

Prevalence, Incidence and Management of Alternaria Blight of Rape-Seed and Mustard (*Brassica juncea* L) through Resistance and Integrated Approach

Sandeep Gupta¹, V.B. Singh^{2*}, A.K. Singh², S.K. Rai³, S.K. Singh¹ and M.C. Dwivedi⁴

¹Division of Plant Pathology, SKUAST of Jammu-180009, India

²RRSS, Raya, SKUAST of Jammu -181143, India

³Division of Plant Breeding and Genetics, SKUAST of Jammu-180009, India

⁴Research Farm, Chatha, SKUAST of Jammu-180009, India

*Corresponding author

ABSTRACT

Keywords

Resistance sources, Disease incidence, Integrated disease Management and Alternaria blight.

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Alternaria blight of rapeseed-mustard is one of the important diseases of rapeseed-mustard in Jammu Division of J&K. Survey conducted during Rabi 2015-16 revealed that maximum disease intensity in leaves at 75 DAS and 100 DAS was 40.13 and 49.90 per cent and in pods was 20.70 and 29.30 per cent, respectively, observed in District Jammu. However, Samba recorded least disease intensity at 75 DAS and 100DAS with 29.58 and 40.35 per cent in leaves and 13.70 and 22.63 per cent in pods. Of the thirty genotypes screened for their reaction against Alternaria blight, none of the genotype was complete resistant or resistant. Four genotypes KM-108, DRMRIJ-31, RSPR-03 and NRCDR-101 showed moderately resistant. In the integrated disease management trial, variety RSPR-03 coupled with early sowing, seed treatment and foliar spray on appearance of disease showed minimum disease intensity 20.0%. However, maximum yield 14.0q/ha was recorded from variety Varuna coupled with early sowing + seed treatment and foliar spray on appearance of disease

Introduction

Rapeseed-mustard (*Brassica juncea* L) is an economically important oilseed crop of the world. In India, rapeseed-mustard is grown over in diverse agro- largest indigenous oilseed crop which contributing 32 per cent of total oilseed production in India climatic conditions ranging from north-eastern/north-western hills to down south. It is second. Out of 63.09 million tonnes of estimated rapeseed-mustard produced over 37.00 million hectares acreage with the productivity of 1850 kg/ha in the world, in India rapeseed-mustard is

cultivated in an area of 6.7 million hectares with a production of 7.90 million tonnes with productivity of 1188 kg/ha (Anonymous, 2014). In Jammu & Kashmir state, rapeseed mustard is cultivated in 0.059 million hectares leading to production of 0.040 million tonnes with a productivity of 682kg/ha (Anonymous, 2015).

Rapeseed-mustard is also exposed to various types of foliar diseases viz., white rust (*Albugo candida*), powdery mildew (*Erysiphe*

cruciferarum), downy mildew (*Peronospora parasitica*) and Alternaria blight (*Alternaria* spp.). Among these, Alternaria blight caused by *Alternaria brassicae* (Berk) Sacc. And *A. brassicicola* (Schw.) has been reported from all the continents of the world causing severe economic yield loss (Meena *et al.*, 2010). Further, Kolte, (1985) reported that the Alternaria blight causes an average yield loss of 46.0-47.0% in yellow sarson and 35.0-38.0% in mustard in India. Kumar and Kolte, (2001) also observed that Alternaria blight is one of the important diseases of *Brassica* responsible for average yield loss of 10.0 to 70.0 per cent at different parts of the Northern India depending upon the severity. Mondal, (2008) reported yield losses upto 10.0 to 40.0 per cent every year by Alternaria blight caused by *A. brassicae* in old alluvial zone of northern part of West Bengal.

The development of high yield varieties coupled with improved production technologies has led to considerable increase in the productivity of rapeseed-mustard in India during past decade. But despite this increase, the yield of oilseed brassicas in India are much below the global average and it is not able to meet the edible oil requirement for its vast population. Among different constraints in the production of rapeseed-mustard, diseases are the most important limiting factors which restrict the cultivation and decrease the productivity of these crops. In Indian context, fungal diseases are rated as one of the most important factor contributing to yield losses in oilseed crops (Grover and Growthaman, 2003).

