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RESEARCH PAPER

Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC : A new fungicide for controlling fungal diseases in wheat

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Abstract : Wheat (*Triticum aestivum* L.) is one of the most important staple food crop of the world affected by yellow rust, brown rust and other foliar diseases which infect leaves, stems and ears causing up to 32 per cent crop loss. Hence, an investigation was initiated to study the bio-efficacy of different standard and new fungicides against various diseases of wheat. A twoyear field experiment was conducted at instructional farm ofRajmata VijayarajeScindia Krishi Vishwa Vidyalaya, Krishi Vigyan Kendra, Sheopur during 2017-18 and 2018-19 in randomized block design replicated three times. Pre-mixture of Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC is a new fungicide combination effective against fungal disease in wheat. Eight treatment were imposed*viz*., Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 50 g ai/ha, Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 100 g ai/ha, Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 150 g ai/ha, Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 200g ai/ha, Fluxapyroxad 300 g/l SC @ 167 g ai/ha, Pyraclostrobin 20% WG @ 100 g ai/ha, Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @ 0.3 g/l of water along with one untreated control. Two sprays were taken up at 15 days interval during flowering stage. Among the various treatments, Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 200 g ai/ harecorded significantly lower per cent disease incidence on wheat crop (5.21 per cent) than control (21.87 per cen). The same treatment recorded highest yield (5650 kg/ha) while control plot yielded least (3394 kg/ha). There were no visual phytotoxicity symptoms observed in terms of chlorosis, necrosis, epinasty, leaf injury, wilting and hyponasty on wheat crop by Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC treatment even at 300 g ai/ha. The current study indicated that two sprays of Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 200 g ai/ha would be a suitable option for the control of yellow rust, brown rust and other foliar diseases in wheat.

Key Words : Wheat, Fluxapyroxad, Pyraclostrobin, Disease, Yield

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is an essential grain food component and is a very important commodity among cereal crops. A 17 per cent world's cropped area is under wheat cultivation which contributes 35 per cent of the staple food and 20 per cent of the calories. In India, wheat is grown in area of about31.0 million hectares with production and productivity of 88.9 million tones

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and 2.87 t/ha, respectively (DES,2015). In Madhya Pradesh, wheat is grown in about 5.52 million hectares area with the production of 15.47 million tones which clearly indicates that the productivity of wheat is quite low *i.e.* 2807 kg/ha than national average (Anonymous, 2019). Diseases in wheat crop is a key point in yield reduction. The effect of diseases on wheat yield has been reported by the majority of researchers worldwide. The serious fungal infection in wheat could reduce 20 per cent yield (Sohail *et al*., 2022). Yellow rust, Brown rust and other foliar diseases of wheat are the most harmful diseases in wheat crop.

Scientists have tried to decrease wheat diseases by breeding techniques, but these techniques take long time. Currently, chemical control has emerged as an effective tool for disease management because it is approachable as well as economical. A significant increase in wheat yieldand reduction in disease incidence has been observed by application of fungicides. On the other hand, disease resistance to fungicideapplication can pose problems in disease management and with the passage of time their evaluation should be performed and the introduction of new fungicide is a pre-requisite to eradicate the resistance of disease.Pyraclostrobin is one an efficient fungicide which could control fungal diseases. It belongs to the strobilurins, a recently introduced group of agrochemical fungicides (Margot *et al*., 1998). Fluxapyroxad is a succinate dehydrogenase inhibitor and is a new active ingredient with pyraclostrobin labeled as Merivon for use against fungal diseases (Schilder, 2015)

Therefore, the present study was designed to evaluate the bioefficacy and phytotoxicity of pre-mix fungicide, Fluxapyroxad 167 g/l and Pyraclostrobin 333 g/l 500 SC for management of wheat diseases as well as their effect on yield and yield attributes in wheat crop.

MATERIAL AND METHODS

Two year field experiment was conducted at instructional farm of RVSKVV, Krishi Vigyan Kendra, Baroda, Sheopur during *Rabi* 2017-18 and 2018-19 with eight treatments of different fungicides, *viz*., Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 50 g ai/ha, Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/ l 500 SC @ 100 g ai/ha, Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 150 g ai/ha, Fluxapyroxad 167 g/ l + Pyraclostrobin 333 g/l 500 SC @ 200g ai/ha, Fluxapyroxad 300 g/l SC @ 167 g ai/ha, Pyraclostrobin 20% WG @ 100 g ai/ha, Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @ 0.3 g/ l of water along with one untreated control. Three treatments for phytotoxicity test, *viz*., Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 150 g ai/ha, Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 300 g ai/ha and untreated control were also taken. Soil of experimental field was clay loam, pH 7.8, organic carbon 0.72, availableN 252.8kg/ha, available P 27.2kg/ ha and available K 185.6kg/ha. The experiment was laid out in a Randomized Block Design with three replications. Wheat variety MP 1203 was sown in line by seed cum fertilizer drill at spacing 22.5 cm on November 28, 2017 and December 05, 2018 by using seed rate 100kg/ha. Fertilizer was used at the rate of N: P: K:: 100:60:40 kg/ ha through DAP, Urea and MOP. Half of nitrogen, full dose of Phosphorus and full dose of Potash were drilled in rows at the time of sowing and remaining N through urea was top dressed at the time of first irrigation. The experimental crop was grown adopting recommended package of practices of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior except disease management. Two sprays of fungicides as per treatments were taken up at 15 days interval during flowering stage. The observation on disease were made as per under:

– Computed per cent disease intensity before spraying (Pre-treatment and just before each spraying).

