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MANAGEMENT OF BLAST [*PYRICULARIA GRISEA* (COOKE) SACC.] DISEASE OF PEARL MILLET THROUGH FUNGICIDES

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ABSTRACT

Blast of pearl millet has emerged as serious disease affecting both grain and fodder production in pearl millet. Among the nine fungicides and two antibiotics at three concentrations were evaluated under *in vitro* condition by poisoned food technique against *Pyricularia grisea* revealed, propiconazole, mancozeb, tricyclazole and carbendazim (12%) + mancozeb (63%) at all the three concentrations completely inhibited the mycelial growth of the pathogen and proved to be most effective. Based on *in vitro* screening, promising fungicides were selected and re-evaluated under field condition against blast of pearl millet. Experiment under field condition revealed that two foliar sprays at an interval of 15 days commencing from the first initiation of disease with tricyclazole, 0.05% or iprobenfos, 0.1% or isoprothiolane, 0.05% was most effective in reducing blast intensity (17.78, 33.59 and 38.19% DI) and increasing grain (3493, 3012 and 2968 kg/ha) and fodder yield (6918, 5383 and 5323 kg/ha, respectively) over control (83.68% DI, grain yield 2483 kg/ha and fodder yield 3338 kg/ha).

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] encounters number of diseases which attack the crop during its growth, cause low yield and economic loss to the peasant and finally to the nation as a whole. The crop suffers from many fungal diseases, among which blast also referred as leaf spot disease caused by *Pyricularia grisea* (Cooke) Sacc. [teleomorph: *Magnaporthe grisea* (Herbert) Barr.] has emerged as a serious disease affecting both forage and grain production in pearl millet (Thakur *et al.*, 2009). The disease has been considered serious in southern coastal plains of the USA where infection from this disease has been found to have significant adverse effects on green forage yield and digestible dry matter (Wilson and Gates, 1993). In India, the disease was first reported in 1942 from Kanpur, Uttar Pradesh (Mehta *et al.*, 1953). The disease has recently become epidemic in almost all high yielding hybrids in certain parts of Middle Gujarat, North Gujarat and Saurashtra region. Mild to severe incidence of the disease has been recorded on a number of commercial hybrids in Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana during recent years (Anon., 2011). The disease is observed in severe form both at seedling and at later stage of plants, which results in premature drying of leaves and reduction in yield. The infection appears on leaves, stem and sheath with abundant sporulation under high humid conditions, especially in dense plant stands (Anon., 2004). Once considered a minor disease of pearl millet, incidence of blast disease caused by *Pyricularia grisea*, has increased at an alarming rate in the recent past in Gujarat (Lukose *et al.*, 2007).

Considering, the emerging and devastating nature of the disease and economic loss of the crop in this area, an attempt was made to evaluate the newer fungicides both *in vitro* and *in vivo* for the control of this important disease in Middle Gujarat condition.

MATERIALS AND METHODS

In vitro screening of fungicides against *P. grisea*

Eleven fungicides belonging to different chemical groups at three different concentrations were tested for their efficacy *in vitro* against *P. grisea* using poisoned food technique (Nene and Thapliyal, 1979). The concentrations of fungicides taken were those of active ingredients present in commercial formulation. The required quantities of each test fungicides were incorporated in a conical flask containing 100 ml molten Pearl millet leaf extract agar (PLEA) medium so as to get required concentration in parts per million (ppm). The flask containing poisoned medium was well shaken to facilitate uniform mixture of fungicides, and then, from this 20 ml was poured in each sterilized Petriplates. On solidification of the medium, the plates were inoculated in the centre by placing 5 mm diameter mycelial culture block cut aseptically with the help of cork borer from 15 days old actively growing pure culture of *P. grisea* grown on PLEA. Three repetitions were kept for each concentration of respective fungicide. The inoculated plates were incubated in B.O.D. at 25 ± 1^0C temperature. The observations on linear growth of fungus were recorded at 24 h interval up to full growth in control Petriplate. The per cent growth inhibition (PGI) of the pathogen over control was worked out by using formula given by Vincent (1927).

$$PGI = \frac{100\ (DC - DT)}{DC}$$

Where,

PGI = Per cent growth inhibition

DC = Average diameter of mycelial colony in control treatment (mm)

DT = Average diameter of mycelial colony in treated set (mm).

