Original Research Article

Productivity, white rust and *Alternaria* blight of Indian mustard influenced by chemical fungicide seed treatment under humid southeastern Agro-climatic zone of Rajasthan, India

ABSTRACT

The purpose of this study was to evaluate effect of different chemical fungicides application as seed treatment on growth, yield attributes and grain yields and incidence of diseases of Indian mustard and the field experiments was carried out in a randomized block design with three replications, consisting of thirteen treatments *viz*, no soaking control, water soaking, 1% KCl, 1% K_2SO_4, 1% $CaCl_2$, 1% NaCl, carbendazim 50% WP, mancozeb M-45, KCl + mancozeb M-45, K_2SO_4 + mancozeb M-45, $CaCl_2$ + mancozeb M-45, NaCl + mancozeb M-45, carbendazim 50% WP + mancozeb M-45. The result revealed that considerably maximum growth attributes (plant height, dry weight/plant, branches/plant, CGR and RGR), yield attributes (siliquae/plant, seeds/siliquae and test weight) and yields (seed, stover and biological) of Indian mustardwas observed when seeds treated with carbendazim 50% WP + mancozeb M-45 which was significant over rest of the treatments andbut it remained at par with K_2SO_4 + mancozeb M-45, KCl + mancozeb M-45 and mancozeb M-45. Seed treatment with carbendazim 50% WP + mancozeb M-45 presented an increase o[1]f 111.96 and 95.67 percent in seed yield, 35.08 and 34.28 percent in stover yield and 48.72 and 45.8 percent in biological yield of crop as against to no soaking control and water soaked treatment, respectively.Inrespect to percent of disease incidence, maximum white rust diseases and *alternaria* blight disease severity was observed under no soaking control and water soaked treatment. Minimum diseases severity was recorded when seeds treated with carbendazim 50% WP + mancozeb M-45. Therefore, it might be recommended that seed treatment before sowing with carbendazim 50% WP + mancozeb M-45 was more effective in reducing white rust of leaf and *alternaria* blight diseases and enhancing the yields of crop with significant increase.

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***Keywords*:**Carbendazim, Mancozeb,CGR, RGR, *Alternaria* blight and White rust

1. INTRODUCTION

Mustard (*Brassicajuncea* L. Czern and Coss) isone of the most important edible oil seed crop after soybean and groundnut crop[10].Vegetable oil has been an indispensable part of Indian households and kitchens and it contributes maximum shares of 40percentof the production of all agricultural commodities globally.In India, different species of rapeseed-mustard is grown in different agro-climatic conditions.According to FAO [10] report India is the largest importer of edible oils with 15percentin the world followed by China and the USA.Indian vegetable oil economy is the world's fourth largest after the USA, China, and Brazil with total oilseed production of 34.2 million tonnes during 2019-20 and area of 26.0 Million hectares, mainly on marginal lands, dependent on monsoon rains and with low levels of input usage. In India, Rapeseed-mustard crop is cultivated in approximately 6.69million hectare area with 10.11million tonne production and 1511kg/ha productivity [2]. It is largely cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat which contribute 81.5percentin terms of area and 87.5percent in term of production. In Rajasthan, it is grown in Alwar, Shri Ganganager, Bharatpur, Tonk, Sawaimadhopur,Baran, Kota,Hanumangarh districts and mostly used for various purposes such as cooking oil, medicinal and industrial uses and condiments. It is also rich in phyto-nutrients, minerals, vitamins as well as antioxidants constituents and serves as a functional food suggested by Kumar and Andy [17].

Indian mustard is typically grown in rainfed ecologies using conserved monsoonal moisture supported by a few winter rainfalls. Its cultivation has confined50percent of its total area only in Rajasthan state of the India. With efficient crop management practices in these areas, rapeseed-mustard can sustain the livelihood of a large number of marginal and poor farmers.The good management practices for mustard crop productions are required for proficient use of limited soil moisture available during the crop season especially at critical stages of crop growth. Highevaporative demand, low soil organic carbon and poor crop management are restricting the national average productivity of oilseed mustard to 1.09 tonnes per hectare as contrast to the world's average of 1.980tonnes per hectare [8 and33]in India and do up the livelihood of the majority of the farmers in the arid and semi-arid regions of India.