Management of Alternaria blight is very much difficult and requires frequent fungicidal sprays. Host resistance is one of the important components of integrated disease management. The regular appearance of this disease with no apparent resistance among the related varieties of Indian mustard

warrants immediate attention for the control of the disease. Skoropad and Tewari (1977) reported that among the oilseed brassicas species, *B. juncea* and *B. rapa* are susceptible to Alternaria blight. Kolte *et.al.* (2000) reported that dwarf *B. juncea* var. Divya showed tolerance against *A. brassicae*. Management of Alternaria blight is being performed mainly by two approaches; first by healthy seeds, a balanced nutrition, proper field sanitation, destruction of diseased debris and crop rotation. Seed treatment with hot water at 50°C for 20-25 minutes also eliminates seed born inoculums (Aneja and Agnihotri, 2013). Second and most extensively used approach is chemical control by application of fungicides.

Keeping in view the economic value of the crop for the region and extensive damage caused by Alternaria blight, the present study, was conducted to find out the suitable management strategy against the Alternaria blight pathogens.

Materials and Methods

Extensive survey of rapeseed-mustard growing areas of Jammu Division was conducted during 2015-16 to monitor the prevalence and status of Alternaria blight of mustard for which three districts *viz.* Jammu, Samba and Kathua were selected on the basis of their area and under the cultivation of the crop. Three villages in each district were identified and three fields of every village were marked for assaying the status of the disease. In each field, five spots (2.0×2.0 m) were identified by stratified random sampling. The disease intensity was recorded using quadrant (1m²) at 4-5 spots in each field. Randomly five plants were selected and tagged for taking observations. Ten leaves and ten pods per plant were taken from different plant parts for scoring disease intensity. The overall scoring was done at 0-5

rating scale on the basis of disease assessment key for *Alternaria* blight in rapeseed-mustard proposed by Conn *et al.*, (1990).

Further PDI shall be calculated by using the following formulae:

$$\text{Per cent disease intensity} = \frac{\text{Sum of all numerical ratings}}{\text{Number of plants examined} \times \text{Maximum disease rating}} \times 100$$

Thirty *B. juncea* genotypes were obtained from AICRP (R/M), Division of Plant Breeding and Genetics SKUAST- Jammu and were raised in triplicate in rows of 3 meter length with a susceptible check of Varuna (two rows) after each five rows of screened genotypes. The trial was flanked with susceptible check (Varuna) for buildup of large number of inoculums. Experiment field where rapeseed-mustard was grown during the previous years was used for the present investigation. The crop spacing maintained was 30x10 cm following standard package of practice (Anonymous, 2007). Randomly five plants from each row were selected and tagged for recording the further observations for initial appearance of the disease symptoms and per cent disease intensity at 75 and 100 days after sowing.

The field experiment was conducted during the year 2015-16 at the Plant Pathological Research Farm, Chatha. Treatments were laid out in the plots of (4x1.5m) in Randomized block design (RBD) with three replications. Two varieties: first, commercially cultivated Varuna (V₁) and second one tolerant to *Alternaria* blight RSPR-03 (V₂) were sown at different dates of sowing *viz.* D₁ (Last week of October), D₂ (Second week of November) and D₃ (Last week of November) with three plant protection treatments *viz.* P₁ (Seed treatment with Mancozeb @ 2.5 g/kg seed), P₂ (Seed treatment with Mancozeb @ 2.5 g/kg seed + foliar spray of Mancozeb @ 0.25% on appearance of disease and P₀ (Unprotected). The seeds were sown in the field with row to row distance of 30 cm and plant to plant

distance of 10 cm with 195 plants per plot. Thinning and weeding of the crop was done whenever it was found to be necessary. All the agronomical practices were followed as per the package of practices of the SKUAST-Jammu. Data on disease intensity was recorded time to time. Yield per plot was also taken for the analysis and to know the effect of each treatment on yield of the crop.

