

Management of Powdery mildew (*Erysiphe polygoni*) of fenugreek

Abstract

India grows fenugreek (*Trigonella foenum graecum* L.), one of the most significant spices. *Erysiphe polygoni* DC caused powdery mildew is one of the main disease to fenugreek production. In Rabi 2019 to 2022, a field experiment was carried out to ascertain the impact of fungicides on the *Erysiphe polygoni* caused powdery mildew disease of fenugreek. In field conditions, Total six fungicides with one water spray and no spray (untreated control) was evaluated for their efficacy to control the powdery mildew disease of fenugreek. All the fungicides were significantly effective in reducing the powdery mildew disease intensity over control. Among these fungicides, at maturity the minimum per cent disease intensity 29.25 was recorded with the spray of hexaconazole (0.005%) @ 1 ml/l and followed by propiconazole (0.025%) @ 1 ml/l showed 31.23 per cent disease intensity. Wettable sulphur (0.2%) @ 2.5 g/l 33.07 % disease intensity were observed. The treatment hexaconazole 5% EC registered higher net realization (Rs. 20,198/ha) and ICBR (1:6.23) followed by propiconazole 25% EC with net realization (Rs. 16,568/ha) with ICBR (1:5.26) followed by sulphur 80% WP with net realization (Rs. 14,858/ha) with ICBR (1:5.24).

Keywords: *Erysiphe polygoni*, Fenugreek, Fungicides, Powdery mildew.

Introduction

Fenugreek (*Trigonella foenum graecum* L.) is a short living important legume crop belongs to the family Fabaceae and known as *methi/metha* with multifarious uses and it is cultivated for seed, leafy vegetable and also for fodder. It is used against the digestive disorders (Sharma *et al.* 1991) and has good medicinal values (Kirtikar and Basu, 1975). Fenugreek seeds are rich source of protein and leaves are rich in minerals, proteins, vitamin A and C. In industry, seeds are used for dye making and for extraction of alkaloids and steroids (Balodi and Rao 1991). The dried leaves and flowers are used for flavouring vegetable curries (Arya 2002).

Fenugreek has been cultivated in most of states of India. It is grown as an extensive scale in Gujarat, Rajasthan, Madhya Pradesh, Uttar Pradesh, Maharashtra and Panjab.

Due to the combined effects of numerous biotic and abiotic factors, fenugreek has a low yield. Fenugreek is suffering from diseases like Powdery mildew [*Erysiphe polygoni* DC.; *Leveillula Taurica* (Lev.)], Downy mildew (*Peronospora trigonellae*), Charcoal rot (*Macrophomina phaseolina*), leaf spot (*Cercospora traversiana*), Damping off (*Pythium aphanidermatum*), *Fusarium* wilt (*Fusarium oxysporum*) are most destructive diseases of fenugreek which causes damage to all above ground plant parts.

The most detrimental fenugreek disease, powdery mildew, has a significant negative influence on all plant portions that are above ground and causes 50 per cent seed yield losses (Kumawat and Shekhawat, 2015). Which is characterized by the appearance of white floury patches on both the surface of leaves and other aerial parts of plants. The later stage of the fenugreek crop becomes serious when pod formation takes place. The disease generally appears during December to January and spreads throughout the field until the crop is fully mature, when the environmental conditions are favourable for the pathogen. It has been well-established that fenugreek powdery mildew has the ability to survive by means of cleistothecia, which are commonly found in plant debris within the field. Another potential source of persistence is through planting seeds contaminated with infected plant debris. This highlights the importance of thorough field and seed management practices to prevent the spread and recurrence of this fungal disease. However, secondary transmission of the disease, which occurs through conidia and may germinate in a wide range of temperatures from 5°C to 35°C, is what causes the most spread and harm. It is a routine practice for farmers to spray fungicides onward from 45 days age to maturity of the crop to save seed yield from the epidemic of disease. Humidity is an important factor related to the onset

and spread of powdery mildew. High relative humidity increases spore formation, and low relative humidity favors spore dispersal, which explains why powdery mildew tends to be a problem when the days are cool and the nights are humid.

