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Gajendra Singh
M Sc, Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

AN Mishra
Asstt. Prof Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

AK Singh
Assoc. Prof, Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

SR Mishra
M Sc Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Rovit Kumar
Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Manoj Kumar
Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Correspondence
Gajendra Singh
M Sc, Department of Agricultural Meteorology, ND. University of Agriculture & Technology Kumarganj, Ayodhya, Uttar Pradesh, India

Effect of different growing environment on growth and yield of mustard cultivars (*Brassica juncea* L.)

Gajendra Singh, AN Mishra, AK Singh, SR Mishra, Rovit Kumar and Manoj Kumar

Abstract
A field experiment was conducted during the *Rabi* season of 2018-19 to access the "Effect of different growing environment on growth and yield of mustard cultivars (*Brassica juncea* L.)" in silty loam soil at Agro-meteorological Research Farm of N.D. University of Agriculture & Technology, Kumarganj, Ayodhya. The experiment was conducted with RBD (Factorial) and replicated four times with nine treatment combinations consisted of three growing environment viz. 20th October, 30th October and 09th November and three cultivars *viz.* Varuna, Narendra rai-1 (NDR-8501) and Kranti. Results revealed that 20th October sown mustard crop produced significantly higher growth and yield due to fulfilment of optimum heat unit requirement and solar light interception for various processes of plant. Among the different cultivars of mustard, Varuna was more conducive for growth, development, grain yield and heat use efficiency as compared to Narendra rai-1 (NDR-8501) and Kranti. Higher seed yield (18.90 q/ha) was recorded under 20th October sowing as compared to 30th October sown mustard crop and 09th November. Among the different cultivars, maximum yield of Varuna was 18.90 q/ha and performed 10.20% and 26.58% higher yield than Narendra rai-1 (NDR-8501) and Kranti respectively.

Keywords: Growth parameter, yield attributes, yield, mustard, growing environment

Introduction
Mustard (*Brassica juncea* L.) belonging to family cruciferae is the third important oilseed crop in the world after soybean (*Glycine max*) and palm oil (*Elaeis guineensis jacq*).). The important mustard growing countries of the world are India, Canada, China, Pakistan, Poland, Bangladesh and Swedan. Mustard is a Latin term 'must'/'mustum' denotes expressed juice of grapes and 'ardens' means hot and burning (Ahlawat, 2008) [1]. India is one of the important country among the oilseeds producing countries of the world. Mustard is the second most important edible oil seed crop after groundnut in India. India occupies the second position in area after China and third position in production in the world after China and Canada. Indian mustard is also grown where annual precipitation of 500 to 1200 mm, temperature of 6^0C to 27^0C and soil pH of 6.5 to 8.3. Mustard requires well drained sandy loam soil and low water (240 - 400 mm) which fits well in the rain fed cropping system. Development of high yielding varieties of mustard has been one of the major

Materials and methods
An experiment was conducted at Agro-meteorological Research Farm of Narendra Deva University of Agriculture & Technology, Kumarganj, and Ayodhya (U.P.) during Rabi season 2018-19. The farm is located 42 km away from Ayodhya city on Ayodhya - Raibareily road at 26˚47′ N latitude and 82˚12′ E longitude and at an attitude of about 113 meter above the mean sea level. The experiment was conducted in R.B.D. (Factorial). Nine treatments combination comprised of three growing environment *viz.* crop sown on 20th October, crop sown on 30th October and crop sown on 9th November along with three cultivars *i.e.* Varuna, Nrendra-Rai-1(NDR-8501) and Kranti. The crop was fertilized with a uniform dose of nitrogen, phosphorus and potassium at 120:60:50 kg/ha, respectively. Urea, DAP and MOP were used as the source of nitrogen, phosphorus and potassium. Half dose of nitrogen along with full dose of phosphorus, potassium and sulphur were applied as basal dressing and remaining dose of nitrogen was top dressed into two equal splits. 1st split was top dressed at 30 DAS and 2nd splits dose at pre flowering stage of the crop.

