were made 1, 2, 7 and 15 days after insecticidal application. Only live aphids were taken into account for counting the aphid population after application of treatments. At maturity, grain yield was recorded on whole plot basis and converted in quintals per hectare (q/ha). The population of coccinellid beetle (both grubs and adults) was also recorded three days after spray while the per cent stripe rust severity was recorded seven days after pesticide application by methodology given by Saari and Prescott (1975). The experimental data were subjected to analysis of variance (ANOVA) and different treatment means were separated by least significant difference test using SAS software (SAS, 2005).

RESULTS AND DISCUSSION

The incidence of aphid during cropping season 2014-15 and the yield obtained during the same period were comparatively low as compared to season 2015-2016. Therefore, the findings of each season are presented separately.

*3.1 Cropping Season 2014-15***:** It was observed that there were no significant differences in aphid population counts recorded in each treatment one day before spray (Table 1). However, when observed one day after spray, treatment of Propiconazole @ 500 ml/ha in 500 litres of water recorded the highest number (33.73 aphids/earhead) of aphids while lowest number of aphids were found in imidacloprid @ 100 ml/ha sprayed plots (6.33 aphids/earhead). Similar trend was observed after 2, 7 and 15 days of spray during which the aphid population was significantly lower in all the treatments except foliar application of propiconazole alone (15.53-28.27 aphids/earhead) and untreated control (16.80-27.40 aphids/earhead).The average aphid population recorded during the 15 days period was lowest in alone application imidacloprid @ 100 ml/ha (2.53 aphids/earhead) followed by the application of combination spray treatment of propiconazole+ imidacloprid @ 100 ml/ha in 250 litres of water (2.56 aphids/earhead) and by then alone application of thiomethoxam @ 50 ml/ha (3.56 aphids/earhead).The severity of stripe rust was recorded maximum i.e. 60 per cent in untreated control. However, it was 10 per cent in treatments where propiconazole was applied alone or in combination with imidacloprid or thiamethoxam while it was 40 per cent in those treatments where only imidacloprid or thiamethoxam was applied alone. The effect of insecticide application alone and in combination with fungicide was observed on coccinellid population and significant reduction in coccinellid population (13.00-17.00 coccinellids/plot) was found when compared to untreated control (39.67/plot). Reduction in coccinellid population was also observed in alone application of fungicide propiconazole @500 ml/ha (22.67 coccinellids /plot).

Grain yield obtained was maximum (51.20 q/ha) from propiconazole + thiamethoxam @ 50 ml/ha in 500 litres of water treated plots and it was at par with all the mixed application of propiconazole+ imidacloprid @ 100 ml/ha in 500 litres of water (50.50 q/ha). Significantly lowest grain yield of 36.40 q/ha was recorded in untreated plots.

*3.2 Cropping Season 2015-16***:** Aphid population did not differ significantly among all the treatments one day before spray (Table 2). However, significant differences were observed among treated plots just after one day of spraying. The lowest aphid population was found in combination treatment of propiconazole+ thiamethoxam @50 ml/ha in 250 litres of water (4.20 aphids/earhead) followed by propiconazole+ imidacloprid @100 ml/ha in 250 litres of water (4.53 aphids/earhead) and then by alone treatment of thiamethoxam @50 ml/ha in 250 litres of water (5.00 aphids/earhead) and. The aphid population remained significantly lower after 2, 7 and 15 days after spray in all the treatments except foliar application of propiconazole (16.40-24.33 aphids/earhead) and untreated control (20.80-32.53 aphids/earhead). After 15 days of spray, no aphids were recorded in combination treatments of propiconazole+imidacloprid/thiamethoxam in 250 litres as well as 500 litres of spray volume. The average aphid population during 15 days period was significantly lower in treatments where insecticide was sprayed alone or in combination with fungicide. Lowest aphid count of 1.96 aphids/earhead was found combination treatment of propiconazole+imidacloprid @100 ml/ha in 250 litres of water followed by alone treatment of imidacloprid @100 ml/ha in 250 litres of water (2.49 aphids/earhead) and propiconazole+ thiamethoxam @50 ml/ha in 250 litres of water (2.46 aphids/earhead).The rust severity index was recorded to highest i.e 40% in untreated plots. The alone application of propiconazole @ 500 ml/ha in 500 litres of water had a rust severity of 5% alongwith 87.5% reduction in disease over control. Even application of propiconazole in combination with two insecticides (imidacloprid and thiamethoxam) had the same severity (5%) as well as same per cent reduction over control (87.5%). However, the disease severity was 20-40 per cent in those treatments where only imidacloprid or thiamethoxam was applied with 0-50% reduction in disease over control. The application of insecticide alone and in combination resulted in reduction of coccinellid population when compared to untreated control plots. The maximum reduction (16.00 coccenellids/plot) was seen in alone application of imidacloprid@100ml/ha in 250 litres of water followed by alone application of insecticide thiomethoxam @ 50ml/ha in 250 litres of water (17.33 coccenellids/plot). Highest grain yield (58.54 q/ha) was recorded from the plots treated with combination of propiconazole + imidacloprid @100 ml in 500 litres of water and it was at par with all the mixed application of propiconazole + thiomethoxam @50 ml in 500 litres of water (58.28 q/ha). The other treatments where only insecticides were applied recorded significantly lower grain yield than mixed application of fungicide and insecticides, however yield in these treatments were still significantly better than untreated control (50.23 q/ha).