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Pesticides have become a key tool for plant protection and improvement of crops in the process of agricultural productivity[35]. Currently, approximately 4.0 million tonnespesticides are used per year on a global basis, most of which herbicides (56 percent) arefollowed by insecticides (19percent), fungicides (25percent) and other types such as rodenticides and nematicides [10 and 23].Globally more than half of the pesticides are utilized in Asia. India stands twelfth position in pesticide consumption globally and third in Asia after China and Turkey[28].A commonly used pesticide includes insecticides, fungicides and herbicides for management ofuncontrolled weeds,insect pests and diseases in agricultural crops. However, in total pesticide consumption, insecticides occupies highest share in India. India shareonlyone percent of the global pesticide use. According to the data of Directorate of Plant Protection, Quarantine and Storage[7], India has utilizedaround 58720 tonnes of pesticide in 2021-22 and per hectare application rate of pesticide was only 0.31 kg in 2017. Consumptionin other countries like China, Japan and America was around 13.07, 11.76 and 3.57 kg/ha of pesticides, respectively[27].Soit is clear that India uses feweramounts of pesticides in per hectare of cropland area, but uncontrolled and hazardous use of pesticide is responsible forthe presence of high pesticide residues in both natural and physical environment.Pesticides are toxic chemicals used on arable fields to control different diseases, insect pests and weeds so as to decrease yield losses and also sustain high productivity of crops [14].Application of pesticide is strategy for effective management of insect pest and diseases and the productivity of crops depends on their effective management [30]. Pesticides are extensively used in all over the world to control different insect pest population and among them; fungicides are specially used to control fungal plant pathogens [20]. Non-target and excessive use of chemical fungicides have caused environmental pollution and development of fungicide resistance in plant pathogens which led to the search for alternative methods[15].

Mancozebis a contact fungicide mainly used to controlmany diseases on wide range of crops [19 and 21]. Mancozeb(polymeric complex of 20% Manganese and 2-5 %Zinc salt of EBDC group) is a fungicide of the carbamate pesticide family. It is marketed by the various trade nameslike DithaneM45, Indofill,Manzeb, Nemispot, Manzane etc. It is applied on various crops including oil producing crop plants,food grain field crops and other fruit crops against a wide spectrum of fungal diseases [29]. Vuyyuru, *et al.*[36] reported that application of fungicides in the soil improved early root and shoot growth and plant establishment that can potentially reduce

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the yield decline in successively planted sugarcane in histosols.Incurrent times, crop suffers from different diseases out of them, white rust and *Alternaria*blight [*Alternariabrassicae* (Berk.) Sacc. &*A. brassicicola* (Schw.)] is one of the serious and widely occurred diseases in mustard crop all over the country [5 and 22] and reported to causes blight of leaf, pod, stem and seed abnormalities [4]. According to Rathi*et al.*[32] and Monika and Kidwai[26]it was reported that *Alternaria* blight reduce upto 70% yield of mustard in India. Mancozeb has power to inhibit spore formation in pathogenic fungi, thereby causing its death [9] and also associated with several health hazards when applied in very high doses.White rust disease in Indian mustard usually appears at the time of flowering as shiny white to creamy yellow raised pustules on lower surface of leaves. Later on, under severe cases, white pustules may also appear on stem inflorescence and pods. Stagheadformations are quite common due to systemic infection [24]. White rust incited by the biotrophic oomycete pathogen,*Albugocandida*, is the serious fungal disease that causes enormous yield loss of 89.8 percentin India due to infection at leaf phase and hypertrophy of flowers and pods[18]. Yadav *et al.*[38]reported that the losses could be in the range from 17 to 44 percentin India.There is very little information available with regard to the effect of chemical fungicide as seed treatment in oil crops generally and on mustard crop particularly. Therefore, the present study was undertaken with a view to know the effect of fungicide seed treatment on growth and yields and severity of diseases particularly white rust and *alternaria* blight on Indian mustard (*Brassicajuncea* L.) under semiarid conditionsof Rajasthan.

