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Effect of Ambient Temperature on Growth and Yield of Mustard (*Brassica juncea* L.) Cultivars

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ABSTRACT

A field experiment was conducted during *rabi* season of 2020-21 in the sandy loam soil of AND University of Agriculture and Technology, Kumarganj, Ayodhya (UP). The experiment was conducted in Split Plot Design (SPD), comprising of three growing environments/ambient temperature viz., 31st October (22.6 °C), 10th November (21.2 °C), 20th November (19.4 °C) and three cultivars i.e., NDR-8501 (V_1), Kranti (V_2) and Varuna (V_3). The experiment was replicated four times. Results revealed that significantly higher leaf area index, dry matter accumulation (DMA) was obtained at crop growing environment/ambient temperature 31st October which were significantly superior over rest both of the crop growing environments/ambient temperature. Higher number of siliqua/plant (287.00), Maximum length of siliqua (8.17) and Maximum number of seeds/siliqua (17.00) were recorded at growing environment/ambient temperature 31st October which was significantly superior over 10th November and 20th November growing environments/ambient temperature. Highest leaf area index (4.46), Maximum number of siliqua/plants, Maximum length of siliqua, Highest dry matter accumulation was found in Varuna cultivar Maximum test weight (4.85 g) was recorded with Varuna cultivar followed by NDR-8501 (4.55) and Kranti (3.85).

Keywords Ambient temperature, Sandy loam soil, Leaf area index, Dry matter accumulation.

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INTRODUCTION

Mustard is the major *rabi* season, high paying oilseed crop in the dry regions of India and stand next to groundnut in the oilseed economy. It is an important oilseed crop of the family Cruciferae/Brassicacea and occupies a prominent place among the leading oilseed crop being next to groundnut both in area and production which accounts nearly 30% of the total oilseeds produced in India, meeting fat requirement of about 50% population in state of Uttar Pradesh, Punjab, Rajasthan and Assam. Genus *Brassica* comprises six species namely *B. nigra, B. oleracea, B. rapa, B. carinata, B. juncea* and *B. napus*. Among them, first three species are elementary and diploid with 2n =16, 18 and 20 chromosomes, respectively and next three are tetraploids with chromosomes numbers 2n=34, 36 and 38, respectively.

These entire crops are grown in diverse agro-climatic regions from North-Eastern hills to North Western hills and down south under irrigated/rain-fed, timely or late sown, saline soils and mixed cropping. Indian mustard (*Brassica juncea* L.) is a winter oilseed crop grown across the North Indian plains.

Table 1. Leaf area index of mustard as affected by ambient temperature/growing environments (T) and cultivars (V).

Treatments	Leaf area index		
	30 DAS	60 DAS	90 DAS
Ambient temperature/growing environments (T)			
31st Oct (T_1) (22.6 °C)	1.49	4.50	4.45
10th Nov (T_2) (21.2 °C)	1.44	4.28	4.22
20th Nov (T_3) (19.4 °C)	1.38	2.77	4.02
SEm±	0.03	0.07	0.06
CD at 5%	NS	0.26	0.22
Cultivars (V)			
NDR-8501	1.43	4.12	4.23
Kranti	1.40	4.60	3.99
Varuna	1.47	2.83	4.46
SEm±	0.03	0.37	0.08
CD at 5%	NS	1.08	0.22

Among the various oilseed crops, it is one of the important because of its potential utilities (Dubie *et al.* 2013) in the bio-fuels industries. Indian mustard can tolerate annual precipitation of 450 to 1150 mm, annual temperature of 5 to 27°C and pH of 6.5 to 8.5. Rapeseed and mustard follow C_3 pathway for carbon assimilation. Thus, it has economical photosynthetic response at 15–20°C temperature. The mustard plants respond to high temperature stress through developmental, physiological and biochemical changes and the type of the observed response depends on several factors (Moradshahi *et al.* 2004) such as Stress Intensity (SI), stress period and genotype. Mustard is substantially sensitive to weather parameters as evidence from the variable response to variable dates of sowing (Kar and Chakravarty 2000). Experimental findings have also shown that sowing date is one of the most critical components affecting mustard crop productivity.

The seed yield of mustard is mainly affected by the ambient temperature especially at the time of flowering and seed setting. It is important to choose an appropriate time of sowing. From mid-October, one month delay in sowing resulted in loss of 40.6 % seed yield (Lallu *et al.* 2010). Early varieties produce a smaller number of siliqua^{-1} plant, which was sown late while early sown late varieties give leafier growth and produces siliqua very late. The optimum date of sowing for mustard varies according to cultivars and climatic conditions. A rise of 3°C in maximum daily temperature (21-24°C) during flowering and grain filling stages causes a recession of about 430 kg/ha in mustard yield. It also improves the fertility of the soil and allows farmers to increase their grazing season. Thus, it is necessary to evaluate the effect of different sowing dates on the plant growth, seed yield and quality. The yield potential of different mustard varieties may differ under different agro-climatic conditions because of their inherent capacity.