Powdery mildew is a foliar pathogen, poses a significant challenge to control. However, there is hope in effectively managing its impact. One of the most suitable strategies is to focus on the efficacy of fungicides in suppressing spore germination. By targeting this critical stage of the disease's life cycle, we can improve our chances of successful management. The present study was Undertaken to assess the yield losses in fenugreek due to powdery mildew disease at varying disease intensities.

Materials and Methods

To evaluate the effect of fungicide on powdery mildew of fenugreek (Table 1), the field experiment was conducted during rabi season with respective years 2019-20, 2020-21 and 2021-22 in randomized blocked design (RBD) on susceptible fenugreek local variety at Department of Plant Pathology, N.M.C.A., NAU, Navsari-389540. The crop was sown with respective dates. i.e. 18/01/2020, 26/11/2020 and 02/11/2021 with three repetitions and spacing was (30 cm x 15 cm) with Plot size are-Gross- 4.05 X 1.2 m² (4 row x 27 Plants) and Net-3.45 X 0.6 m² (2 rows X 23 Plants) (Fig.1,2,3,4,5,6,7)

Table 1. Experimental details

Tr. No.	Name of Treatments	Concentrations (a. i %)	Quantity g or ml/ l	Quantity g or ml/10 lit
1	Carbendazim 50 % WP	0.025	0.5 g	5 g/10 lit
2	Sulphur 80 % WP	0.2	2.5 g	25 g/10 lit.
3	Propiconazole 25 % EC	0.025	1.0 ml	10 ml/10 lit.
4	Hexaconzole 5% EC	0.005	1.0 ml	10 ml/10 lit.
5	Difenconazole 25% EC	0.025	1.0 ml	10 ml/10 lit.
6	Pyraclostrobin 13.3 % WG	0.025	2.0 g	20 g/10 lit.
7	Water Spray	-	-	-
8	No spray	-	-	-

Total six fungicides, one water spray and no spray (untreated control) treatment was maintained in experiment. Fungicides were sprayed twice at an interval of 15 days starting from the initial appearance of the disease. The per cent diseases intensity was recorded after 15 days of last spray of fungicides by examining. 20 leaves from 10 randomly selected plants in each treatment. For disease, scoring on leaves 0-5 scale (Table 2) was used as mentioned below (Prakash and Saharan 1999). Per cent disease intensity was calculated by using formula given below. At harvesting, seed yield per plot was recorded and calculated in kg/ha. Cost benefit ratio was also worked out and results were analysed statistically. Disease rating and per cent disease intensity (PDI) was calculated as per method suggested with slight modification (Prakash and Saharan 1999).

Table 2. Disease rating scales.

Scale	Percentage	Particulars
0	0-5	Healthy
1	6-20	Suppressed colonies
2	21-40	Upper leaf surface only
3	41-60	Upper and lower surface both side
4	61-80	On leaves and petioles
5	> 80	On leaves, petioles and stems

$$PDI = \frac{\text{Sum of all numerical rating}}{\text{No. of leaves examined} \times \text{Maximum disease rating}} \times 100$$

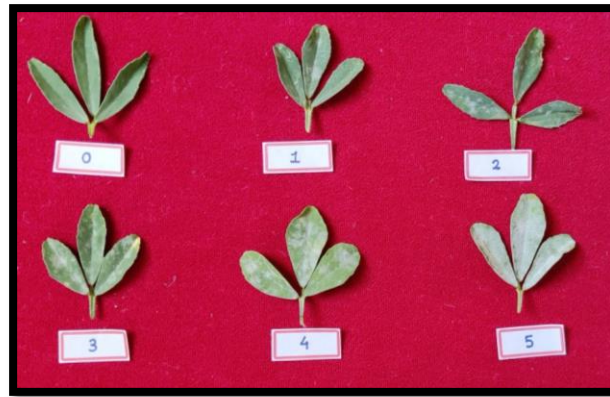


Fig 1. Leaf area affected by powdery mildew disease (0-5 scale)