Results and Discussion

To assess the status of *Alternaria* blight of rapeseed-mustard in different districts of Jammu division, an extensive survey was conducted during 2015-16 at different villages of district Kathua, Samba and Jammu. The data presented in the table 1 revealed that disease was encountered in all the locations surveyed at 75 days after sowing (DAS) and 100 DAS. The overall per cent disease intensity (PDI) at leaf stage at 75DAS ranged from 28.90 to 44.13. Maximum disease intensity was observed in Chatha (44.13%) followed by Akhnoor (41.20%) while minimum disease intensity was recorded in the village Gudwal (28.90%). However, PDI on leaf at 100 DAS ranged from 35.20 to 50.80. Maximum disease intensity on leaf at 100 DAS was observed in Chatha (50.80%) followed by Akhnoor (50.26%). The minimum disease intensity was observed in the village Gudwal (35.20%). Similarly, overall PDI on pods at 75 DAS ranged from 12.60 to 22.40. The maximum disease intensity on pods was recorded at the village Chatha (22.40%) at 75 DAS and minimum in village Gudwal (12.60%). However, PDI on pods at 100 DAS ranged from 19.30 to 32.26. The maximum disease intensity on pods was observed in Chatha (32.26%) and minimum in Gudwal (19.30%) at 100 DAS.

The data also revealed that maximum disease intensity on leaf and on pod at 75DAS and 100DAS was observed from Jammu (40.13% and 49.90% on leaves and 20.70 and 29.30 on

Pods) followed by Kathua (32.92% and 44.48% on leaves and 16.40% and 27.07% on pods), respectively. However, Samba district recorded least disease intensity 29.58% and 40.35% on leaves and at pods it was 13.70% and 22.63% at 75DAS and 100DAS, respectively. The per cent disease intensity was higher in Jammu and Kathua districts as compared to Samba district it may be due to variation in environmental conditions, land topography and irrigation facilities, and thus may result in huge loss in yield. In Jammu and Kathua districts, irrigation facilities are better as compared to district Samba. Similar findings have also been advocated by Chattopadhyay *et al.*, (2005) during his study that *Alternaria* blight was favoured by high humidity, rain fall, decrease in maximum and minimum temperature and sunshine hours. Losses due to this disease have been reported from India and world by different workers. Losses ranging from 15.0 to 71.0 per cent in rapeseed-mustard has been recorded by Kadian and Saharan, (1983) and Ram and Chouhan, (1998). Kolte, (1985) reported 10.0 to 75.0 per cent losses in yield of oilseed crops from India. In addition to direct yield losses, the disease adversely affects the seed quality by reducing seed size, seed discoloration and reduction in oil content (Kaushik *et al.*, 1984). Hong *et al.*, (1996) reported that *Alternaria* blight results in yield losses up to 71.4 per cent.

Average yield loss in the range of 32-57 per cent due to *Alternaria* blight has been reported from Nepal (Shrestha *et al.*, 2005). Besides India, disease is reported to be of major economic importance in Australia, France and Poland and of moderate importance in Canada and United Kingdom (Sharma and Kolte, 1994; Verma and Saharan, 1994; Barman and Bhagavati, 1995).

It is evident from the data presented in table 2 that all the genotypes exhibited moderately resistant to highly susceptible disease reaction

against *Alternaria* blight which recorded 23.8 to 78.5 per cent disease intensity on leaves and 15.8 to 76.5 PDI on pods at 100 DAS. Data of 75DAS and 100DAS exhibited maximum PDI on Varuna which was as par with Kranti followed by SKM-1027. The minimum PDI on leaves (23.8) and on pods (15.8) was observed on the genotype RSPR-03. It was followed by KM-108 where PDI was 24.2 and 16.5 on leaves and pods, respectively after 100DAS.