Mustard is a multiple use crop, besides its oil value, seeds are also used as condiments in preparation of pickles, flavoring curries and vegetables. Fats and oils play an important role in the human dietary system as well as the economy of the country. The mustard oil is utilized for human consumption throughout the Indian sub-continent in cooking and frying. The leaves of young plants are used as a green vegetable as they supply enough sulfur minerals in the human diet. The oil cakes are used for cattle feeds and manures.

MATERIALS AND METHODS

A field experiment was conducted in sandy loam soil of agro-meteorological research farm, Acharya Narendra Deva University of agriculture and technology, Kumarganj, Ayodhya. The experiment was conducted in SPD (Split Plot Design) design with nine treatment combinations consisted of three ambient temperatures viz., T_1 (22.6°C) (31st October 2020), T_2 (21.2°C) (10th November 2020) and T_3 (19.4°C) (20th November 2020) and three cultivars viz., V_1 (NDR-8501), V_2 (Kranti) and V_3 (Varuna). The experimental site was located at 26°47′ N latitude and 82°12′ E longitude and at an altitude of about 113 meter above the mean sea level.

The leaf area of five plants was measured by leaf area meter at 30, 60 and 90 days after sowing of the crop. Leaf area index was calculated by the formula :

$$LAI = \frac{Leaf\ area}{Ground\ area}$$

Half meter of the crop was cut down from the

Table 2. Dry matter accumulation (g/m²) of mustard as influenced due to different ambient temperature/growing environments (T) and cultivars (V).

Treatments	Dry matter accumulation			
	30 DAS	60 DAS	90 DAS	At harvest
Ambient temperature/growing environments (T)				
31st Oct (T_1) (22.6 °C)	59.73	206.27	825.00	916.67
10th Nov (T_2) (21.2 °C)	56.63	194.20	776.70	863.00
20th Nov (T_3) (19.4 °C)	52.20	167.87	671.01	745.57
SEm±	1.112	2.538	10.955	18.413
CD at 5%	3.85	8.78	37.91	63.72
Cultivars (V)				
NDR-8501	56.57	199.30	797.07	885.63
Kranti	53.97	159.80	639.12	710.13
Varuna	58.03	209.23	836.52	929.47
SEm±	1.01	3.66	14.88	14.38
CD at 5%	2.99	10.87	44.22	42.72

second row of both sides. These plant samples were collected in paper bags after cutting in small pieces it was sun dried. After complete sun drying it was put in electric oven at 60°C for drying to obtain a constant dry weight. The dry weight of samples was expressed in g/m^2.

Total numbers of branches were counted of selected randomly five plants in each plot, collected from the experimental field. At harvest total number of siliquae of sample plants of each plot were counted and their mean value was calculated. Number of siliquae was counted separately on primary, secondary and tertiary branches. Total number of siliqua plant^{-1} was taken out by summing up the number of siliquae on different type of branches. From the individual plots, the net plot area was harvested and produce was sun dried. After sun drying, the crop was threshed and cleaned separately on the net plot basis. The final weight was recorded in kg plot^{-1} and finally converted into q ha^{-1}.

The maximum and minimum temperatures were recorded during the last 24 hr in °C with maximum and minimum thermometers placed in the single Stevenson screen of Agrometeorological Observatory of the University at 1400 IST and 0700 IST. Generally, minimum temperature occurs just before the sunrise, early in the morning.

RESULTS AND DISCUSSION

Data presented in Table 1 revealed that leaf area index of mustard as affected by growing environments/ambient temperature and cultivars recorded at successive growth stages. LAI increased successive till 60 DAS and there after declined. It is quite obvious from the data that the LAI was significantly affected due to different growing environment/ambient temperature at all the stages. Significantly higher leaf area index was obtained at growing environment/ambient temperature 31st October as compared to growing environment/ambient temperature on 10th November, while growing environment/ambient temperature 20th November proved lowest LAI at all the stages of crop. These findings are in agreement with Panda *et al.* (2004) and Singh *et al.* (2019).

Leaf area index was non-significant at 30 DAS and significantly affected at 60 and 90 DAS due to the cultivars. At 90 DAS, highest LAI (4.46) was recorded with Varuna. From the data it was observed that the kranti cultivar recorded lowest (3.99) LAI at all the growth stages. These findings were also observed by Singh *et al.* (2008).

It is quite obvious from the data presented in Table 2 that dry matter accumulation varied significantly due to growing environment/ambient temperature at all the stages of mustard. It was recorded higher under the treatment when mustard was sown on 31st October while significantly superior over rest both of the growing environment/ambient temperature. Late sown mustard recorded lowest dry matter at all the stages. Similar results were also obtained by Singh and Singh (2002) and Lallu *et al.* (2010).

Dry matter accumulation was significantly influenced by cultivars at all the stages of mustard crop. Higher dry matter accumulation was observed in Varuna followed by NDR-8501 while cultivar kranti recorded lowest dry matter accumulation at all the stages of mustard. These results are also in

Table 3. Yield attributes of mustard as affected by ambient temperature/growing environments (T) and cultivars (V).

