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Chemical management of powdery mildew caused by *Erysiphe polygoni* DC on Urdbean and its economic analysis

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Abstract
Powdery mildew of Urdbean caused by *Erysiphe polygoni* DC is one of the major constraints in the production, which cause both qualitative and quantitative loss of grains. In the present study we have evaluated the efficacy of fungicides for managing powdery mildew of urdbean. The fungicides Penconazole 10% EC (@ 0.25 ml/ L, 0.5 ml/L, 1.0 ml/ L and 1.50 ml/ L), Hexaconazole 5% SC @ 1.0 ml/ L, Difenoconazole25% EC@ 0.50 ml/L and Captan 70% + Hexaconazole 5% WP @ 1.25 g /L were evaluated for their bio-efficacy against powdery mildew of Urdbean. Pooled data of experiments conducted at MARS, UAS, Dharwad for two years during 2017 and 2018 revealed that, all the chemicals were found effective in reducing the severity of the disease and their by increasing the urdbean yield. Among them, Penconazole 10% EC @ 1.5 ml/L was found to be the most effective in managing the powdery mildew of urdbean (9.91 PDI) and which is on par with Penconazole 10% EC @ 1.0 ml/L recorded powdery mildew severity of 10.15 PDI. Penconazole 10% EC @ 0.50 ml/L (11.93 PDI) was the next best treatment followed by Difenconazole 25% EC@ 0.50 ml/ L (13.25 PDI) and Hexaconazole 5% SC @ ml/L (13.54 PDI) when compared to untreated control which has recorded the maximum PDI of 66.90. Significantly the highest seed yield of 686.20 kg/ha was observed with Penconazole 10% EC @ 1.5 ml/L with B:C ratio of 2.20 followed by Penconazole 10% EC @ 1.0 ml/L (683.00 kg/ha) with maximum B: C ratio of 2.22 compared to least seed yield of 308.83 kg/ha in untreated control with least B:C of 1.06. Thus the dose of Penconazole10% EC @ 1 ml per liter of water was found to be the minimum dose required for better management of the powdery mildew disease in urdbean.

Keywords: Urdbean, powdery mildew, fungicides, penconazole

Introduction
Urdbean (*Vigna mungo*) is known to suffer from several fungal and viral diseases. Among the fungal diseases, powdery mildew caused by *Erysiphe polygoni* DC is considered as a major one. The loss inflicted is proportional to the disease intensity and varies considerably depending on the stage of plant growth. The disease has world-wide importance, occurring wherever it is grown, particularly in the Indian sub-continent and southeast-Asian countries (Butler, 1918) [3]. In India the disease is present in almost all states of the country and becomes severe in dry season causing 9.0- 50.0 per cent yield loss (Pandey *et al*., 2009) [15].

Powdery mildew of urdbean causes both qualitative and quantitative loss of grains. The reduction in photosynthetic activity and physiological changes are considerable, which lead to potential reduction in yield (40-90%) depending on stage and time at which the disease appears. However, disease intensity depends upon the cultivar, growing period and environmental conditions. The disease appears on all the above ground parts of the plant. Initial symptoms are marked by faint, slightly dark areas on the leaves. These areas develop into small, white powdery spots. They enlarge and coalesce to form a complete coating of white powder on leaves, stem and pods. The powdery mass consisting of mycelium and conidia eventually turn dirty white. In case of severe infection, it spreads all over the leaf and defoliation takes place. Disease induces forced maturity in the plants causing heavy yield losses.

The fungus has very wide host range and present in nature throughout the year. Secondary spread of the disease is by air borne *Oidia* which are capable of germinating even under dry condition with moderate temperature and infection takes place repeatedly.

The disease can be managed by spraying fungicides. Many systemic and non-systemic fungicides are reported to manage the powdery mildew of urdbean. The information on the efficacy of different new fungicides against powdery mildew of urdbean is insufficient. Hence there is a need to evaluate new fungicides against *Erysiphe polygoni* DC. Hence, the present investigation was undertaken with the objective to evaluate the efficacy of fungicides against Powdery mildew (*Erysiphe polygoni* DC.) disease in urdbean crop.

Materials and Methods

The present investigation was carried out at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka) during late-*kharif* 2017-18 and 2018-19. Commercial fungicides Penconazole 10% EC (@ 0.25 ml/ L, 0.5 ml/L, 1.0 ml/ L and 1.5 ml/ L), Hexaconazole 5% SC @ 1.0 ml/ L, Difenoconazole25% EC@ 0.50 ml/L and Captan 70% + Hexaconazole 5% WP @ 1.25 g /L were evaluated in the present study. The field experiment was laid out in Randomized Block Design with 8 treatments and three replications. Urdbean variety 'DU-1' was sown at 30 cm x 10cm spacing. Recommended dose of fertilizers was applied and irrigated lightly for better seed germination. Thinning and gap filling operations were carried out ten days after sowing to maintain uniform plant population. First spraying was done immediately on appearance of powdery mildew disease and subsequent second spray was given at an interval of 15 days. The plot without fungicidal spray was treated as untreated control plot.