Of the genotypes screened, four genotypes *viz.* KM-108, DRMRIJ-31, RSPR-03 and NRCDR-101 showed moderately resistant disease reaction at 75DAS and 100DAS with PDI (11.0-25.0%). Sixteen genotypes *viz.* RB-78, NML-42, TM-108, PR-2012-4, SKM-1208, KMR-14-4, Rohini, RSPR-69, RRN-772, RRN-778, Divya-55, KMR-13-4, NPJ-179, NPJ-180, TM-106-1 and Novgold were found to be moderately susceptible with PDI (26.0-50.0%) while seven genotypes *i.e.* TM-204, RMM-09-1-1, KMR-13-3, DRMR-675-39, RGN-329, RH-0761 and RH-0923 were found to be susceptible recording a disease intensity (51.0-75.0%) on leaves and pods at 75DAS and 100DAS. However, three genotypes *viz.* Varuna, Kranti and SKM-1027 were found to be highly susceptible to *Alternaria* blight recording a disease intensity of more than 75% at 75DAS and 100DAS.

Thirty genotypes were procured from AICRP (R/M), Division of Plant Breeding and Genetics, SKUAST-Jammu and evaluated for their reaction against *Alternaria* blight to find out the resistant sources. During the experiment it was found that none of the genotype was resistant to the disease. Out of all the genotypes screened four genotypes *viz.* RSPR-03, KM-108, DRMRIJ-31 and NRCDR-101 showed moderate resistance. Sources of resistance to the disease have been identified in wild and related species of *Brassicaceae*. For instance, *Sinapis alba*, commonly known as white mustard (Hansen

and Earle, 1997), *Camelina sativa*, *Eruca sativa* (Tewari and Conn, 1993), *Diplotaxis* species (Sharma *et al.*, 2002) and *B. maurorum* (Chrungu *et al.*, 1999). Dang *et al.*, (2000) has reported that genotypes *viz.* DIR-1507 and DIR-1522 of *B. juncea* had stable resistance against *Alternaria* blight. Fifty four lines/varieties were tested by Srivastva *et al.*, (2001) in an *Alternaria* sick plot and observed that none of the varieties were resistant to *Alternaria* blight. Kumar, (2008) reported partial resistance in three genotypes of *B. juncea viz.* Kranti, PR-8988 and PR-9024. Kolte *et al.*, (2008) also reported *B. juncea* strains EC-399296, EC-399299, EC-399301 and EC-399313 have shown tolerance to *Alternaria* blight. Singh *et al.*, (2009) at N.D. University of Agriculture and Technology, Faizabad screened 81 lines of Indian mustard against *Alternaria* blight under natural epiphytotic conditions and reported that none of the genotype was completely free from visible symptoms of the disease. Only YET-25 was fairly resistant, however, 10 lines were moderately resistant. Mondal, (2008) tested various varieties and reported that Jhumkta,

Sanjuka, Aseech, Seeta and Bhaigirathi found to be better and could be recommended. Rahman *et al.*, (2010) found varying degree of disease severity while evaluating 26 lines of rapeseed-mustard during the extensive research on *Alternaria* blight at RARS, Jamalpur. On the basis of disease index he observed that none of the lines was highly resistant or resistant, while six lines among them appeared to be moderately resistant to *Alternaria* blight. All these above reports show confirmation for our results. It can be concluded that use of germplasm which showed resistance to *Alternaria* blight during the present studies may be utilized in future resistance breeding programme and reduce disease intensity as well as spread under Jammu conditions and thereby minimize the losses incurred by farmers to *Alternaria* blight of rapeseed-mustard.

The minimum disease intensity (20.0%) was recorded in variety RSPR-03 coupled with 26th October of sowing and seed treatment with mancozeb @ 2.5g/kg + foliar spray of mancozeb @ 0.25% on appearance of disease.