Fig 2. Initiation of powdery mildew disease on fenugreek leaves

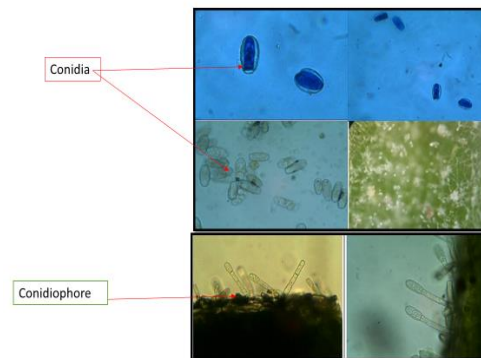


Fig 3. Microscopic view of fenugreek powdery mildew



Fig 4. Field view of fenugreek powdery mildew

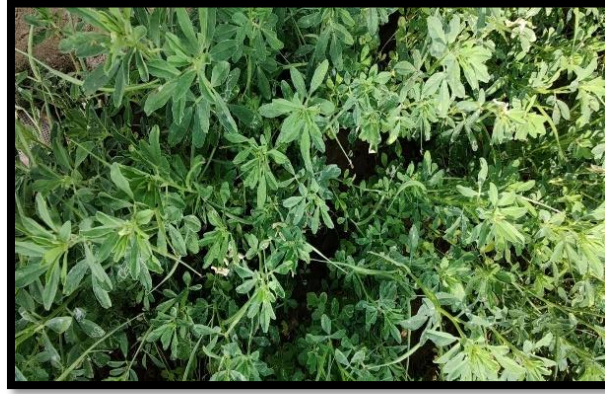


Fig 5. Effect of three spray of Hexaconzole 5 % EC @ (0.005%) @ 10 ml/ 10 lit against powdery mildew disease

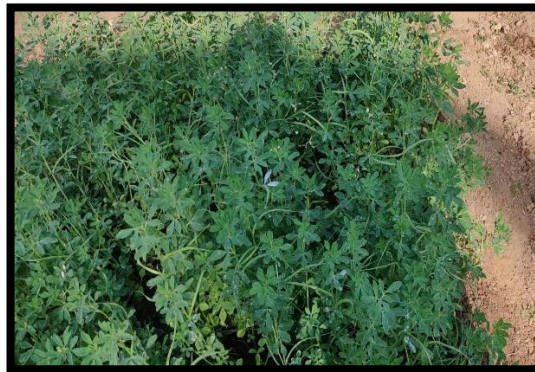


Fig 6. Effect of three spray of Propiconzole 25 % EC (0.025%) @ 10 ml/10 lit against powdery mildew disease



Fig 7. Effect of Control (No spray) against powdery mildew disease

Results and Discussion

Total six fungicides, one water spray and no spray (untreated control) were evaluated for management of powdery mildew of fenugreek by spraying twice at 15 days interval under natural field conditions. Three years pooled results on per cent disease intensity (Table 3) that all the fungicides were significantly effective in reducing the powdery mildew disease intensity over control.

Year 2019-20

The powdery mildew intensity recorded at disease initiation stage (before spraying) ranged from 8.33 to 9.72 per cent. Sprays of different fungicides were under taken at initiation of disease followed by second spray of an interval of 15 days. The per cent disease intensity was recorded before first spray, 15 days after first spray (before second spray), 15 days

after second spray and maturity stage. The data revealed that before spray, all the treatment showed non-significant *i.e* the disease appearance was more or less similar in all the treatments.