The severity of the powdery mildew was recorded during both the seasons using 0-5 scale (Mayee and Datar, 1986) [11] and per cent disease Index (PDI) was calculated.

Powdery mildew 0-5 scale (Mayee and Datar, 1986)

Grade	Leaf area infection (%)	Reaction
0	No infection	HR
1	0.1 to 10% leaf area is infected	R
2	10.1 to 25.0% leaf area is infected	MR
3	25.1 to 50.0% leaf area is infected	MS
4	50.1 to 75.0% leaf area is infected	S
5	75.1 to 100.0% leaf area is infected	HS

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of the individual disease ratings}}{\text{Number of leaves observed} \times \text{Maximum disease grade}} \times 1\,00$$

The yield was recorded from each plot and computed to yield kg/ha, gross returns, net returns and benefit cost ratio were also calculated according to standard procedures. The data were subjected to statistical analysis after using transformations such as arc sine transformation for Per cent Disease Index.

Results and Discussion

Disease severity (PDI)

Pooled data of experiments conducted at MARS, UAS, Dharwad for two years during 2017 and 2018 (Late *Kharif*) revealed that, all the chemicals were found effective in reducing the severity of the disease (Table. 1 and Fig. 1)and their by increasing the urdbean yield. Among them, Penconazole 10% EC @ 1.5 ml/L cent was found to be the most effective in managing the powdery mildew of urdbean (9.91 PDI) and which is on par with Penconazole 10% EC @ 1.0 ml/L recorded powdery mildew of 10.15 PDI. Penconazole 10% EC @ 0.50 ml/L (11.93 PDI) was the next best treatment followed by Difenconazole 25% EC@ 0.50 ml/ L (13.25 PDI) and Hexaconazole 5% SC @ ml/L (13.54 PDI) when compared to maximum PDI was recorded in untreated control (66.90). The results are in agreement with several workers who reported powdery mildew management in various crops through fungicides (Begum, 1989 [2], Upadhyay and Gupta, 1994 [18], Kapoor and Sugha, 1995 [8], Malani *et al*., 1998 [10], Naik and Nagaraja, 2000 [13], Moshe 2001 [12], Saxena and Moly Saxena, 2002 [17], Gupta and Amit Kumar 2008 [6], Divyjyothi, 2012 [5], Channaveeresh, 2013 [4], Ashwini *et al*., 2016 [1] and Madhuri and Karunasagar, 2020 [9], reported that carbendazim @ 0.1% proved effective in minimizing the powdery mildew disease incidence by recording lowest Per cent Disease Index (PDI) of 34.15%, seed yield of 925 kg/ha & Cost Benefit ratio of 1:1.68. Jayasekharn and Ebenezar, 2016 [7], reported that the maximum reduction of disease incidence was recorded in wettable sulphur 0.25% (15.80%) followed by carbendazim 0.1% (58.91%) and castor oil 1% with *Ampelomyces quisqualis* (48.53%) However castor oil 1% followed by *A. quisqualis* application at 10 days interval recorded 20.28 per cent increased yield with maximum cost benefit ratio of 1 : 2.01

Triazole fungicides interfere with the biosynthesis of fungal sterols and inhibit ergosterol biosynthesis (Rawal, 1993) [16]. Ergosterol is essential to the structure of cell wall and its absence causes irreparable damage to the cell wall thus fungus dies. Apart from this also interfere in conidia and haustoria formation. These changes in a sterol content and saturation of the polar fatty acids leading to alterations in membrane fluidity and behaviour of membrane bound enzymes (Nene and Thapliyal, 1993) [14].

Table 1: Evaluation of different fungicides against powdery mildew caused by *Erysiphe polygoni* DC on urdbean

Treatments	Treatment details	Percent Disease Index (PDI)			Yield (kg/ha)		
		2017	2018	Pooled 2017-18	2017	2018	Pooled 2017-18
T1	Control	79.50 *(63.24)	54.30 (47.49)	66.90 (55.37)	313.33	304.33	308.83
T2	Penconazole 10% EC @ 0. 25 ml/ L	17.53 (24.76)	13.43 (21.51)	15.48 (23.12)	509.00	503.00	506.00
T3	Penconazole 10% EC @ 0. 50 ml/ L	14.43 (22.33)	9.43 (17.9)	11.93 (20.11)	635.00	639.00	637.33
T4	Penconazole 10% EC @ 1.0 ml/ L	12.67 (20.86)	7.64 (16.05)	10.15 (18.45)	681.67	682.33	683.00
T5	Penconazole 10% EC @ 1.5 ml/L	12.30 (20.54)	7.53 (15.93)	9.91 (18.23)	684.33	688.00	686.20
T6	Hexaconazole 5% SC @ 1.0 ml/L	15.70 (23.34)	11.37 (19.72)	13.54 (21.53)	625.33	627.33	626.33
T7	Difenoconazole25% EC@ 0.50 ml/ L	15.37 (23.08)	11.13 (19.5)	13.25 (21.29)	630.33	642.67	634.83
T8	Captan 70% + Hexaconazole 5% WP @ 1.25 gm/L	19.60(26.26)	12.10(20.37)	15.85(23.29)	617.67	618.67	618.17
SEm.±		0.88	0.65	0.56	17.28	17.19	13.59
CD at 5%		2.69	1.98	1.71	51.59	52.86	41.24