The findings of both the seasons showed that combinations of propiconazole with imidacloprid or thiamethoxam did not have any effect on their efficacies. Also, no toxic effect of combining insecticide and fungicide was observed on the wheat. The insecticide and fungicide alone or in combinations proved highly effective in controlling the wheat aphids and stripe rust.The insecticides and fungicides did not lose their effectiveness as evident from 80-90 per cent disease and aphid control level. The insecticide and fungicide alone or in combinations proved highly effective in controlling the wheat aphids and stripe rust. There was significant reduction in aphid population in all pesticide combinations as compared to untreated control during both the seasons. However, aphid control and reduction in coccinellid population was significantly less when the combination of insecticide and fungicide were sprayed in 500 litres of spray volume as compared to 250 litres of spray volume per hectare. The probable reason could be low concentration of active ingredient of insecticide in 500 litres of spray volume as compared 250 litres of spray volume which might have led more survival of aphids and their coccinellid predators. It was also observed that coccinellid population was significantly reduced with the application of propiconazole alone. Some previous studies (Sutherland et al., 2010; Martinson et al., 2001; and Michaud, 2001) have also shown detrimental effects of fungicides on the natural enemies of insects. However, detailed investigations under laboratory condition are required to prove the negative effect of fungicides on natural enemies of insects.

These findings are in line with previous studies that also reported the compatibility of imidacloprid and propiconazole as foliar application for aphid management (Singh and Kaur, 2017; Babu and Sharma, 2003). Pike et al. (1993) tested compatibility of Imidacloprid with fungicides (carboxin-thiram, triadimenol-captan, and tebuconazole-thiram) as a seed-treatment control of Russian Wheat Aphid and found no compatibility problems in insecticide performance by combining imidacloprid with fungicides on the seed. Mixtures of imidacloprid and tebuconazole at rates of 1.05/0.04 and 0.7/0.04 g a.i of pesticide, respectively, per kg of seeds, were evaluated for three consecutive growing seasons of winter wheat in Sudan. It was observed that plant stand per unit area increased compared with their respective untreated control. Both rates of imidacloprid efficiently controlled the maize aphid (*Melanaphis maidis*) and suppressed the green bug (*Schizaphis graminum*) for 6–8 weeks after sowing (Ahmed, 2001). In another study by Morales-Rodriguez and Wanner (2015), insecticide thiamethoxam was effectively combined with fipronil as a seed treatment to protect wheat crops from wireworm damage which resulted in significant reduction in wireworm larval populations in the field.

CONCLUSIONS

The studies clearly indicated that the application of insecticide and fungicide alone or in combinations proved highly effective in controlling the wheat aphids and stripe rust. Also, combinations of propiconazole with imidacloprid or thiamethoxam did not affect their individual efficacies. Farmer can use this pesticide combination (propiconazole + insecticides in 500 litres of water per hectare) for the simultaneous management of aphids and yellow rust in field. It will reduce pesticide application cost and will also save time.

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Table 1. Influence of insecticides alone and in combination with fungicides against foliar aphid *Rhopalosiphum maidis* in wheat during 2014-15