After 15 day of first spray, per cent disease intensity in all the treatments were significantly superior over control. The minimum per cent disease intensity (20.56%) was observed in foliar spray with hexaconazole (0.005%) @ 1 ml/l which is at par with propiconazole (0.025%) @ 1 ml/l (23.61%), wettable sulphur (0.2%) @ 2.5 g/l (24.72%) and difenconazole (0.025%) @ 1 ml/l (27.22%). Highest per cent disease intensity was observed control treatment with no spray (46.94%).

After 15 days of second spray, per cent disease intensity in all the treatments were significantly superior over control. Similar trend was observed as shown in after 15 days of first spray. The minimum per cent disease intensity (20.83%) was observed in foliar spray with hexaconazole (0.005%) @ 1 ml/l which is at par with propiconazole (0.025%) @ 1 ml/l (24.45%) and wettable sulphur (0.2%) @ 2.5 g/l (25.55%) and difenconazole (0.025%) @ 1 ml/l (28.33%). Highest per cent disease intensity was observed control treatment with no spray (51.11%).

At maturity stage, the minimum per cent disease intensity (22.50%) was observed in foliar spray with hexaconazole (0.005%) @ 1 ml/l which is at par with propiconazole (0.025%) @ 1 ml/l (25.83%) and wettable sulphur (0.2%) @ 2.5 g/l (26.94%). The highest per cent disease intensity was observed control treatment with no spray (64.72%).

Year 2020-21

In year 2020-21 the powdery mildew intensity recorded at disease initiation stage (before spraying) ranged from 9.44 to 11.11 per cent. At maturity the minimum 24.44 per cent disease intensity was recorded with the application of hexaconazole (0.005%) @ 1 ml/l at par with propiconazole (0.025%) @ 1 ml/l showed 26.39 per cent disease intensity followed by wettable sulphur (0.2%) @ 2.5 g/l 30.83% disease intensity were observed. Fungicides, carbendazim (0.025%) @ 0.5 g/l 44.44% followed by 44.17 per cent was recorded in the treatment of pyraclostrobin (0.025%) @ 2 g/l, respectively. In case of water spray and no spray, recorded 58.32 and 66.17 per cent disease intensity, respectively.

Year 2021-22

The powdery mildew intensity recorded at disease initiation stage (before spraying) ranged from 9.44 to 10.56 per cent. At maturity the minimum 24.72 per cent disease intensity was recorded with the application of hexaconazole (0.005%) @ 1 ml/l with up to 66.94 per cent disease intensity over control. However, propiconazole (0.025%) @ 1 ml/l showed 24.72 per cent disease intensity and wettable sulphur (0.2%) @ 2.5 g/l 31.67 per cent disease intensity were observed. Among the fungicides, maximum 42.78 and 45.83 per cent was recorded in the treatment of carbendazim (0.025%) @ 0.5 g/l and pyraclostrobin (0.025%) @ 2 g/l, respectively. In case of water spray and no spray, recorded 59.72 and 66.94 per cent disease intensity, respectively.

(Pooled result 2019-22)