Seed yield and Net returns

Significantly the highest seed yield of 686.20 kg/ha was observed with Penconazole 10% EC @ 1.5 ml/L with B:C ratio of 2.20 followed by Penconazole 10% EC @ 1.0 ml/L (683.00 kg/ha) with maximum B: C ratio of 2.22 compared to least seed yield of 308.83 kg/ha in untreated control with least B:C of 1.06 (Table. 2 and Fig. 2). However, Penconazole 10% EC @ 1.5 ml/L recorded maximum yield, the net returns and B:C ratio were more with Penconazole 10% EC @ 1.0 ml/L. Thus the dose of Penconazole10% EC @ 1 ml per liter of water was found to be the minimum dose required for better management of the powdery mildew disease in urdbean with maximum net returns and B: C ratio of 26235 and 2.22 respectively.

Table 2: Cost benefit ratio of fungicide management of powdery mildew caused by *Erysiphe polygoni* DC on urdbean

Treatments	Treatment details	Yield kg/ ha pooled	Cost of Cultivation (Rs/ha)	Gross Returns (Rs/ha)	Net Returns (Rs/ha)	B:C ratio
T1	Control	308.83	20325	21618.33	1293	1.06
T2	Penconazole 10% EC @ 0. 25 ml/ L	506.00	21075	35420.00	14345	1.68
T3	Penconazole 10% EC @ 0. 50 ml/ L	637.33	21325	44613.33	23288	2.09
T4	Penconazole 10% EC @ 1.0 ml/ L	683.00	21575	47810.00	26235	2.22
T5	Penconazole 10% EC @ 1.5 ml/L	686.20	21825	48034.00	26209	2.20
T6	Hexaconazole 5% SC @ 1.0 ml/L	626.33	20975	43843.33	22868	2.09
T7	Difenoconazole25% EC@ 0.50 ml/ L	634.83	22475	44438.33	21963	1.98
T8	Captan 70% + Hexaconazole 5% WP @ 1.25 gm/L	618.17	21575	43271.67	21697	2.01
SEm.±		13.59				
CD at 5%		41.24				

Control | Penconazole 10% EC @ 1.0 ml/ L

Fig 1: Effectiveness of fungicide Penconazole 10% EC @ 1.0 ml/ L for the management of powdery mildew caused by *Erysiphe polygoni* DC on urdbean

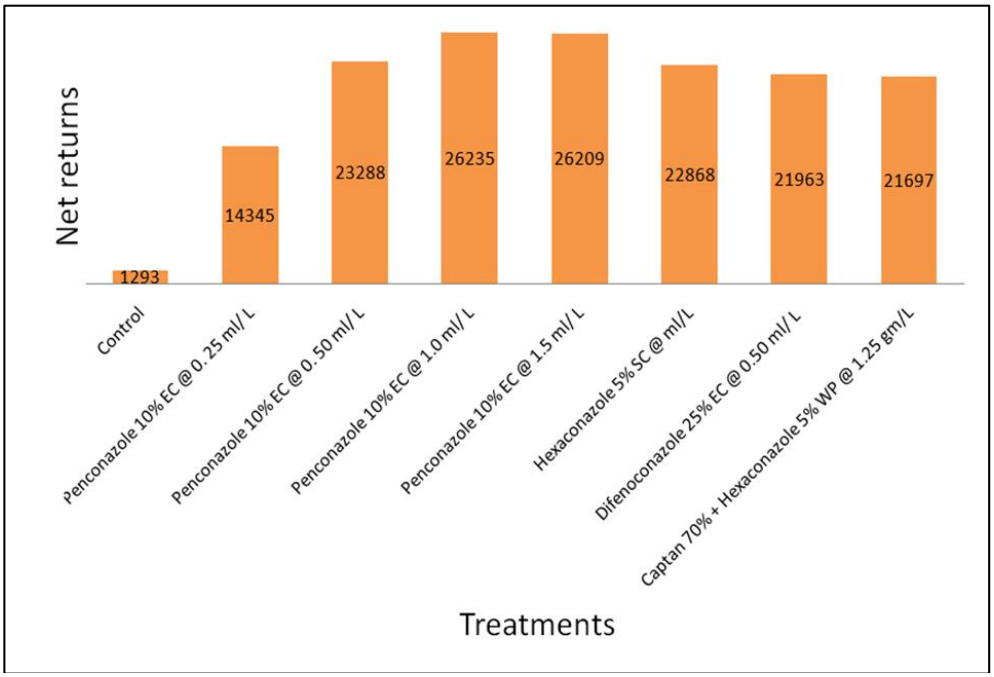

Fig 2: Graphical representation of net returns for fungicide management of powdery mildew caused by *Erysiphe polygoni* DC on urdbean

Conclusion

Penconazole10% EC @ 1 ml per liter of water was found to be the minimum dose required for better management of the powdery mildew disease in urdbean with maximum net returns and B: C ratio.

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