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2. MATERIALS AND METHODS

The field experiment on mustard crop was conducted at the Instructional Farm (Agronomy), Career Point University, Kotaduring *rabi*season situated in southeast part of Rajasthan at an altitude of 579.5metreabove mean sea level and at 24º35' N latitude and 73º42' E longitude. The region falls under humid southeastern agro climatic zone of Rajasthan. The soil was medium blackand having neutral pH, medium in organic carbon (0.67 percent), available nitrogen and available potassium, and low in phosphorus.In this experiment,thirteen treatments were laid out in randomized block design with three replications and comprised of thirteen treatments of chemical seed treatments *viz*, no soaking control, water soaking, 1% KCl, 1% K_2SO_4, 1% $CaCl_2$, 1% NaCl, Carbendazim 50% WP, Mancozeb M-45, KCl + Mancozeb M-45, K_2SO_4 + Mancozeb M-45, $CaCl_2$ + Mancozeb M-45, NaCl + Mancozeb M-45, Carbendazim

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50% WP + MancozebM-45.Healthy seeds of mustard were sown at the depth of 3-4cm, keeping inter-row spacing of 45 cm apart using a recommended seed rate of 4 kg/ha. Before sowing, Seeds were treated with chemicals as per treatments. The crop was fertilized with full recommended dose of phosphorus and half dose of nitrogen as basal just beforesowing the seed through DAP and urea and remaining half dose of nitrogen was applied as top dressing at 40 days after sowing.Intercultural operations, thinning and weeding were carried out as and when required. Observations on growth, yield attributes and yield of mustard were recorded.Crop growth rate(g $m^{-2}day^{-1}$) andrelativegrowth rate (g $g^{-1}day^{-1}$) at different growth stages of mustard crop was calculated byusing the following formula as described by Hunt [16]and Gardner *et al.*[11], respectively.

$$\text{Crop Growth Rate} = \frac{W_2 - W_1}{t_2 - t_1}$$

$$\text{Relative Growth Rate} = \frac{(\text{Log}_e\ W_2 - \log_e\ W_1)}{t_2 - t_1}$$

Where: W_2 and W_1 was the dry weight of plant and t_2 and t_1 was times of sampling,

$\log_e$ value = 0.4342945.

The severity percent of white rust and *Alternaria* blightdiseasewere observed in experimental plots by examining the plant parts like leaves and pods with the help of the standard pictorial scale proposed by Conn *et al.*[6]. The data collected in percentages were processed using angular transformation and they were analyzed statistically by using analysis of variance [13] to calculate the least significant difference (LSD) between treatment means (P = 0.05).

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3. RESULT AND DISCUSSION

3.1 Growth attributes

It is evident from the table 1-3 that plant height, number of branches per plant, dry weight per plant, crop growth rate and relative growth rate at different crop stages was significantly increased by fungicide seed treatments as compared to no soaking control and water soaked treatment.Maximum plant height (55.67cm at 40DAS) was recorded when seeds treated with

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carbendazim 50% WP + mancozebM-45 and significantly superior over rest of the treatments but at par with K_2SO_4 + mancozebM-45, KCl + mancozebM-45 and mancozebM-45.At 60 DAS, maximum plant height of 95.49 cm recorded with carbendazim50% WP + mancozebM-45 was at pat to K_2SO_4 + mancozebM-45, KCl + mancozebM-45, mancozebM-45, carbendazim50% WP, NaCl + mancozebM-45 and $CaCl_2$ + mancozebM-45 and significant higher over rest of the treatments.While at 80 DAS, carbendazim50% WP + mancozebM-45 treatment recorded highest plant height (165.3cm) being at pat with K_2SO_4 + mancozebM-45, KCl + mancozebM-45, NaCl + mancozebM-45, $CaCl_2$ + mancozebM-45, mancozebM-45 and carbendazim50% WP and significant over rest of the treatments. Maximum plant height increase was recorded between 60 to 80 days after sowing.Rokib and Monjil[34] reported that seeds treated with dithaneM-45 produced seedlings with higher shoot length, root length and seedling vigourfollowed by Deconil. At 20 DAS, higher percent increased vigour index over control was found in dithaneM-45 (24.64%) and deconil(22.44%), respectively. Mohammed and Alrajhi, [25] reported that maximum shoot length (11.78%) of chickpea was found when seeds were treated with Secure 600WG (Mancozeb+Fenamidon), while maximum root length (21.80%) was recorded when seeds were treated with Provax 200WP(Carboxin+Thiram) over control. Totalnumber of branches per plant at different crop stages was improved with fungicide seed treatments.At 80 DAS, highest number of branches/plant recorded when seeds were treated with carbendazim50% WP + mancozebM-45 (7.35) and significant as compared to rest of the treatment except KCl + mancozebM-45 and K_2SO_4 + mancozebM-45 treatment. However, seed treatment with carbendazim50% WP + mancozebM-45, KCl + mancozebM-45 and K_2SO_4 + mancozebM-45 treatment was at par to each others. Number of branches per plant continued up to 80 DAS and maximum increase in number of branches/plant was noted at 40 DAS.Total dry biomass accumulation at different crop stages was improved with fungicide seed treatments as compared to control and water soaked treatment (Table 2).Dry matter accumulation continued with the age of crop. Highest biomass accumulation at 40 day after sowing was recorded with carbendazim50% WP + mancozebM-45 treatment seeds which were significant over rest of the treatments. While treatment KCl + mancozebM-45 and K_2SO_4 + mancozebM-45 was at par with carbendazim50% WP + mancozebM-45 combination. At 60 day after sowing, maximum biomass accumulation (11.05g/plant) was recorded with carbendazim50% WP + mancozebM-45 which was significant as compared to rest of the treatments. Treatment KCl + mancozebM-45