The powdery mildew intensity recorded at disease initiation stage (before spraying) ranged from 9.35 to 9.91 per cent (Table 4). It is very clear from the results that, all the fungicides were significantly effective in reducing the powdery mildew disease. At maturity the minimum per cent disease intensity 29.25 was recorded with the spray of hexaconazole (0.005%) @ 1 ml/l and followed by propiconazole (0.025%) @ 1 ml/l showed 31.23 per cent disease intensity. Wettable sulphur (0.2%) @ 2.5 g/l 33.07 % disease intensity were observed. 39.25 and 40.65 per cent disease intensity was recorded in carbendazim (0.025%) @ 0.5 g/l and pyraclostrobin (0.025%) @ 2 g/l, respectively. In case of water spray and no spray, recorded 49.38 and 54.31 per cent disease intensity, respectively (Table IV and Fig. 5,6,7). Narayana *et al.* 2005 reported that hexaconazole provided the highest control of grape powdery mildew disease and crop yield. Singh 2006 recorded that all the fungicides reduced the disease severity significantly over the control, with maximum reduction with hexaconazole (0.1%), which was on par with propiconazole (0.1%) and wettable sulfur (0.3%). Yield of coriander was higher by 2.54, 2.00 and 2.20 times compared to the control, hexaconazole (0.1%), propiconazole (0.1%) and wettable sulfur (0.3%), respectively. Cost-benefit ratio was 1:5.3, 1:4.0 and 1:4.5 in hexaconazole (0.1%), propiconazole (0.1%) and wettable sulfur (0.3%), respectively to control of powdery mildew disease of coriander (*C. sativum*), caused by *Erysiphe polygoni*. Kumawat *et al.* 2016 also studied that fungicides, hexaconazole recorded minimum (9.60%) per cent disease intensity with maximum (84.68%) per cent disease control and seed yield (24.61 q/ha) by increasing 63.08 per cent seed yield. Dinocap

with two sprays was second best and recorded 10.39 per cent disease intensity with 56.05 per cent increased seed yield after two sprays at 15 days interval over unprotected check.

Economics

The economics is calculated by considering the profit increase over control for different treatments. The treatment hexaconazole 5% EC registered higher net realization (Rs. 20,198/ha) and ICBR (1:6.23) followed by propiconazole 25% EC with net realization (Rs. 16,568/ha) with ICBR (1:5.26) followed by sulphur 80% WP with net realization (Rs. 14,858/ha) with ICBR (1:5.24). However, the other treatment had significantly higher disease and less yield than hexaconazole 5% EC, propiconazole 25% EC, Sulphur 80% WP (Table 5).

Conclusion

Three sprays of hexaconazole 5 EC (0.005%) @ 10 ml/ 10 lit. or propiconazole 25 EC (0.025%) @ 10 ml/10 lit or sulphur 80 WP (0.2%) @ 25g/10 lit of water for effective management of powdery mildew and to get higher yield. The first spray should be given with anyone fungicides after initiation of disease and subsequent two sprays at 15 days of interval to manage powdery mildew of fenugreek.

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Table 3. Field evaluation of fungicides for the management of fenugreek powdery mildew 2019-2022

