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Studies on Powdery Mildew of Rapeseed-Mustard (*Brassica juncea* L.) Caused by *Erysiphe cruciferarum* and Its Management

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Out of tested ten treatments of fungicides, bioagents and nutrients seed treatments iprodione + carbendazim (1:1)@ 2g/kg seed, was found to be most effective in reducing disease intensity with increasing yield and 1000 seed weight, followed by removal of three lower leaves. $ZnSO_4$ + sulphur as per recommendation was the most effective fungicide for the management of powdery mildew disease.

Key words: *Erysiphe cruciferarum*, powdery mildew, mustard, fungicides, management.

Rapeseed mustard *Brassica juncea* is *the* second most important oilseed crop after groundnut, contributing nearly 30% of the total oilseed production in India. The crop suffers from many diseases but the important among them are powdery mildew *Erysiphe cruciferarum*, Opiz. ex Junell, downy mildew, white rust, *Alternaria* blight (Mukerji, *et al.*, 1999). Powdery mildew disease caused by *Erysiphe cruciferarum* Opiz. ex. L. Junell, infecting all aboveground parts of the plant has been reported from several parts of the world and is considered an important constraint in husbandry of Indian mustard in India. Though total destruction of the crop due to the disease is rare and usually yield losses at harvest are not staggering, they can reach up to 17 % (Dange et al. 2002) in India. Also reported a yield loss of 17.5% in powdery mildew infected plants at Hissar (Saharan (1992). Powdery mildew first appears on the upper surface in the lowermost (oldest) leaves as small (4-5 cm diameter), scattered, white almost circular colonies which eventually coalesce as the colonies grow further eventually and covering the entire leaf surface under favourable environmental conditions (Singh, 2000a). This disease is most commonly observed on the upper sides of the leaves. Infected buds may fail to open. Powdery mildew is severe in warm climates. This is because the fungus does not need the presence of water on the leaf surface for the infection to occur. However, the relative humidity needs to be high for spore germination. Therefore, the disease is common in crowded plantings where air circulation is poor and in damp, shaded areas. Powdery mildew of mustard affects not only foliage but also developing green siliquae as well as grown plant (Enright and Cipollini, 2007).

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MATERIALS AND METHODS

Survey and collection of disease samples from different Locations

A survey was conducted of mustard crop grown at Oilseed Farm of the University and other joining areas of Kanpur Nagar such as Chaubepur, Sarsaul and Ghatampur Dec-Feb (2011-2012) seasons.

Severity of disease

Fifteen leaves were randomly collected from each one square meter plot of each field during the course of survey. These leaves were arranged into six groups from zero to five on the basis of the percentage leaf affected. Disease intensity was recorded at the maturity stage as per the scale .The per cent disease index was calculated by the following formula.

$$\text{Disease index (\%)} = \frac{\text{sum of all numerical ratings}}{\text{Total number of leaves observed} \times \text{Max. Grade}} \times 100$$

Symptomatology of the disease under natural conditions

The disease symptoms produced on leaves were observed under natural conditions of infection. The shape, size, colour and characteristic feature of the superficially growth of the fungus were recorded from initial to fully developed stage on the different crops of rapeseed-mustard group.

Screening of mustard germplasm for disease resistance

Screening of forty-two germplasm of rapeseed-mustard groups *(Brassica juncea, Brassica carinata, Brassica napus, Eruca sativa and B. rapa)* were carried out during Rabi 2011-2012 under artificial conditions. In order to promote a severe natural epidemic of disease, the planting of 3m double line of highly susceptible variety "Varuna" was incorporated after each five rows. The genotypes were gown in two rows each of 3m length with spacing of 40x10 cm in R.B.D. The recommended agronomic practices were adopted for raising a good crop.

Scale (0-9) for rating reaction to Powdery mildew

0- (Immune) =Nil
1- (Highly Resistant) = less than 5 %
3- (Resistant) = 5-10%
5- (Moderately Resistant) =11-25
7- (Susceptible) =26-50%
9- (Highly Susceptible) = more than 50%

integrated disease management:

Effect of different combination of fungicides, nutrients and bio-agents for the integrated disease management of Powdery mildew.