S. No.	**Treatments**	**Aphid population per earhead**						**Cocci-nellid/plot**	**Strip rust severity (%)**	**Percent disease reduction over control**	**Grain Yield (q/ha)**
		Before spray	**Days after spray**				**Average**	**Days after spray**			
		1	**1**	**2**	**7**	**15**		**3**	**7**		
1	Imidacloprid @ 100 ml/ha in 250 litres of water	34.40a (5.94)	6.33c (2.70)	2.13c (1.77)	1.67c (1.63)	0.00c (1.00)	2.53c (1.88)	15.00c (4.12)	40	33.33	43.08b
2	Thiamethoxam @ 50 ml/ha in 250 litres of water	36.80a (6.15)	7.93c (2.99)	3.20c (2.05)	3.13c (2.03)	0.00c (1.00)	3.56c (2.14)	13.00c (3.74)	40	33.33	44.14b
3	Propiconazole @ 500 ml/ha in 500 litres of water	36.73a (6.14)	33.73a (5.89)	28.27a (5.41)	21.27a (4.72)	15.53a (4.06)	24.7a (5.07)	22.67b (4.00)	10	83.33	43.21b
4	Propiconazole+ Imidacloprid @100 ml/ha in 250 litres of water	32.07a (5.74)	6.67c (2.77)	2.80c (1.95)	2.33c (1.82)	0.00c (1.00)	2.95c (1.99)	13.33c (3.87)	10	83.33	45.88b
5	Propiconazole+ Thiamethoxam @50ml/ha in 250 litres of water	34.00a (5.91)	6.87c (2.80)	5.00c (2.44)	3.80c (2.19)	0.00c (1.00)	3.91c (2.22)	14.67c (4.24)	10	83.33	45.34b
6	Propiconazole+ Imidacloprid @100 ml/ha in 500 litres of water	36.00a (6.08)	9.60b (3.25)	6.80b (2.79)	4.33b (2.30)	2.33b (1.82)	5.76b (2.60)	16.00c (4.12)	10	83.33	50.50a
7	Propiconazole+ Thiamethoxam @50ml/ha in 500 litres of water	34.00a (5.91)	10.00b (3.31)	7.27b (2.87)	4.80b (2.40)	3.13b (2.03)	6.30b (2.70)	17.00c (4.36)	10	83.33	51.20a
8	Untreated Control	34.80a (5.97)	32.60a (5.78)	27.40a (5.31)	21.40a (4.71)	16.80a (4.22)	24.55a (5.05)	39.67a (6.78)	60	0.00	36.40c

Table 2. Influence of insecticides alone and in combination with fungicides against foliar aphid *Rhopalosiphum maidis* in wheat during 2015-16

S. No.	Treatments	Aphid population per earhead						Cocci-nellid/plot	Strip rust severity (%)	Percent disease reduction over control	Grain Yield (q/ha)
		One day before spray	Days After spray								
			1	2	7	15	Average				
1	Imidacloprid @ 100 ml/ha in 250 litres of water	31.07a (5.66)	5.13b (2.48)	3.33c (2.08)	1.53c (1.59)	0.00c (1.00)	2.49c (1.87)	16.00c (4.12)	20-40	0-50	56.26b
2	Thiamethoxam @ 50 ml/ha in 250 litres of water	29.73a (5.54)	5.00b (2.45)	3.53c (2.12)	1.33c (1.53)	0.00c (1.00)	2.46c (1.86)	17.33c (4.90)	20-40	0-50	56.24b
3	Propiconazole @ 500 ml/ha in 500 litres of water	29.93a (5.56)	24.20a (5.02)	24.33b (5.03)	19.80b (4.56)	16.40b (4.17)	21.18b (4.71)	27.67b (5.35)	5	87.5	55.21b
4	Propiconazole+ Imidacloprid @100 ml/ha in 250 litres of water	30.60a (5.62)	4.53b (2.35)	2.00c (1.73)	1.40c (1.55)	0.00c (1.00)	1.98c (1.72)	18.00c (4.00)	5	87.5	57.11a
5	Propiconazole+ Thiamethoxam @50ml/ha in 250 litres of water	28.20a (5.40)	4.20c (2.28)	2.27c (1.80)	1.40c (1.55)	0.00c (1.00)	1.96c (1.72)	17.67c (3.74)	5	87.5	56.73b
6	Propiconazole+ Imidacloprid @100 ml/ha in 500 litres of water	28.80a (5.46)	5.55b (2.55)	3.87c (2.20)	0.93c (1.39)	0.00c (1.00)	2.58c (1.89)	18.33c (4.47)	5	87.5	58.54a
7	Propiconazole+ Thiamethoxam @50ml/ha in 500 litres of water	30.33a (5.60)	5.40b (2.53)	4.07c (2.25)	1.20c (1.48)	0.00c (1.00)	2.66c (1.91)	19.67c (4.80)	5	87.5	58.28a
8	Untreated Control	29.27a (5.50)	27.80a (5.37)	32.53a (5.79)	21.60a (4.75)	20.80a (4.67)	25.68a (5.17)	42.33a (6.32)	40	0.0	50.23c