Tr. No.	Name of Treatments	Concentrations (a.i %)	Quantity g or ml/l	PDI Before 1 st spray				PDI 15 days after 1st Spray				PDI days after 2nd Spray				PDI Maturity				Yield (Kg/ ha)			
				2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled
1	Carbendazim 50 % WP	0.025	0.5 g	8.61 (16.99)	10.56 (18.94)	9.44 (17.89)	9.54 (17.93)	31.67 (34.23)	35.56 (36.60)	35.28 (36.43)	35.75 (34.14)	32.22 (34.54)	36.67 (37.27)	38.06 (38.09)	35.65 (40.77)	33.06 (35.10)	44.44 (41.81)	42.78 (40.85)	39.25 (40.03)	973.21	1153.14	1130.18	1085.51 ^{de}
2	Sulphur 80 % WP	0.2	2.5 g	8.89 (17.34)	10.83 (19.18)	9.72 (18.15)	9.81 (18.23)	24.72 (29.76)	26.39 (30.89)	25.83 (30.54)	30.40 (25.61)	25.55 (30.35)	28.33 (32.15)	29.72 (33.03)	27.87 (35.42)	26.94 (31.24)	30.83 (33.73)	31.67 (34.24)	33.07 (29.77)	1299.67	1261.16	1329.47	1296.77 ^{ab}
3	Propiconazole 25 % EC	0.025	1.0 ml	8.61 (17.06)	9.44 (17.89)	10.00 (18.42)	9.35 (17.79)	23.61 (28.75)	19.72 (26.36)	21.11 (27.35)	27.49 (21.30)	24.45 (29.47)	23.33 (28.87)	22.50 (28.32)	23.43 (32.10)	25.83 (30.45)	26.39 (30.91)	28.61 (32.33)	31.23 (26.88)	1315.29	1296.12	1381.97	1331.12 ^{ab}
4	Hexaconazole 5% EC	0.005	1.0 ml	8.33 (16.77)	9.72 (18.15)	10.00 (18.42)	9.35 (17.79)	20.56 (26.96)	17.11 (24.43)	14.75 (22.59)	24.66 (17.41)	20.83 (27.15)	20.00 (26.55)	17.78 (24.94)	19.54 (29.16)	22.50 (28.31)	24.44 (29.62)	24.72 (29.81)	29.25 (23.87)	1387.38	1386.62	1400.10	1391.37 ^a
5	Difenconazole 25% EC	0.025	1.0 ml	9.17 (17.62)	10.00 (18.43)	10.56 (18.94)	9.91 (18.33)	27.22 (31.44)	31.11 (33.90)	28.06 (31.98)	32.44 (28.77)	28.33 (32.14)	33.06 (35.10)	32.78 (34.93)	31.39 (37.95)	29.72 (33.03)	38.06 (38.08)	39.44 (38.90)	36.67 (35.67)	1114.49	1225.26	1356.28	1232.01 ^{bc}
6	Pyraclostrobin 13.3 % WG	0.025	2.0 g	9.17 (17.59)	9.44 (17.87)	9.44 (17.87)	9.35 (17.77)	29.44 (32.86)	33.61 (35.41)	32.22 (34.58)	34.28 (31.73)	33.89 (35.58)	37.78 (37.92)	35.28 (36.44)	35.65 (40.86)	37.44 (37.68)	44.17 (41.65)	45.83 (42.61)	40.65 (42.43)	1026.72	1206.93	1287.96	1173.87 ^{cd}
7	Water Spray	-		8.89 (17.32)	11.11 (19.33)	9.72 (18.14)	9.91 (18.27)	34.44 (35.90)	40.00 (39.23)	39.17 (38.74)	37.96 (37.83)	43.89 (41.47)	44.72 (41.97)	46.39 (42.93)	45.00 (46.79)	54.72 (47.72)	58.32 (49.80)	59.72 (50.61)	49.38 (57.61)	1052.14	1060.45	1069.73	1060.77 ^{de}
8	No. Spray	-		9.72 (18.04)	10.28 (18.70)	9.72 (18.16)	9.91 (18.29)	46.94 (43.25)	49.72 (44.84)	51.11 (45.64)	44.58 (49.26)	51.11 (45.64)	52.78 (46.59)	54.44 (47.55)	52.78 (51.77)	64.72 (53.58)	66.17 (54.43)	66.94 (54.91)	54.31 (65.96)	919.16	1019.96	1032.50	990.54 ^e
	SEM± (T)			0.91	0.83	0.49	0.44	1.54	0.75	0.52	0.5948	1.52	0.63	0.25	0.5561	1.55	0.65	0.48	0.5825	78.67	70.01	83.85	42.34
	CD 5% (T)			NS	NS	NS	NS	4.66	2.27	1.56	1.6983	4.62	1.91	0.76	1.5877	4.70	1.96	1.46	1.6632	238.62	212.37	254.34	119.96
	SEM± (Y×T)			-	-	-	0.7624	-	-	-	1.0302	-	-	-	0.9631	-	-	-	1.0090				77.72
	CD 5% (Y×T)			-	-	-	NS	-	-	-	NS	-	-	-	NS	-	-	-	NS				NS
	CV %			9.06	7.70	4.65	7.321	8.09	3.81	2.67	5.34	7.64	3.05	1.21	4.72	7.23	2.79	2.06	4.46	11.99	10.10	11.63	5.73

• Figure outside parentheses are original values while those insides are arcsine transformed values.