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(10.16g/plant) and K_2SO_4 + mancozebM-45 (10.58g/plant) was at par with carbendazim50% WP + mancozebM-45 and also significant over rest of the treatments in respect to total biomass accumulation of mustard crop. At 80 days after sowing, maximum total biomass accumulation (21.27g/plant)recordedwhen seed was treated with carbendazim50% WP + mancozebM-45 treatment and significant over rest of the treatments but at par with carbendazim50% WP, mancozebM-45, KCl + mancozebM-45, K_2SO_4 + mancozebM-45, $CaCl_2$ + mancozebM-45, NaCl + mancozebM-45 and KCl treatment. Maximum dry matter increase was recorded between 60 to 80 days after sowing. The improvement in the growth attributes viz., plant height, no. of branches plantper plant and dry weight per plant at different growth stages might be due to the favourable effect of chemical fungicide treatments in initial stage always help the crop for better growth environment by providing nutrition, better utilization of genetic potentiality of the crop variety and other inputs and no incidence of fungal infection or growth that improved photosynthesis activity and cell elongation which ultimately increase the biomass production and other parameters.Vuyyuru, *et al.*[36] reported that that mancozebas soil application improved sugarcane shoot and root dry matter by 3-4 times and shoot-root length, fine-root length, and root surface area by 2-3 times compared to untreated soil.

Crop growth rate of mustard crop at different stage was influenced by fungicide seed treatments as compared to no soaking control and water soaked treatments (Table 2). Crop growth rate was continued to 80 days after sowing and represent maximum increment between 60-80 DAS. During 20-40 DAS, maximum crop growth rate of 4.585 g $m^{-2}day^{-1}$ was recorded when seeds treated with carbendazim 50% WP + mancozeb M-45 treatmentand significant over rest of the treatments but it remained at par with K_2SO_4 + mancozebM-45 treatment. While, seed treatment with carbendazim 50% WP + mancozeb M-45 noted maximum crop growth rate of 13.754 g $m^{-2}day^{-1}$ between 40-60 DAS which was significant over rest of the all treatments. Between 60-80 DAS, considerable higher crop growth rate of 22.131 g $m^{2}day^{-1}$ was observed with the seed treatment of carbendazim 50% WP + mancozeb M-45 remained at par with K_2SO_4 + mancozebM-45 and KCl + mancozebM-45 and significant as compared to rest of all treatments. Further result revealed that relative crop growth rate of mustard was also improved by fungicide seed treatments between 20-40 DAS (Table 3). Between 40-60 DAS, significantly higher relative growth rate (0.094g $g^{-1}day^{-1}$) was noted with carbendazim 50% WP + mancozebM-45 which was significant over rest of all the treatments. However, between 60-80

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DAS, maximum relative growth rateby mustard crop was recorded with carbendazim 50% WP + mancozeb M-45 and significant over rest of the treatments but it remained at par with K_2SO_4 + mancozebM-45, KCl + mancozebM-45 and mancozebM-45.The enhancement in crop growth rate and relative growth rate of crop might be owing to higher biomass production and fast photosynthetic activity of crop.