Leaf area index

The leaf area of five plants was measured by automatic leaf area meter. Leaf area index was calculated by the formula.

$$\text{Leaf area index} = \frac{\text{Leaf area (m}^2\text{)}}{\text{Ground area (m}^2\text{)}}$$

Harvest index (%)

The harvest index is the ratio of grain yield and biological yield, it was calculated by following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \text{ x } 100$$

Table 1: Leaf area Index of Indian mustard as affected by growing environment and cultivars

Treatments	Leaf area index		
	30 DAS	60 DAS	90 DAS
Growing environment			
20th Oct.	1.49	4.61	4.46
30th Oct.	1.42	4.45	4.21
09th Nov.	1.37	4.23	4.05
SEm±	0.02	0.07	0.07
CD at 5%	0.08	0.22	0.21
Cultivars (3)			
Varuna	1.47	4.58	4.39
NDR-8501	1.40	4.41	4.32
Kranti	1.35	4.20	4.01
SEm±	0.02	0.07	0.07
CD at 5%	0.08	0.22	0.21

Table 2: Dry matter accumulation of Indian mustard as affected by growing environment and cultivars

Treatments	Dry matter accumulation (g/m²)			
	30 DAS	60 DAS	90 DAS	At Harvest
Growing environment				
20th Oct.	55.6	165.4	572.2	632.6
30th Oct.	52.6	156.3	541.2	599.4
09th Nov.	42.2	124.5	433.6	484.3
SEm±	0.85	2.60	9.18	10.21
CD at 5%	2.49	7.59	26.80	29.80
Cultivars				
Varuna	55.3	164.7	570.0	630.3
NDR-8501	51.2	152.0	526.7	584.0
Kranti	43.9	129.5	450.2	502.1
SEm±	0.85	2.60	9.18	10.21
CD at 5%	2.49	7.59	26.80	29.80

Table 3: Yield and yield attributes of Indian mustard as affected by growing environment and cultivars

Treatments	No. of siliquae/plant	Length of siliqua (cm)	No. of seeds/siliqua	Test weight (g)	Grain Yield (q/ha)	Stover yield (q/ha)
Growing environment						
20th Oct.	278.9	7.7	16.5	4.4	20.5	72.8
30th Oct.	267.6	7.4	13.3	4.2	18.2	64.1
09th Nov.	261.2	6.7	12.5	4.2	15.5	56.3
SEm±	4.50	0.13	0.25	0.07	0.31	1.15
CD at 5%	13.15	0.37	0.74	0.21	0.91	3.35
Cultivars						
Varuna	289.6	8.0	15.5	4.8	19.8	69.0
NDR-8501	263.3	7.3	14.2	4.4	18.4	65.0
Kranti	230.9	6.5	12.6	3.6	16.0	59.2
SEm±	4.50	0.13	0.25	0.07	0.31	1.15
CD at 5%	13.15	0.37	0.74	0.21	0.91	3.3

Results and discussions

Growth parameters

Leaf area index of mustard as affected by growing environment and cultivars recorded at successive growth stages have been presented in table-1. 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 at all the stages. Delayed, sowing by achieved lower leaf area index at all the stages of mustard crop which might be due to less vegetative growth because of less favorable environmental conditions when crop was sown too early and late sowing conditions. Significantly higher Leaf area index was obtained at planting date 20th October as compared to sowing done on 30th October, while growing environment 09th November proved lowest LAI at all the stages of crop. These findings are in agreement with Panda *et al.* (2004) [10], Bhuiyan *et al.* (2008) [2] and Kumari *et al.* (2012).Leaf area index was affected significantly at all the stages due to cultivars. Among the varieties Varuna recorded significantly higher leaf area index at 60 DAS, 90 DAS and at harvest as compared to Narendra

Rai-1 and Kranti. The results are in conformity with Singh *et al.* (2008) [3-15].

Dry matter accumulation as influenced by different growing environment and cultivars has been presented in table-2. It is quite obvious from the data that dry matter accumulation varied significantly due to growing environment at all the stages of mustard. It was recorded higher under the treatment when mustard was sown on 20th October while significantly superior over rest both of the growing environment. Late sown mustard recorded lowest dry matter at all the stages. Accumulation of dry matter in the plant is directly related to plant height, leaf area index and number of branches plant^{-1} which were appreciably reduced as sowing delayed. The results are in conformity with the Singh and Singh (2002) [14] and Lallu *et al*. (2010) [6]. Dry matter accumulation was affected significantly at all the stages due to cultivars. Among the varieties Varuna recorded significantly higher dry matter accumulation at 60, 90 DAS and at harvest as compared to Narendra Rai-1 and Kranti respectively and its probable reason might be attributed to genetic characters of Varuna which has higher capacity to utilized the photosynthetic more efficiently for maximum leaf area index, number of branches plant^{-1} and ultimately the dry matter production. The results are in conformity with the Kumar *et al.* (2008) [3].

Yield attributing characters

Number of siliquae/plant as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the number of siliquae/plant. Higher number of siliquae/plant (278.9) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The lowest number of siliquae/plant was recorded when sowing was done at 09th November. The results are in conformity with the Singh (1989), Thakuria and Gogoi (1996). Number of siliquae/plant was significantly affected by different cultivars. Maximum numbers of siliquae/plant (289.60) were recorded with Varuna cultivar followed by NDR-8501 (263.3) and then Kranti (230.9). These findings are in agreement with Singh *et al.* (2008) [3-15].