Category	Numerical value	Criteria	Disease reaction
I	0	Healthy	Disease free
II	1	1-10% leaf area infected	Resistant
III	2	11-25% leaf area infected	Moderately resistant
IV	3	26-50% leaf area infected	Moderately susceptible
V	4	51-75% leaf area infected	Susceptible
VI	5	>75% leaf area infected	Highly susceptible

Thirty *B. juncea* genotypes which were screened as follows

- | | | | |
|--------------|---------------|-----------------|----------------|
| 1. Varuna | 2. Kranti | 3. RB-78 | 4. NML- 42 |
| 5. TM- 108 | 6. PR-2012-4 | 7. SKM-1208 | 8. KM-108 |
| 9. DRMRIJ-31 | 10. KMR-14-4 | 11. Rohini | 12. RMM-09-1-1 |
| 13. TM-204 | 14. KMR-13-3 | 15. DRMR-675-39 | 16. RGN-329 |
| 17. RSPR-03 | 18. NRCDR-101 | 19. RSPR-69 | 20. RRN-772 |
| 21. RRN-778 | 22. Divya-55 | 23. RH-0761 | 24. SKM-1027 |
| 25. RH-0923 | 26. KMR-13-4 | 27. NPJ-179 | 28. NPJ-180 |
| 29. TM-106-1 | 30. Novgold | | |

The treatment details are as follows	
T ₁ – Varuna + 26 th October of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₁ D ₁ P ₁)	T ₁₀ – RSPR-03 + 26 th October of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₂ D ₁ P ₁)
T ₂ – Varuna + 26 th October of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₁ D ₁ P ₂)	T ₁₁ – RSPR-03 + 26 th October of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₂ D ₁ P ₂)
T ₃ – Varuna + 26 th October of sowing + unprotected (V ₁ D ₁ P ₀)	T ₁₂ – RSPR-03 + 26 th October of sowing + unprotected (V ₂ D ₁ P ₀)
T ₄ – Varuna + 14 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₁ D ₂ P ₁)	T ₁₃ – RSPR-03 + 14 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₂ D ₂ P ₁)
T ₅ – Varuna + 14 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₁ D ₂ P ₂)	T ₁₄ – RSPR-03 + 14 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₂ D ₂ P ₂)
T ₆ – Varuna + 14 th November of sowing + unprotected (V ₁ D ₂ P ₀)	T ₁₅ – RSPR-03 + 14 th November of sowing + unprotected (V ₂ D ₂ P ₀)
T ₇ – Varuna + 27 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₁ D ₃ P ₁)	T ₁₆ – RSPR-03 + 27 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed (V ₂ D ₃ P ₁)
T ₈ – Varuna + 27 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₁ D ₃ P ₂)	T ₁₇ – RSPR-03 + 27 th November of sowing + seed treatment with mancozeb @ 2.5 g/ kg seed + foliar spray of mancozeb on appearance of disease @ 0.25% (V ₂ D ₃ P ₂)
T ₉ – Varuna + 27 th November of sowing + unprotected (V ₁ D ₃ P ₀)	T ₁₈ – RSPR-03 + 27 th November of sowing + unprotected (V ₂ D ₃ P ₀)

Table.1 Per cent disease intensity of *Alternaria* blight of rapeseed -mustard in Different districts of Jammu Division

Location	Per cent disease intensity			
	Leaf		Pod	
	75 DAS*	100 DAS	75 DAS	100 DAS
Kathua				
Chadwal	30.80	42.20	15.30	23.10
Lakhri	34.50	46.60	17.30	30.66
Deoli	33.46	44.66	16.60	27.46
Range	30.80 to 34.50	42.20 to 46.60	15.30 to 17.30	23.10 to 30.66
Mean S.E(m) ±	32.92 ± 1.10	44.48 ± 1.27	16.40 ± 0.58	27.07 to 2.19
Samba				
Sangwal	29.30	38.80	13.30	24.00
Gudwal	28.90	35.20	12.60	19.30
Gho-Rakhwala	30.54	47.06	15.20	24.60
Range	28.90 to 30.54	35.20 to 47.06	12.60 to 15.20	19.30 to 24.60
Mean SE(m)±	29.58 ± 0.49	40.35 ± 3.51	13.70 ± 0.77	22.63 ± 1.67
Jammu				
Rapper	35.06	48.66	18.92	26.60
Akhnoor	41.20	50.26	20.80	29.06
Chatha	44.13	50.80	22.40	32.26
Range	35.06 to 44.13	48.66 to 50.80	18.92 to 22.40	26.60 to 32.26
Mean SE (m) ±	40.13 ± 2.67	49.90 ± 0.64	20.70 ± 1.00	29.30 ± 1.63
Overall range	28.90 to 44.13	35.20 to 50.80	12.60 to 22.40	19.30 to 32.26
Grand mean SE (m) ±	34.21 ± 1.77	44.96 ± 1.78	16.93 ± 1.09	26.33 ± 1.34