Treatments	No. of siliqua/ plant	Length of siliqua (cm)	No. of seeds/ siliqua	Test weight (g)
Ambient temperature/growing environments (T)				
31st Oct (T_1) (22.6 °C)	287.00	8.17	17.00	4.53
10th Nov. (T_2) (21.2 °C)	271.00	7.87	15.10	4.41
20th Nov. (T_3) (19.4 °C)	254.27	7.13	13.97	4.31
SEm±	5.66	0.11	0.21	0.01
CD at 5%	19.59	0.38	0.73	NS
Cultivars (V)				
NDR- 8501	273.70	7.83	15.60	4.55
Kranti	243.30	7.03	14.33	3.85
Varuna	295.27	8.30	16.13	4.85
SEm±	5.39	0.14	0.32	0.07
CD at 5%	16.02	0.42	0.94	0.21

conformity with the findings of Singh *et al.* (2019) and Kumar *et al.* (2010).

Data pertaining to number of siliqua/plant, length of siliqua, seeds/siliqua and test weight (g) as affected by growing environments/ambient temperature and cultivars have been presented in Table 3. A perusal of data showed that different growing environments/ ambient temperature influenced significantly to the amount of siliqua/plant. Higher number of siliqua/ plant (287.00) was recorded at growing environment/ambient temperature 31st October which was significantly superior over 10th November and 20th November growing environments/ambient temperature. The lowest number of siliqua/plants was recorded when sowing was done at 20th November. Different growing environments/ambient temperature influenced significantly to the length of siliqua/plant. Maximum length of siliqua (8.17) and Maximum number of seeds/siliqua (17.00) was recorded at growing environment/ambient temperature 31st October which was significantly superior over 10th November and 20th November growing environments/ambient temperature. The minimum length of siliqua (7.3) and number of seeds siliqua^{-1}(13.97) was recorded at growing environment/ambient temperature of 20th November. A perusal of data showed that test weight was non-significant due to different growing environments/ambient temperature.

Number of siliqua/plants was influenced significantly due to different cultivars. Maximum numbers of siliqua/plant (295.27) were obtained with Varuna followed by NDR-8501 (273.70) and Kranti (243.30) cultivars. These findings are in agreement with Singh *et al.* (2008) and Singh *et al.* (2019).

Length of siliqua was significantly influenced by different cultivars. Maximum length of siliqua (8.30) was observed with Varuna followed by NDR-8501 (7.83) and Kranti (7.03) cultivars. These findings are in conformity with the finding of Singh *et al.* (2008).

Number of seeds siliqua^{-1} was influenced significantly due to the different cultivars. Maximum numbers of seeds/siliqua (16.13) were obtained with Varuna cultivar followed by NDR-8501 (15.60) and Kranti (14.33) cultivars. Similar results were also observed by Singh *et al*. (2008) and Singh *et al.* (2019).

Test weight was significantly influenced due to different cultivars. Maximum test weight (4.85) was observed with Varuna followed by NDR-8501 (4.55) and Kranti (3.85) cultivars. Similar results were also observed by Singh *et al.* (2008).

CONCLUSION

Significantly higher leaf area index was obtained at crop growing environment/ambient temperature 31st October at 60 DAS (4.5) as compared to 10th November (4.28), while crop growing environment/ ambient temperature 20th November (2.77) proved lowest LAI at all the crop growth stages. Dry matter accumulation was recorded higher under growing environment/ambient temperature 31st October (916.67) which were significantly superior over rest both of the crop growing environments/ambient temperature. Higher number of siliqua/plant (287.00), Maximum length of siliqua (8.17) and Maximum number of seeds/siliqua (17.00) were recorded at growing environment/ambient temperature 31st October which was significantly superior over 10th November and

20th November growing environments/ambient temperature. Highest leaf area index (4.46) was found in Varuna cultivar and the data also revealed that Kranti cultivar recorded lowest (3.99) leaf area index at all the growth stages of mustard crop. Highest dry matter accumulation was recorded Varuna cultivar (929.47 g/m^2) which was at par with NDR-8501 cultivar (885.63 g/m^2) while significantly lowest dry matter was found with Kranti cultivar (710.13 g/m^2) at all the phenophages of mustard crop. Maximum number of siliqua/plant (295.27) was noticed with Varuna cultivar followed by NDR-8501 (273.70) and Kranti (243.30) cultivars. Maximum length of siliqua (8.30) was observed with Varuna followed by NDR-8501 (7.83) and Kranti (7.03) cultivars. Maximum numbers of seeds/siliqua (16.13) were recorded with Varuna cultivar followed by NDR-8501 (15.60) and Kranti (14.33). Maximum test weight (g) (4.85) was recorded with Varuna cultivar followed by NDR-8501 (4.55) and Kranti (3.85). It is concluded that early sown cultivars give the maximum yield of the mustard crop due the fulfillment of thermal unit.

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