Length of siliqua (cm) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the length of siliqua/plant. Maximum length of siliqua (7.7) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The minimum length of siliqua was recorded when sowing was done on 09th November the results conformity with Singh (1989) [12]. Length of siliqua was significantly affected by different cultivars. Maximum length of siliqua (8.0) was recorded with Varuna cultivar followed by NDR-8501 (7.3) and then Kranti (6.5) Singh *et al.* (2008) [3-15].

Number of seeds/siliqua as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the number of seeds/siliqua. Maximum number of seeds/siliqua (16.5) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. These findings are in agreement with Singh (1989) [12], Singh (1991) [13] and Yadav *et al.* (1994) [17]. Number of seeds siliqua^{-1} was significantly affected by different cultivars. Maximum numbers of seeds/siliqua (15.5) were recorded with Varuna cultivar followed by NDR-8501 (14.2) and then Kranti (12.6). Similar results are reported by Singh *et al.* (2008) [3-15].

Test weight (g) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the test weight. Maximum test weight (4.4) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The results conformity with here in Singh (1989) [12] and Singh (1991) [17].Test weight was significantly affected by different cultivars. Maximum test weight (4.8) was recorded with Varuna cultivar followed by NDR-8501 (4.4) and then Kranti (3.6). Similar results are reported by Singh *et al.* (2008) [3-15].

Yield

Grain yield (q/ha) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the grain yield. Maximum grain yield (20.5 q/ha) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The minimum grain yield (15.5 q/ha) was recorded when sowing was done at 09th November Panda *et al.* (2004a), Lallu *et al.* (2010) [6] and Kumari *et al*. (2012).The grain yield (q/ha) was significantly affected by different cultivars. Maximum grain yield (19.8 q/ha) was recorded with Varuna cultivar followed by NDR-8501 (18.4 q/ha) and then Kranti (16.0 q/ha). All the growth and yield attributes which determined the grain yield of mustard crop, were adversely influenced when the sowing were done on too early and late sowing, which might be resulted to poor growth and translocation of photosynthetic from source to sink and ultimately lower yield was recorded. Similar results are reported by Singh *et al*. (2008) [3-15].

Stover yield (q/ha) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the Stover yield. Maximum Stover yield (72.8 q/ha) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The minimum Stover yield (56.3 q/ha) was recorded when sowing was done at 09th November. All the growth and yield attributes which determined the Stover yield of mustard crop, were adversely influenced when the sowing were done on too early and late sowing, which might be resulted to poor growth and translocation of photosynthetic from source to sink and ultimately lower yield was recorded. The results are in agreement with Sarma *et al.* (1999) and Kumar and Singh (2003).The Stover yield (q/ha) was significantly affected by different cultivars. Maximum Stover yield (69.0 q/ha) was recorded with Varuna cultivar followed by NDR-8501 (65.0 q/ha) and then Kranti (59.2 q/ha). Similar results are reported by Singh *et al* (2008) [3-15].

Biological yield (q/ha) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the Biological yield. Maximum Biological yield (93.4 q/ha) was recorded when crop was sown on 20th October which was significantly superior over 30th October and 09th November crop growing environment. The minimum Biological yield (71.8 q/ha) was recorded when sowing was done at 09th November. The Biological yield (q/ha) was

significantly affected by different cultivars. Maximum Biological yield (88.8 q/ha) was recorded with Varuna cultivar followed by NDR-8501 (83.47 q/ha) and then Kranti (75.2 q/ha). The results obtained were found in close accordance with Khan and Saha, (2008) [11] and Nihalan *et al.*, (2008) significant effect of all treatments on the biological yield of mustard was also observed.

Harvest index (%) as affected by growing environment and cultivars have been presented in table-3. A perusal of data showed that different growing environment influenced significantly to the Biological yield. Maximum Harvest index (22.0 %) was recorded when crop was sown on 30th October which was significantly superior over 20th October and 09th November crop growing environment. The Harvest index (%) was significantly affected by different cultivars. Maximum Harvest index (22.3 %) was recorded with Varuna cultivar followed by NDR-8501 (22.0 %) and then Kranti (21.2 %). Similar results are reported by Singh *et al.* (2008) [3-15].

Conclusions

Higher growth and yield was observed when crop was sown on 20th October than that of 30th October and 09th November, which expose the crop to abiotic stresses for more time might have favoured higher leaf area index, dry matter production, yield attributing characters and yield at maturity. The varietal performance of 20th October was sown crop found suitable for higher yield followed by 30th October and 09th November. Among the variety Varuna was recorded higher growth and yield as compared to other cultivars.

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