Considering the importance of disease and variation in the recommendations of different fungicides by various workers for the control of blast disease, a field experiment was carried out with the fungicides, which were found effective under laboratory screening to test relative field efficacy of different fungicides in controlling the blast disease of pearl millet.

The field experiment was laid out at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif* 2012-13 in Randomized Block Design (RBD) with ten treatments along with three replications using blast susceptible variety GHB-538. All the recommended agronomical practices were followed during experimentation. The crop was sown with 45 × 15 cm spacing having gross plot size 3.0 x 2.7 mt. in the second week of July 2012. Two foliar sprays of fungicides were given commencing from the appearance of blast disease and a subsequent spray was given after 15 days of first spray. The intensity of blast was recorded after seven days of each spray. Ten plants were selected randomly and labeled from each plot for scoring the disease intensity. These labeled plants were observed for disease intensity from upper, middle and lower leaves using disease rating scale of 0-9 (IRRI, 1988). The grain and fodder yield per ha and test weight were recorded.

Standard Evaluation System (SES) for blast (IRRI, 1988)

Scale	Description
0	No lesions.
1	Small brown specks of pinhead size without sporulating center.
2	Small roundish to slightly elongated, necrotic grey spots, about 1-2 mm in diameter with a distinct brown margin, lesions are mostly found on the lower leaves.
3	Lesion type is the same as in scale 2, but significant number lesions are on the upper leaves.
4	Typical sporulating blast lesions, 3 mm or longer, infecting less than 2 % of the leaf area.
5	Typical blast lesions infecting 2-10 % of the leaf area.
6	Blast lesions infecting 11-25 % leaf area.
7	Blast lesions infecting 26-50 % leaf area.
8	Blast lesions infecting 51-75 % leaf area.
9	More than 75 % leaf area affected.

The per cent disease intensity (PDI) was calculated by using the following formula

$$PDI \quad \frac{\text{Sum of numerical ratings}}{\text{No. of leaves observed} \quad \text{Maxitmum ratings (9)}} \quad 100$$

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads.

In vitro screening of fungicides against P. grisea

The observations on mycelial growth and per cent growth inhibition (PGI) recorded after eight days of incubation are presented in Table 1. All the fungicides screened were found significantly superior in inhibiting the mycelial growth of *P. grisea* over control. Propiconazole, mancozeb, tricyclazole and carbendazim (12%) + mancozeb (63%) completely inhibited the mycelial growth at all the three concentrations tested and thus appeared significantly superior over rest of the treatments. The next best treatments in order of merit were propineb at 1000, 1500 and 2000 ppm concentration (83.33, 88.89 and 91.11%) followed by aureofungin at 250, 500 and 750 ppm concentration with 75.92, 87.03 and 87.41 per cent growth inhibition, respectively.

The next best was iprobenfos at 1000, 1500 and 2000 concentration with 80.37, 81.86 and 81.86, azoxystrobin 18.2% + difenconazole 11.4% at 500, 1000 and 1500 ppm concentration with 78.52, 80.74 and 84.08, isoprothiolane at 1000, 1500 and 2000 ppm concentration with 73.33, 75.19 and 75.56, carbendazim at 250, 500 and 750 ppm concentration with 31.11, 38.89 and 53.7 and streptomycin sulphate at 250, 500 and 750 ppm concentration with 21.11, 25.92 and 31.48 per cent growth inhibition, respectively as compared to control.

The similar result has also been obtained by Hossain and Kulkarni (2001) who reported cent per cent inhibition of radial growth with propiconazole and tricyclazole, while mancozeb was the best among non-systemic fungicides in inhibiting the radial growth of *P. oryzae*. Gohel *et al*. (2008) reported tricyclazole, mancozeb, carbendazim, iprobenfos and propiconazole were highly fungitoxic against *P. oryzae*. Macwan (2009) noted cent per cent growth inhibition of *P. oryzae* with tricyclazole.