The trial was conducted with 10 treatments of different combination of fungicides, micro nutrients, and bio-agents as seed treatment, soil application and alone as seed treatment alone and in combination with foliar spray by bio-agents and fungicides. reported that revealed that all the treatments were found significantly effective in reducing the disease intensity and increased the seed yield over the control. Among tested treatments ,foliar spray of carbedazim, a systemic fungicide recorded minimum disease intensity (24.45%)followed by Ridomil MZ-72(24.9%) and Wettable Sulphur (25.56%) over the untreated control treatment(62.63%).However, foliar spray of *Trichoderma harzianum* showed significant reduction disease intensity (36.63). As far as seed yield concerned, singnificantly maximum seed yield 1620.5 kg/ha was recorded with the treatment of carbendazim followed by foliar spray of *T.harzianum* gave1552 kg/ha .Foliar spray of *T.harzianum also gave maximum grain weight (5.2g).*(Rajendra Prasad 2012**).**

The experiment was conducted in a Randomized Block Design (RBD) with three replication at Oilseed Farm, Kalyanpur of the university during Rabi 2011-2012. The Susceptible variety Varuna was sown at spacing of 40X10 cm between row and plant in 3m X 5m plot size. All recommended agronomical practices were adopted Bioagents was collected from G.B.P. University of Agriculture and Technology, Pantnagar. Moistened seeds of variety (Varuna) were treated with the bio-agents @10g/kg seed and treated seeds were shade dried before sowing.

T_1- Seed Treatment (ST),*Trichoderma harzianum*@10g/kg seed + *psudomonas floreseance* T_2- Zink sulphate (soil application)@15kg + Borax @ 10kg + sulphur@15kg/h T_3- Removal of three lower leaves T_4-(ST), Iprodione + carbendazim (1:1) @2g/kg followed by two spray of carbendazim + mancozeb @0.2% T_5- Zink sulphate + Borax +Sulphur(basal application) followed by tow spray of carbendazim + mancozeb @ 0.2% T_6 - Zink sulphate + Borax + sulphar (basal application) followed by Foliar Spray of *P. Fluorescens* T_7- Removal of three leaves followed by Foliar Spray (FS) of Ridomil MZ-72 @0.2%, T_8- (ST), Iprodione +carbendazim (1:1)@ 2g/kg seed followed by removal of three lower leaves, T_9- (ST) Propioconazole (Tilt) @0.1% followed by foliar spray @0.1% T_{10}- Control.

Effect of different combination of micro nutrients and fungicides for management of major disease of Indian mustard

The trial was conducted with ten treatments of different combination of fungicides and micro nutrients as soil application, basal application alone and in combination with foliar spray by fungicides. The experiment was conducted in a Randomized Block Design (RBD) with three replication at Oilseed Farm, Kalyanpur of the university during Rabi 2011-2012. The Susceptible variety Varuna was sown at spacing of 40X10 cm between row and plant in 3m X 5m plot size.

Evaluation of different fungicides and micro nutrients with different combination via, T_{1-} $ZnSO_4$@15 kg/h , T_{2-} Borax @10kg/h, T_{3-} Sulphur as per local recommendation,T_{4-} $ZnSO_4$ @15kg/h+Borax@10kg/h , T_{5-} $ZnSO_4$@ 15kg/h+ Sulphur as per recommendation T_{6-} Borax@10kg/h + Sulphur as per recommendation , T_7 $ZnSO_4$+Borax+Sulphur , T_8- spray of slaked lime @1% w/v at 50 days of after sowing ,T_9- spray of mancozeb @0.2% and 50 days after sowing , T_{10}- control .

RESULTS AND DISCUSSION

Morphological studies of the pathogen

Mycelium

Mycelium of the fungus is amphigenous, white, septate spreading and persistent.

Conidia

Conidia are hyaline, borne singly or in short chain measuring 25-45x12-16µm in size and cylindrical in shape. Conidia germinate only from one end the germ tube.

Perithecia

Scattered, globose at first yellowish orange, becoming brown to dark brown and black with maturity, 90-130µm in diameter.