– Final observation on per cent disease intensity recorded 10 days after final spray.

– Disease assessment for foliar diseases is done as per standard method.

Further, the scale was converted into severity (Percent disease Index *i.e*. PDI) using the following formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total no. of } \frac{\text{Leaves}}{\text{Bunces}} \text{ assessed x Maximum disease grade}} \times 100$$

The observation of phytotoxicity on wheat crop was done on the basis of phytotoxicity rating scale (PRS) for the applied testing fungicide at 1, 3, 5, 7 and 10 days after first spray. The parameters on phytotoxicity were taken as chlorosis, necrosis, wilting, scorching, hyponasty and epinasty by using the following scale.

The grains after threshing were weighed and recorded as grain yield kg per plot and converted into kg per hectare. After quantifying all these parameters, the collected data were analyzed statically by applying analysis of variance (ANOVA) and means were

Score	Phytotoxicity (%)
0	No phytotoxicity
1	0 – 10
2	11 – 20
3	21 – 30
4	31 – 40
5	41 – 50
6	51 – 60
7	61 – 70
8	71 – 80
9	81 – 90
10	91 – 100

compared at 5% level of probability by using least significant difference (LSD).

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads :

Effect of fungicides on per cent disease index (PDI):

The result presented in Table 1 and 2 revealed that, the disease incidence was statistically non-significant before imposition of treatments as it ranges from 10.27 to 12.41 per cent. All the fungicides were found effective in reducing diseasesin wheat over control. After two sprays the mean disease incidence was ranged from 3.85 to 21.87 per cent. The lowest mean disease incidence 5.21 per cent and 3.85 per cent were recorded in the treatment Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 200 g a.i/ha during 2017-18 and 2018-19, respectively, which was closely followed by Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 150 g a.i/ha (5.94 % and 4.27 per cent during 2017-18 and 2018-19, respectively). Highest mean disease incidence was recorded in untreated control treatment. This is mainly due to fluxapyroxad shows broad spectrum of activity and is announced to be a mixing partner for epoxiconazole and pyraclostrobin to be used in many crops including fruits, vegetables and cereals (Ravikumar *et al*., 2018; Semar *et al*., 2011 and Walter, 2010).

Though the Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC @ 0.3 g/l significantly reduced the disease incidence in wheat, but new generation chemical combination Fluxapyroxad 167 g/l

Table 1: Effect of different fungicide treatments on fungal disease and grain yield of wheat (*Rabi*- 2017-18)

Tr. No.	Treatment details	Dose/ha a. i. (g)	Per cent disease incidence (PDI)			Mean PDI	Per cent disease control (%)	Grain yield (kg/ha)
			Before Spray	10days after 1st spray	10 days after 2nd spray			
T_1	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	50	12.38 (20.59)	8.26 (16.69)	6.59 (14.86)	7.43 (15.81)	66.04	4544
T_2	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	100	11.01 (19.37)	7.92 (16.33)	6.48 (14.72)	7.20 (15.56)	67.09	4795
T_3	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	150	11.12 (19.47)	7.17 (15.52)	4.70 (12.44)	5.94 (14.10)	72.85	5499
T_4	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	200	12.33 (20.55)	6.23 (14.43)	4.20 (11.76)	5.21 (13.20)	76.16	5650
T_5	Fluxapyroxad 300 g/l SC	167	12.41 (20.62)	9.16 (17.62)	8.75 (17.20)	8.96 (17.41)	59.05	3971
T_6	Pyraclostrobin 20% WG	100	11.74 (20.04)	8.75 (18.18)	8.33 (16.76)	8.54 (16.99)	60.95	4178
T_7	Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC	0.3 g/L	11.00 (19.33)	6.87 (15.15)	5.46 (13.51)	6.17 (14.38)	71.81	5482
T_8	Untreated control	-	11.08 (19.44)	18.74 (25.65)	25.00 (30.00)	21.87 (27.88)	-	3394
	S.E.±		0.55	0.42	0.35	0.39		72.10
	CD @ 5%		NS	1.26	1.05	1.17		203.0

NS= Non-significant

+ Pyraclostrobin 333 g/l 500 SC @ 200 g a.i/ha was more efficient. Because pyraclostrobin belongs to the strobilurins group, is the leading systemic, found to exert their fungicidal action by blocking electron transport in the mitochondrial respiratory chain in fungi (Gerth *et al*., 1980). The pre-mix fungicides were found highly effective in controlling the fungal diseases in wheat when compared to the individual fungicide spray separately (Table 1 and 2). Karaoglanidisa and Karadimosb (2006) also observed that effectiveness of strobilurins increases when mixed with other broad spectrum or contact fungicides. They provided better control of diseases compared to single applications of fungicides. As the concentration of pre-mix fungicideFluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC increased, Per cent Disease Incidence on crop also reduced. This might be due to the extent of inhibition of sporangial germination increased with the increase in concentration of fungicide.