Naik and Jamadar (2014) evaluated different fungicides *in vitro* against *Pyricularia grisea*, incitant of blast of pearl millet and reported that among the non-systemic fungicides, mancozeb 75 WP gave maximum inhibition (93.30%) of the mycelial growth of the pathogen which was on par with captan (70%) + hexaconazole (5%) (93.17%). While among systemic fungicides, tricyclazole 75 WP gave maximum inhibition of the mycelial growth (87.78%) of the pathogen followed by difenconazole 25 EC (86.91%), hexaconozole 5 EC (85.33%) and propiconazole 25 EC (75.92%).

Effectiveness of the fungicides found promising in present *in vitro* study can be attributed to their mode of action leading to adverse effect on growth and development of *P. grisea*. Tricyclazole is a unique fungicides act as systemic with protectant activity and protects plants from infection by preventing penetration of the epidermis by the fungus. The compound acts by inhibiting melanization within the appressorium, thus causing a lack of rigidity in the appressorial wall. Tricyclazole has no apparent effect on spore germination although sporulation is reduced.

Propiconazole causes demethylation of C-14 during ergosterol biosynthesis leading to accumulation of C-14 methyl sterols. The biosynthesis of these ergosterols is critical to the formation of cell walls of fungi. Lack of normal sterol production slows or stops the growth of the fungus, and preventing further infection and/or invasion of host tissues.

Mancozeb prevents fungal spores from germinating,

Table 1: Screening of fungicides and antibiotics against *P. grisea in vitro*

Sr.No.	Fungicides	Concentration (ppm)	Averagemycelial growth (mm)	Per cent Growth Inhibition (PGI)
1	Propiconazole(25 EC)	1000	0	100
		2000	0	100
		3000	0	100
2	Mancozeb(75 WP)	1000	0	100
		2000	0	100
		3000	0	100
3	Tricyclazole(75 WP)	500	0	100
		1000	0	100
		1500	0	100
4	Carbendazim (12%) + Mancozeb (63%)(75 WP)	1000	0	100
		1500	0	100
		2000	0	100
5	Propineb(70 WP)	1000	15.00	83.33
		1500	10.00	88.89
		2000	8.00	91.11
6	Aureofungin(46.7 SP)	250	21.67	75.92
		500	11.67	87.03
		750	11.33	87.41
7	Iprobenfos(48 EC)	1000	17.67	80.37
		1500	16.33	81.86
		2000	16.33	81.86
8	Azoxystrobin 18.2%+ Difenconazole 11.4% (29.6 SC)	500	19.33	78.52
		1000	17.33	80.74
		1500	14.33	84.08
9	Isoprothiolane(40 EC)	1000	24.00	73.33
		1500	22.33	75.19
		2000	22.00	75.56
10	Carbendazim(50 WP)	250	62.00	31.11
		500	55.00	38.89
		750	41.67	53.7
11	Streptomycin sulphate(90 SP)	250	71.00	21.11
		500	66.67	25.92
		750	61.67	31.48
12	Control	-	90.00	-
	S.Em. ±	-	0.84	-
	C.D. at 5 %	-	2.38	-

Table 2: Effect of fungicides on leaf blast intensity and yield of pearl millet

Trt.No.	Treatments	Concentration(%)	Leaf blast intensity (%)	Grain yield (kg/ha)	Fodder yield(kg/ha)	Test wt.(g)
1	Tricyclazole (Mantis 75 WP)	0.05%	24.94 (17.78)	3493	6918	11.04
2	Iprobenfos (Kitazin 48 EC)	0.1%	35.42 (33.59)	3012	5383	9.07
3	Isoprothiolane (Fujione 40 EC)	0.05%	38.17 (38.19)	2968	5323	8.91
4	Carbendazim (Bavistin 50 WP)	0.05%	41.06 (43.15)	2904	5055	8.75
5	Carbendazim (12%) + Mancozeb (63%) (Sixer 75 WP)	0.15%	41.90 (44.60)	2801	4997	8.53
6	Propiconazole (Tilt 25 EC)	0.1%	42.88 (46.31)	2767	4978	8.28
7	Propineb (Antracol 70 WP)	0.1%	44.41 (48.97)	2675	4498	8.21
8	Aureofungin (Aureofungin 46.7 SP)	0.025%	44.96 (49.93)	2642	4229	7.43
9	Neem leaf extract	10%	52.31 (62.62)	2583	3999	7.25
10	Control	-	66.17 (83.68)	2483	3338	6.70
	S.Em. ±		2.22	123.12	245.69	0.48
	C.D. at 5 %		6.60	365.82	729.98	1.43

Note: Figure in parentheses indicate re-transformed values of arcsine.

destruction of cell wall by various plant enzymes, enhances plant immunizations and degrades cell wall of fungal pathogens completely or partially. Carbendazim 12% + Mancozeb 63% is a broad spectrum fungicide with protective and curative action with contact and systemic in nature.