Table 1. Disease intensity of powdery mildew of rapeseed mustard at the University Farm and farmer's field

S.No.	Location	Disease incidence (%)
1.	Oilseed Research Farm, Kalyanpur, C.S.A.U.A.T., Kanpur	70.0
2.	Farmer's Field Ghatampur, Kanpur	56.8
3.	Farmer's Field Chaubepur, Kanpur	26.4
4.	Farmer's Field Sarsaul, Kanpur	39.4

Table 2. Effect of different combination of fungicides, nutrients and bioagents for the integrated disease management of Powdery mildew

S. No.	Treatment	Powdery mildew Disease intensity (%)	Yield (kg/ha)	1000 seed weight (gm)
1	T-1	56.1(48.4)	1008	4.25
2	T-2	48.3(44.0)	1093	4.1
3	T-3	24.6(29.7)	1275	4.21
4	T-4	39.3(38.8)	1099	4.3
5	T-5	49.3 (46.6)	1039	4.13
6	T-6	21.9(27.8)	1193	4.2
7	T-7	25.8(30.5)	1147	4.08
8	T-8	20.1(26.6)	1284	4.79
9	T-9	59.2(50.2)	1005	4.16
10	T10	68.8(56.0)	998	4.09
	CV	1.839	6.863	
	CD	1.254	130.608	

Angular transformed values are given in parenthesis

Appendages

Myceloid present all over the surface of perithecia, narrow hyaline to faintly colour seldom branched of the ten unequal in length up to three times the size of the perithecia. Asci oval to pyriform 3-12 in number usually 6-8 with and indistinct stipe and 50-70x 30-45µm in size.

Ascospore

Ovoid 2-7 in number and 16-22x11-14µm in size.

The fungus causing powdery mildew of rapeseed mustard was identified as *Erysiphe cruciferarum* (Opiz.Ex.L.Junnell). The survey conducted during 2011-12 at different locations of Kanpur district, revealed that the disease occurred widely, with the average disease severity varying from 26.4.4-70.0 per cent. The highest disease severity 70.0 per cent. Was recorded at Oilseed Research Farm, Kalyanpur, Kanpur, whereas it was lowest 26.4 percent at Farmer's field, Chaubepur and Kanpur. The symptoms of disease appeared in the month of February. First appearance of symptoms was on upper surface of leaves, and later stages on stems and siliquae. In case of severe infection powdery mass appear on leaves, petiols, stem and siliquae.

Morphological features of the fungus pathogen are an obligate parasite. The mycelium of the fungus is amphigenous, white septate spreading and persistent. Conidia are hyaline, borne singly or in short chain 25-45x12-16um in size and cylindrical in shape. perithecia are scattered, globose at first yellowish orange, becoming brown to dark brown and black with maturity, 90-130µm in diameter. Cell of perithecia are irregular brown and 10-25µm in diameter. Appendages are numerous myceloid present all over the surface of perithecia, narrow hyaline to faintly colour seldom branched of the ten unequal in length up to three times the size of the perithecia. Asci oval to pyriform 3-12 in number usually 6-8 with and indistinct stripe and 50-70 x 30-45µm in size. Ascospores are ovoid 2-7 in number and 16-22x11-14µm in size. Conidia germinate only from one end the germ tube in normally branched having up to three branches. Also reported that powdery mildew symptoms can be observed at any stage of the crop but are more severe during flowering stage of green gram. (Arjunan *et al.* 1976)

Perfect stage

Perfect stage of the fungus develops rarely but it occurs quite abundantly on late sown mustard crop (Saharan & Koushik, 1981, Sankhla et al 1967).

integrated disease management

Effect of different combination of fungicides, nutrients and bioagents for the integrated disease management of Powdery mildew.