Table 4. Field evaluation of fungicides for the management of fenugreek powdery mildew 2019-2022 (Pooled)

Tr. No.	Name of Treatments	Concentrations (a. i %)	Quantity g or ml/ l	PDI Before 1 st spray Pooled	PDI 15 days after 1st Spray Pooled	PDI 15 days after 2nd Spray Pooled	PDI Maturity Pooled	Yield Pooled (Kg/ ha)
1	Carbendazim 50 % WP	0.025	0.5 g	9.54 (17.93)	35.75 (34.14)	35.65 (40.77)	39.25 (40.03)	1085.51 ^{de}
2	Sulphur 80 % WP	0.2	2.5 g	9.81 (18.23)	30.40 (25.61)	27.87 (35.42)	33.07 (29.77)	1296.77 ^{ab}
3	Propiconazole 25 % EC	0.025	1.0 ml	9.35 (17.79)	27.49 (21.30)	23.43 (32.10)	31.23 (26.88)	1331.12 ^{ab}
4	Hexaconzole 5% EC	0.005	1.0 ml	9.35 (17.79)	24.66 (17.41)	19.54 (29.16)	29.25 (23.87)	1391.37 ^a
5	Difenconazole 25% EC	0.025	1.0 ml	9.91 (18.33)	32.44 (28.77)	31.39 (37.95)	36.67 (35.67)	1232.01 ^{bc}
6	Pyraclostrobin 13.3 % WG	0.025	2.0 g	9.35 (17.77)	34.28 (31.73)	35.65 (40.86)	40.65 (42.43)	1173.87 ^{cd}
7	Water Spray	-		9.91 (18.27)	37.96 (37.83)	45.00 (46.79)	49.38 (57.61)	1060.77 ^{de}
8	No. Spray	-		9.91 (18.29)	44.58 (49.26)	52.78 (51.77)	54.31 (65.96)	990.54 ^e
	SEM± (T)			0.44	0.5948	0.5561	0.5825	42.34
	CD 5% (T)			NS	1.6983	1.5877	1.6632	119.96
	SEM± (Y×T)			0.7624	1.0302	0.9631	1.0090	77.72
	CD 5% (Y×T)			NS	NS	NS	NS	NS
	CV %			7.321	5.34	4.72	4.46	5.73

- Figure outside parentheses are original values while those insides are arcsine transformed values.

Table-5. Cost benefit ratio of various treatments used for managements of fenugreek powdery mildew

Sr. NO	Treatment	Yield (Kg/ha)	Yield increase over control (Kg/ha)	Total additional income (Rs/ha)	Quantity of inputs used (kg/lit/ha)	Total cost of treatment (Rs/ha)	Net realization (Rs/ha)	ICBR
			Main product	= main product x 60				
1	Carbendazim 50 % WP	1086	95	5700	750	3494.5	2205.50	1.63
2	Sulphur 80 % WP	1297	306	18360	3750	3502	14858.00	5.24
3	Propiconazole 25 % EC	1331	341	20460	1500	3892	16568.00	5.26
4	Hexaconazole 5% EC	1391	401	24060	1500	3862	20198.00	6.23
5	Difenconazole 25% EC	1232	241	14460	1500	9202	5258.00	1.57
6	Pyraclostrobin 13.3 % WG	1174	183	10980	3000	10702	278.00	1.03
7	Water Spray	1061	70	4200	1500	3202	998.00	1.31
8	No. Spray	991	0	0	0	1072	0.00	0.00

- Total additional income=Yield x 60 Rs/kg seed price of fenugreek
- Labour cost=355/person= (2 labour & 3 time) = (6x 355=2130)
- Total cost of treatment= price of fungicides+ harvesting cost (4 * 268=1072) (T1=292.5, T2=300, T3=690, T4=660, T5=6000, T6=7500)
- Quantity of inputs used= Net realization=total additional income-Total cost of treatment
- ICBR= total additional income/Total cost of treatment