DAS* – Days after sowing

Table.2 Disease reaction of different *B. juncea* genotypes against *Alternaria* blight pathogens under natural conditions

Genotype	Initial appearance of the disease(DAS)	Per cent disease intensity					
		Leaves			Pods		
		75 DAS	100 DAS	Disease Reaction	75 DAS	100 DAS	Disease Reaction
Varuna	40	52.8	78.5	HS	45.4	76.5	HS
Kranti	42	50.5	77.7	HS	47.8	75.2	HS
RB – 78	44	35.6	48.4	MS	25.5	36.8	MS
NML – 42	43	37.8	48.6	MS	25.6	38.5	MS
TM – 108	45	38.5	49.6	MS	25.8	37.6	MS
PR-2012-4	50	29.2	45.4	MS	18.5	27.8	MS
SKM-1208	44	38.5	47.6	MS	26.2	36.4	MS
KM-108	54	17.6	24.2	MR	10.8	16.5	MR
DRMRIJ-31	53	17.8	24.6	MR	12.6	18.2	MR
KMR-14- 4	45	34.2	43.8	MS	23.8	29.6	MS
Rohini	48	36.4	45.4	MS	20.5	32.4	MS
RMM-09-1-1	42	44.6	62.2	S	32.6	51.5	S
TM-204	43	40.4	60.8	S	28.8	50.4	S
KMR-13-3	43	39.2	59.5	S	29.5	50.8	S
DRMR-675-39	42	44.2	61.8	S	30.8	51.2	S
RGN-329	42	40.8	61.5	S	29.5	50.4	S
RSPR-03	56	17.8	23.8	MR	9.6	15.8	MR
NRCDR-101	54	18.2	24.4	MR	10.4	18.5	MR
RSPR-69	47	30.8	43.5	MS	20.8	30.6	MS
RRN – 772	48	35.5	48.4	MS	23.6	36.8	MS
RRN – 778	46	34.6	46.8	MS	24.8	34.4	MS
Divya – 55	48	32.8	45.6	MS	22.6	34.8	MS
RH- 0761	45	40.8	61.6	S	26.4	50.5	S
SKM-1027	44	53.2	76.5	HS	47.6	75.8	HS
RH- 0923	46	40.8	61.7	S	28.5	50.8	S
KMR- 13-4	48	32.6	43.8	MS	20.5	30.4	MS
NPJ – 179	49	27.8	38.6	MS	15.6	26.8	MS
NPJ – 180	50	27.4	36.8	MS	16.2	25.2	MS
TM-106-1	46	30.8	41.6	MS	16.5	27.8	MS
Novgold	52	28.5	39.8	MS	16.2	26.6	MS

DAS – Days after sowing

Disease free- Immune, 1-10% -Resistant, 11-25% -Moderately resistant, 26-50% - Moderately susceptible, 51-75% - Susceptible, >75% - Highly susceptible