Management of blast of pearl millet under field condition

The data presented in Table 2 revealed that all the treatments significantly reduced the per cent leaf blast intensity as compared to control (83.68%). Among them, tricyclazole was found significantly superior over the rest of treatments showing minimum (17.78%) leaf blast intensity. The next best treatment was iprobenfos (33.59%) which was at par with isoprothiolane

(38.19%). Treatment of carbendazim (43.15%), carbendazim (12%) + mancozeb (63%) (44.60%), propiconazole (46.31%), propineb (48.97%) and aureofungin (49.93%) were mediocare. The neem leaf extract was fail in reducing the disease.

Regarding grain yield, the treatment effects were significant (Table 4.13 and Fig.10a & 10b). Tricyclazole was found significantly superior, recording highest grain yield (3493 kg/ha). The next best treatment was iprobenfos (3012 kg/ha) which was at par with isoprothiolane (2968 kg/ha) followed by carbendazim (2904 kg/ha), carbendazim (12%) + mancozeb (63%) (2801 kg/ha), propiconazole (2767 kg/ha) and propineb (2675 kg/ha). The rest of the treatment, aureofungin (2642 kg/ha) and neem leaf extract (2583 kg/ha) were moderately effective over control treatment (2483 kg/ha).

Treatment effects for fodder yield were significant. The trend was similar to that of grain yield. The fodder yield was significantly highest (6918 kg/ha) in tricyclazole. The next best treatment was iprobenfos (5383 kg/ha) which was at par with isoprothiolane (5323 kg/ha) followed by carbendazim (5055 kg/ha), carbendazim (12%) + mancozeb (63%) (4997 kg/ha) and propiconazole (4978 kg/ha). The treatments propineb (4498 kg/ha), aureofungin (4229 kg/ha) and neem leaf extract (3999 kg/ha) were moderately effective over control treatment (3338 kg/ha).

In case of test weight, tricyclazole was found significantly superior over the rest recording highest (11.04 g) 1000 grain weight. The next best treatment was iprobenfos (9.07 g) which was at par with isoprothiolane (8.91 g) followed by carbendazim (8.75 g), carbendazim (12%) + mancozeb (63%) (8.53 g), propiconazole (8.28 g) and propineb (8.21 g). The next in order were aureofungin (7.43 g) and neem leaf extract (7.25 g) as compared to untreated control (6.70 g).

In the present study, tricyclazole (0.05%) was found significantly superior in reducing leaf blast and achieving the higher yield over rest of the treatments. The next effective treatments were iprobenfos (0.1%), isoprothiolane (0.05%) and carbendazim (0.05%).

Prajapati *et al*. (2004) reported tricyclazole (beam) (0.045%) as most effective fungicide for the control of rice blast and increasing yield. Similar results were also reported by Vijaya (2002), Gohel *et al*. (2009), Sood and Kapoor (1997), Sunder *et al*. (1994) and Peterson (1990). Effectiveness of iprobenfos (kitazin) (3.75 kg a.i./ha) in controlling rice blast and increasing grain yield has also been reported by Sharma and Kumar (1992). Lukose *et al*. (2007) reported that carbendazim (0.05%) reduced the blast disease intensity and increased the grain and fodder yield with maximum net return and ICBR. Varma and Santhakumari (2012) have reported that Isoprothiolane (1.5 ml/lit) reduced rice blast incidence with maximum increase in grain and straw yield. Thus, the results of earlier workers are also in line with the results obtained in the present investigations. With respect to botanicals and organic products, Pal *et al*. (2015) reported that maximum percent inhibition at 1% concentration in case of poultry manure (54.13%) followed by neem leaf extract (34.20%) against *P. grisea* causing blast disease of rice.

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