3.2 Yield attributes and yields

The data presented in table 3 showed that number of siliquae per plant, number of seeds per silquae and test weight of mustard crop was considerable improved by different chemical fungicide seed treatments. Seed treatment with carbendazim50% WP + mancozebM-45 recorded significantly highest number of siliquae per plant as compared to rest of the treatments but it remained at pat with K_2SO_4 + mancozebM-45. However, all other chemical fungicide treatments also enhanced the number of siliquae per plant of mustard as against to no soaking control and water soaked treatments. In terms of number of seeds per siliquae and test weight of mustard, carbendazim 50% WP + mancozeb M-45 treatment found significantly superior over rest of the treatments. The percent of increment in number of seed per siliquae was 78.01 and 69.27 and in test weight was 70.32 and 63.18 percent higher over no soaking control and water soakedtreatment, respectively. However, all other chemical fungicide seed treatments were statistically at par to each other and significantly superior tocontrol and water socked treatments.The increase in these parameters (number of siliquae per plant, number of seed per siliquae, test weight) could be also ascribed to overall improvement in plant growth attributes and vigour with chemical fungicide treatments that favoured the health soil environment with no fungal infection of diseases, better utilization of factors like genetic potentiality of the crop variety, irrigation, fertility, active solar radiation and formation of grain and its development which resulted into increase in number of siliquae, number of seed and test weight of mustard seed. Our findings are close proximity ofYadav*et al.*[39] andGetachew and Abeble[12].

Scrutiny of data revealed that chemical fungicide seed treatment significantly enhanced the seed yield, stover yield and biological yield of mustard crop (Table 4). Maximum seed yield of 2215 kg/ha recoded when seeds treated with carbendazim50% WP + mancozebM-45 which was significant over rest of the treatments and accounted 111.96 and 95.67 percent as compared to no soaking control and water soaked treatment. While, carbendazim 50% WP + Mancozeb M-

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45 treatment remained at par with K_2SO_4 + mancozebM-45, KCl + mancozebM-45, mancozebM-45, carbendazim50% WP and $CaCl_2$ + mancozebM-45. All fungicide treatments also increase seed yield in comparison to no soaking control and water soaked treatments. Highest stover yield of 6561 kg/ha noted with carbendazim50% WP + mancozebM-45 that was found significant over rest of the treatments except K_2SO_4 + mancozebM-45, KCl + mancozebM-45 and mancozebM-45. carbendazim50% WP + mancozebM-45 treatment increased the stover yield by 35.08 and 34.28 percent overno soaking control and water soaked treatment, respectively. However, all other chemical fungicides also increased the seed yield as compared to no soaking control andwater socked treatments. In respect to biological yield, maximum value of 8776 kg/ha observed when seeds were treated with carbendazim 50% WP + mancozebM-45and significant over rest of the treatments but remained statistically at par with K_2SO_4 + mancozebM-45, KCl + mancozebM-45, mancozebM-45, carbendazim50% WP and $CaCl_2$ + mancozebM-45. Treatmentcarbendazim50% WP + mancozebM-45 caused a significant increase in biological yield of crop by 48.72 and 45.8 percent over no soaking control and water soaked treatments, respectively.Chemical fungicide seed treatments were failed to bring significant improvement in harvest index of crop but higher than no soaking control and water soaked treatments.Marked variation in seed and stover yield of mustard obtained under different chemical fungicide treatments might be due to effective disease control at initial stages and favourable soil condition for nutrition which, in turn, increase the growth parameters (plant height, branches per plant, dry weight per plant, CGR and RGR) and yield attributes (number of siliquae per plant, number of seed/silquae and test weigh). Biological yield is cumulative effect of seed and stover yields of mustard. Use of chemical fungicide treatments not only reduce the incidence of diseases but also help the crop for better utilization of nutrients from soil and optimum utilization of agronomic (genetic potentiality of the crop variety, irrigation, fertility) and environmental factors (solar ration)which exert their utmost strength in achieving the more economic yield. Our findings are supported byAkinbo*et al.*[1],Mathivanan and Prabavathy [21],Meena*et al.* [22],Yadav *et al.*[37], Ramesh and Zacharia[31], Yadav *et al.* [39] andGetachew and Abeble[12].