Source - Conn *et.al.* 1990

Table.3 Integrated management of Alternaria blight of rapeseed-mustard

Treatments		Disease intensity (%)	Yield (q/ha.)
T ₁	V ₁ D ₁ P ₁	44.00	13.00
T ₂	V ₁ D ₁ P ₂	36.00	14.00
T ₃	V ₁ D ₁ P ₀	54.50	12.50
T ₄	V ₁ D ₂ P ₁	52.50	11.30
T ₅	V ₁ D ₂ P ₂	45.00	12.80
T ₆	V ₁ D ₂ P ₀	62.50	10.20
T ₇	V ₁ D ₃ P ₁	58.00	09.75
T ₈	V ₁ D ₃ P ₂	55.50	10.50
T ₉	V ₁ D ₃ P ₀	68.50	08.50
T ₁₀	V ₂ D ₁ P ₁	26.00	12.20
T ₁₁	V ₂ D ₁ P ₂	20.00	12.50
T ₁₂	V ₂ D ₁ P ₀	32.00	10.80
T ₁₃	V ₂ D ₂ P ₁	46.00	09.90
T ₁₄	V ₂ D ₂ P ₂	38.50	10.80
T ₁₅	V ₂ D ₂ P ₀	48.00	09.00
T ₁₆	V ₂ D ₃ P ₁	47.50	08.20
T ₁₇	V ₂ D ₃ P ₂	42.40	09.60
T ₁₈	V ₂ D ₃ P ₀	53.00	07.20

S.E(m)± 0.946 0.47

LSD(P= 0.05) 2.73 1.36

It was followed by RSPR-03 coupled with 26th October of sowing and seed treatment with mancozeb where 26.0% disease intensity was recorded. However, maximum disease intensity (68.5%) was observed in variety Varuna coupled with 27th November of sowing where no plant protection measure was adopted.

Similarly, table 3 also revealed that highest yield (14.0 q/ha) was recorded in the variety Varuna coupled with 26th October of sowing and seed treatment with mancozeb @ 2.5g/kg seed + foliar spray of mancozeb @ 0.25% on the appearance of disease and it was significantly superior among all the treatments. It was followed by variety Varuna coupled with 26th October of sowing and seed treatment with mancozeb @ 2.5g/kg seed where 13.0 q/ha yield was obtained. However, minimum yield 7.20q/ha was recorded in the variety RSPR-03 coupled with 27th November of sowing where no plant protection measures were adopted.

Among the 18 treatment in integrated disease management, it was observed that variety RSPR-03 coupled with 26th October of sowing + seed treatment with mancozeb @ 2.5 g/kg seed + foliar spray of mancozeb @ 0.25% on appearance of disease symptoms showed minimum disease intensity (20.0%). However, maximum disease intensity (68.50%) was observed for the variety Varuna in case of unprotected condition and last date of sowing *i.e.* 27th November.

Maximum yield (14.00 q/ha) was recorded from the variety Varuna coupled with 26th October of sowing + seed treatment with mancozeb @ 2.5 g/kg seed + foliar spray of mancozeb @ 0.25% on appearance of disease symptoms. However, minimum yield (7.20 q/ha) was recorded for the variety RSPR-03 in case of unprotected conditions and last date of sowing *i.e.* 27 November.

Early October sowing (Kolte, 1985) balanced NPK application N₁₀₀ P₄₀ K₄₀ (Sharma and Kolte, 1994) and sanitation are the important top priority practices in the management of Alternaria blight. The increase in infection rate of Alternaria blight is directly proportional to delay in planting of the crop.

Use of early maturing varieties allows disease escape mechanism. Seed treatment alone will not give sufficient persistence for the control of Alternaria blight (Kolte *et al.*, 2000).

Early sowing of well stored clean certified seeds, timely weeding, maintenance of optimum plant protection and avoidance of irrigation at flowering and pod formation stages may help to manage the disease (Meena *et al.*, 2002). Mancozeb was the best among all treatments resulting in lowest disease severity on leaves of mustard (Meena *et al.*, 2004). Integration of all the best components comprising early sowing, resistant genotypes, seed treatment and foliar spray of fungicide on appearance of disease provides maximum yield.

Although, disease intensity in Varuna was more than the resistant cultivar RSPR-03 but it gave more yield to that of resistant genotype RSPR-03 because Varuna is agronomically more superior, higher yielding and bearing large number of pods than RSPR-03 due to which better grain yield was obtained even from the more disease intensity. Bishwas *et al.*, (2007) reported that Alternaria blight of mustard could be minimized by alternation in date of sowing.

The above results also suggests that Alternaria blight in mustard in rapeseed-mustard can be successfully managed by adopting an integrated approach *i.e.* use of early maturing and disease tolerant variety, early October sowing and need based strategy of fungicide use.

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