Evaluation of different fungicides, chemical and bio-agents with different combination viz

T_1- Seed Treatment , *Trichoderma harzianum* @10g/kg seed + *psudomonas*

Table 3. Effect of different combination of micro nutrients and fungicide for management of major disease of Indian mustard

S. No.	Treatment	Powdery mildew Disease intensity (%)	Yield (kg/ha)	1000 seed weight (gm)
1	T-1	29.9(33.1)	1375	4.23
2	T-2	39.1(38.6)	1287	4.19
3	T-3	52.6(46.40)	1314	4.15
4	T-4	48.2(43.9)	1201	4.21
5	T-5	22.3(28.1)	1411	4.25
6	T-6	27.1(31.3)	1399	4.13
7	T-7	28.6(32.3)	1238	4.18
8	T-8	34.7(36.1)	1312	4.27
9	T-9	24.5(29.6)	1455	4.82
10	T10	57.2(49.1)	1148	4.12
	CV	1.176	3.413	
	CD	0.749	76.981	

Angular transformed values are given in parenthesis

floreseance , T_2- Zink sulphate (soil application) @15kg + Borax @ 10kg + sulphur@15kg/h, T_3- Removal of three lower leaves, T_4-(ST), Iprodione + carbendazim (1:1) @2g/kg followed by two spray of carbendazim + mancozeb @0.2%, T_5- Zink sulphate + Borax +Sulphur(basal application) followed by tow spray of carbendazim + mancozeb @ 0.2%, T_6 - Zink sulphate + Borax + sulphar (basal application) followed by Foliar Spray of *P. Fluorescens,* T_7-Removal of three leaves followed by Foliar Spray (FS) of Ridomil MZ-72 @0.2%, T_8- (ST), Iprodione +carbendazim (1:1)@ 2g/kg seed followed by removal of three lower leaves, T_9-(ST) Propioconazole (Tilt) @0.1% followed by foliar spray @0.1%, T_{10}- Control. To find out the efficacy of different combination against Powdery mildew. Data presented in Table 2 revealed that all the treatments were found significantly effective in reducing the disease intensity and increasing the yield over the control during the year (2011-2012).

The data presented in table 2 clearly indicated that amongst the tested seed treatments Iprodione +carbendazim (1:1) @ 2g/kg seed followed by removal of three lower leaves, (T-8) were found most effective to reduce the disease intensity (20.1%) on plant and increase the yield (1284 kg/ha) during 2011-2012 respectively. However, the highest thousand grain weight 4.09g was also recorded with the treatments of Iprodione + carbendazim and of removal of three lower leaves, during the year.

Effect of different combination of micro nutrients and fungicide for management of major disease of Indian mustard

Evaluation of different fungicides and micro nutrients with different combination via, T_1 -$ZnSO_4$@15 kg/h, T_2 - Borax @10kg/h, T_3- Sulphur as per local recommendation, T_4- $ZnSO_4$@15kg/h+Borax@10kg/h, T_5- $ZnSO_4$@ 15kg/h+ Sulphur as per recommendation, T_6 - Borax@10kg/h + Sulphur as per recommendation, T_7- $ZnSO_4$+Borax+Sulphur, T_8 - Spray of slaked lime @1% w/v at 50 days of after sowing,T_9 - Spray of mancozeb @0.2% and50 days after sowing , T_{10} - Control. Were tested to find out the efficacy of different combination against powdery mildew. Data presented in Table-3 revealed that all the treatments were found significantly effective in reducing the disease intensity and increasing the yield over the control during the year (2011-2012).

The data presented in table 3 clearly indicated that amongst the tested treatments $ZnSO_4$@15kg/h+ sulphur as per recommendation **T_5** were found most effective to reduce the disease intensity (22.3%) and gave the highest yield (1411kg/ha) during 2011-2012.However, the highest thousand grain weight 4.25g over the control. Mostly effective treatment i.e. basal application of with mancozeb and spray with was found reducing the disease severity. While the **T_9**- spray of mancozeb @0.2% and 50 days after sowing showed that maximum seed yield 1455 kg/ha during 2011-12.

CONCLUSION

Powdery mildew of rapeseed mustard is a common and prevalent disease of oil seed and other crops. The present study indicates the fungicides; bioagents have promising effect on the management of powdery mildew of rapeseed mustard. There is need for further investigation on the study of efficacy of different bioagents and fungicides which can address the problem of management of the *Erysiphe cruciferarum* pathogen. The proper characterization of large no of isolate of *Erysiphe cruciferarum which* will help in economical and sustainable management of the pathogen. This paper contains limited information about the pathogen and management, so there is need for further investigation on this pathogen.

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