3.3 Diseases Severity

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Further findings in table 4 showed that reduced percent incidence of white rust and *alternaria* blight disease in Indian mustard was observed when seeds treated with all chemical fungicide seed treatments. Maximum white rust severity and *alternaria* blight diseases severity in mustard crop was recorded with no soaking control and water soaked treatments. Minimum percent white rust severity and *alternaria* blight severity was observed when seed treated with carbendazim 50% WP + mancozeb M-45and had significant effect on reducing white rust severity and *alternaria* blight severity as compared to rest of the treatments. However, all other treatments except no soaking control and water soaking treatment also reduce the percent incidence of both diseases (white rust and *alternaria* blight) on mustard. Similar results were reported by Getachew and Abeble [12] andBairwa*et al*.[3].

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4. CONCLUSION

On the basis of findings from this study it might be concluded thatchemical fungicide seed treatment with carbendazim 50% WP + mancozeb M-45 was found more effective in reducing the percent severity of white rust and *alternaria* blight diseases on mustard crop as well as improving yields of crop with significant increasethat helps in stability of crop productivity.

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Table 1.Effect of chemical fungicides seed treatment on plant height and number of branches/per plant of Indian mustard

Treatment	**Plant height (cm)**				**Total number of branches/plant**		
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**40 DAS**	**60 DAS**	**80 DAS**
No soaking control	1.01	32.22	68.14	135.15	1.2	2.87	3.93
Water soaking	1.16	33.26	71.84	142.65	1.16	3.37	4.13
1% KCl	1.37	41.28	83.38	150.21	1.53	4.23	6.33
1% K_2SO_4	1.35	39.68	81.81	148.34	1.46	4.11	6.13
1% $CaCl_2$	1.29	36.94	73.71	144.75	1.33	3.77	5.81
1% NaCl	1.17	35.61	75.28	143.89	1.27	3.67	5.66
Carbendazim 50% WP	1.57	45.41	85.41	154.12	1.86	4.63	6.77
Mancozeb M-45	1.62	45.72	88.42	157.1	2.16	4.87	6.89
% KCl + Mancozeb M-45	1.67	51.07	91.64	158.71	2.59	5.33	7.01
1% K_2SO_4 + Mancozeb M-45	1.76	53.55	92.91	160.43	2.73	5.63	7.213
1% $CaCl_2$ + Mancozeb M-45	1.51	44.72	85.26	152.91	1.66	4.43	6.67
1% NaCl + Mancozeb M-45	1.41	43.41	85.48	150.45	1.6	4.37	6.49
Carbendazim 50% WP + Mancozeb M-45	1.82	55.67	95.49	165.33	2.81	5.73	7.35
SEm (±)	0.19	2.84	3.64	5.32	0.14	4.83	0.43
LSD *(P=0.05)*	NS	8.28	10.64	15.54	0.40	14.11	1.26

Table 2.Effect of chemical fungicide seed treatment on plant dry weight and crop growth rate of Indian mustard

Treatment	**Dry weight/plant (g)**			**Crop Growth Rate (g m^{-2} day^{-1})**		
	40 DAS	**60 DAS**	**80 DAS**	**20-40 DAS**	**40-60 DAS**	**60-80 DAS**
No soaking control	0.85	5.44	13.5	1.385	7.51	13.426
Water soaking	1.34	6.14	14.49	2.145	7.616	13.693
1% KCl	2.02	7.61	18.69	3.238	8.005	18.148
1% K_2SO_4	1.71	7.11	18.16	2.916	7.644	17.593
1% $CaCl_2$	1.68	6.89	17.11	2.748	7.649	16.882
1% NaCl	1.64	6.48	16.27	2.711	7.616	16.759
Carbendazim 50% WP	2.11	9.27	19.22	3.443	8.955	19.615
Mancozeb M-45	2.24	9.87	19.89	3.694	9.921	19.909
% KCl + Mancozeb M-45	2.39	10.16	20.86	3.835	11.538	20.298
1% K_2SO_4 + Mancozeb M-45	2.62	10.58	21.06	4.283	12.021	21.026
1% $CaCl_2$ + Mancozeb M-45	2.06	8.45	18.94	3.274	8.682	19.037
1% NaCl + Mancozeb M-45	2.03	8.1	18.87	3.27	8.477	18.615
Carbendazim 50% WP + Mancozeb M-45	2.81	11.05	21.27	4.585	13.754	22.131
SEm (±)	0.16	0.37	0.96	0.21	0.44	0.85
LSD *(P=0.05)*	0.45	1.09	2.81	0.62	1.29	2.48