Table 2: Effect of different fungicide treatments on fungal disease and grain yield of wheat (*Rabi*- 2018-19)

Tr. No.	Treatment details	Dose/ha a. i. (g)	Per cent disease incidence (PDI)			Mean PDI	Per cent disease control (%)	Grain yield (kg/ha)
			Before spray	10days after 1st spray	10 days after 2nd spray			
T_1	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	50	11.64 (19.92)	8.41 (16.85)	7.10 (15.44)	7.76 (16.17)	61.22	4380
T_2	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	100	11.27 (19.52)	7.04 (15.37)	5.62 (13.66)	6.33 (14.57)	68.35	4819
T_3	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	150	10.27 (18.68)	4.90 (12.68)	3.65 (10.97)	4.27 (11.93)	78.63	5547
T_4	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	200	11.88 (20.14)	4.23 (11.79)	3.47 (10.67)	3.85 (11.32)	80.75	5703
T_5	Fluxapyroxad 300 g/l SC	167	11.20 (19.52)	9.37 (17.82)	9.16 (17.62)	9.27 (17.72)	53.66	3926
T_6	Pyraclostrobin 20% WG	100	11.31 (19.64)	8.96 (17.40)	8.33 (16.76)	8.64 (17.10)	56.78	4073
T_7	Azoxystrobin 18.2% w/w + Difenoconazole 11.4% w/w SC	0.3 g/L	11.44 (19.65)	7.13 (15.48)	5.67 (13.76)	6.40 (14.65)	68.02	5063
T_8	Untreated control	-	10.64 (18.99)	18.12 (25.19)	21.87 (27.73)	20.00 (26.56)	-	3551
	S.E.±		0.61	0.41	0.35	0.35		75.05
	CD @ 5%		NS	1.22	1.03	1.05		212.30

NS=Non-significant

Table 3: Phytotoxicity effect of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC on wheat crop (rabi-2017)

Sr. No.	Treatment	g.a.i/ha	Phytotoxicity parameters																													
			chlorosis					Necrosis					Epinasty					Leaf injury					Wilting					Hyponasty				
			1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
1.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	Untreated Control	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Phytotoxicity effect of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC on wheat crop (rabi-2017)

Sr. No.	Treatment	g.a.i/ha	Phytotoxicity parameters																													
			chlorosis					Necrosis					Epinasty					Leaf injury					Wilting					Hyponasty				
			1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
1.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	Untreated Control	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4: Phytotoxicity effect of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC on wheat crop (*Rabi*-2018)

Sr. No.	Treatment	g.a.i/ha	Phytotoxicity parameters																													
			chlorosis					Necrosis					Epinasty					Leaf injury					Wilting					Hyponasty				
			1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
1.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	Untreated control	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Effect of fungicides on yield of wheat :

During the first year of study, the highest grain yield (5650 kg/ha) of wheat was recorded in the treatment Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 200 g a.i/ha, followed by Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC @ 150 g a.i/ha (5499 kg/ha). Least wheat grain yield (3394 kg/ha) was recorded in the treatment untreated control (Table 1). All fungicide treatments significantly increased the yield of wheat as compared to untreated control. Similar trend was observed in second year also. It has both excellent preventive and curative activity through the inhibition of fungi at the several stages of the fungal lifecycle including spore germination, germ tube growth, appresoria formation and mycelial growth (Strathmann *et al*., 2011). Overall, Fluxapyroxad 167 g/l + Pyraclostrobin 333g/l 500SC @ was found to be the best treatment for controlling fungal diseases in wheat. It also resulted in 66 and 60 per cent increase in yield over untreated control during 2017-18 and 2018-19, respectively.

Phytotoxicity effect of fungicides on wheat :

The results of phytotoxicity studies of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l 500 SC are presented in Table 3 and 4. The observation on chlorosis, necrosis, wilting, scorching, yellowing and epinasty were recorded during both the year of study. None of the treatments shown any type of phytotoxicity symptoms of chlorosis, necrosis, wilting, scorching, yellowing and epinasty even at higher dose of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l500 SC @ 300 g a.i/ha.

Conclusion:

The combi-product of Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l500 SC was found more efficient in controlling the fungal diseases of wheat. Fluxapyroxad 167 g/l + Pyraclostrobin 333 g/l SC @ 200 g a.i/ha is the optimum dose to control the fungal diseases of wheat and recorded the highest grain yield, it was found effective and superior to other fungicides evaluated together. No phytotoxic symptoms were recorded after spraying on the crop plants even at higher dose.

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