Table 3.Effect of chemical fungicides seed treatment on relative growth rate, number of siliqua/plant, number of seed/siliqua and test weight of Indian mustard

Treatment	**Relative Growth Rate (g g^{-1} day^{-1})**			**Number of**	**Number of**	**Test**
	20-40 DAS	**40-60 DAS**	**60-80 DAS**	**Siliquae/plant**	**seeds/siliquae**	**weight (g)**
No soaking control	0.152	0.057	0.033	133.28	8.14	2.84
Water soaking	0.158	0.059	0.038	169.47	8.56	2.96
1% KCl	0.216	0.066	0.045	250.07	11.01	4.01
1% K_2SO_4	0.196	0.063	0.042	247.47	10.58	3.88
1% $CaCl_2$	0.166	0.063	0.042	226.33	10.49	3.70
1% NaCl	0.162	0.059	0.041	193.4	9.70	3.37
Carbendazim 50% WP	0.243	0.069	0.048	264.93	13.20	4.29
Mancozeb M-45	0.247	0.070	0.051	272.6	13.53	4.44
% KCl + Mancozeb M-45	0.248	0.073	0.052	295	13.77	4.48
1% K_2SO_4 + Mancozeb M-45	0.251	0.077	0.053	303.27	14.01	4.69
1% $CaCl_2$ + Mancozeb M-45	0.239	0.066	0.046	261.72	12.66	4.17
1% NaCl + Mancozeb M-45	0.237	0.066	0.045	250.87	12.36	4.09
Carbendazim 50% WP + Mancozeb M-45	0.266	0.094	0.055	329.13	14.49	4.83
SEm (±)	0.032	0.004	0.002	9.94	0.87	0.26
LSD *(P=0.05)*	NS	0.011	0.006	29.01	2.55	0.75

Table 4.Effect of chemical fungicides seed treatment on yields and white rust and *Alternaria* blight diseases of Indian mustard

Treatment	**Yields (kg/ha)**			**HI**	***White rust**	***Alternaria*blight**
	Seed	**Stover**	**Biological**	**(%)**	**(% severity)**	**(% severity)**
No soaking control	1045	4857	5901	0.18	51.42 (61.14)	43.69 (47.74)
Water soaking	1132	4886	6019	0.19	51.07 (60.56)	43.07 (46.66)
1% KCl	1588	5280	6868	0.23	45.69 (51.24)	38.06 (38.04)
1% K_2SO_4	1420	5121	6541	0.22	41.96 (44.93)	38.41 (38.63)
1% $CaCl_2$	1395	5099	6493	0.21	48.11 (55.44)	39.02 (39.64)
1% NaCl	1282	5043	6325	0.20	49.45 (57.76)	40.29 (41.96)
Carbendazim 50% WP	1973	6084	8057	0.25	39.09 (39.77)	31.97 (28.08)
Mancozeb M-45	2041	6262	8303	0.25	36.62 (35.62)	31.17 (26.82)
% KCl + Mancozeb M-45	2107	6383	8490	0.25	35.65 (34.01)	30.38 (25.61)
1% K_2SO_4 + Mancozeb M-45	2176	6480	8656	0.26	35.07 (33.06)	28.72 (23.16)
1% $CaCl_2$ + Mancozeb M-45	1870	5840	7710	0.24	40.84 (42.80)	33.12 (29.90)
1% NaCl + Mancozeb M-45	1691	5543	7234	0.23	41.25 (43.54)	34.65 (32.39)
Carbendazim 50% WP + Mancozeb M-45	2215	6561	8776	0.25	31.13 (26.76)	27.09 (20.76)
SEm (±)	120	372	414	0.02	1.88	1.55
LSD *(P=0.05)*	351	1087	1207	NS	5.53	4.51

*LSD (P = 0.05) for angular transformed values.a Figures in parenthesis are actual values and others are angular transformed ones.
HI-harvest index