Effect of date of sowing in mustard (*Brassica juncea* L.) genotypes on seed growth and yield

UNDER PEER REVIEW

Abstract

The experiment was conducted at farmer's field during *rabi* 2019-2020 and Department of Seed Science and Technology College of Agriculture Raichur and Department of Crop Physiology, University of Agriculture Sciences Raichur, (India).Three genotypes of mustard were sown during November- December in three different dates at an interval of fifteen days to know the effect of sowing date on seed yield and quality of mustard (*Brassica juncea* L.). Significant variations due to different sowing dates were observed in plant height, number of primary branches palnt^{-1}, number of secondary branches plant^{-1}, chlorophyll content, number of siliqua plant^{-1}, number of seed siliqua^{-1}, 1000 weight, yield plant^{-1}and yield ha^{-1} and oil content of mustard. Delay in sowing caused a significant reduction in the seed yield and quality. Results showed that the highest seed yield was 1962.48 kg ha^{-1} obtained from 2nd week of November early sowing. The lowest seed yield was 1902.10 kg ha^{-1} from 2nd week of December late sowing. From the results, the best sowing date of mustard is on 2nd week of November in the northern parts of Karnataka.

Introduction

Indian mustard (*Brassica juncea* L.) is an important oil yielding crop belongs to the family Brassicaceae. A natural amphidiploid derived from *B. nigra* and *B. campestris*. Autogamy species with (2 to 15 %) of cross pollination.Time of sowing is very important for mustard production(Mondal *et al* 1999). Optimum sowing time plays an important role to exploit the genetic potential of a variety as it provides optimum growth conditions such as temperature, light, humidity and rainfall (Iraddi VS 2008). Sowing dates is an important factor that determines the length of growing season and hence yields (Sharghi *et al* 2011). Delayed planting, unfavorable weather conditions during the flowering period, fertilization and pod formation can cause a decrease in duration of maturity period, the number of pods per plant, the number and weight of grains, and finally can lead to decrease in seed yield (Soleymani *et al* 2010) From the above points it is clear that date of sowing plays a great role in mustard seed production. Keeping in view of these facts, the present investigation was carried out to study the effect of sowing date on flowering and seed set of mustard (*Brassica juncea* L.).

Material and Methods

The investigations were carried out during *rabi* 2019-2020 in the Itagi village of devadurga taluka of Raichur district, and laboratory experiment was conducted in the Department of Seed Science and Technology College of Agriculture Raichur and Department of Crop Physiology, University of Agriculture Sciences Raichur, (India) situated at $16^{0}28^{'}$ north latitude and $77^{0}6^{'}$ east longitude with an altitude of 389 m above the mean sea level. The three genotypes NRCHB – 101, PM-25 and PM-30 of Indian mustard were sown in field on the three date of sowing, i.e., 2^{nd} week of November, 4^{th} week of November and 2^{nd} week of December during 2019 and 2020 laid out in factorial randomized block design with three replications under normal fertility conditions. Observations on the effect of sowing date on seed yield and quality parameters were recorded.

Results and Discussion

Effect of sowing date on growth parameters

Effect between the genotypes and dates of sowing was found significant highest plant height was recorded at D1 (2^{nd} week of November) in NRCHB – 101 genotype (156.27 cm) Further, lowest plant height was recorded in D3 (2^{nd} week of December) in PM-25 under late date of sowing (142.19 cm) at harvest (fig 1). Present study revealed the presence of wide range of variability for plant height among the genotypes selected for different date of sowing time and the variability in plant height might be due to the genetic makeup of the different genotypes. The results of present investigation are in agreement with the earlier reports of Zafar *et al*. (2008)

It was observed that genotype NRCHB – 101 at D1 (2^{nd} week of November) had higher SPAD values (45.12) and genotype PM-30 had lower values at D3 (2^{nd} week of December) (39.21) at flowering stage. In present investigation among different sowing dates observed that the genotypes which had higher SPAD values (NRCHB – 101) also had maximum stomatal conductance, photosynthetic rate and as well as the yield levels. These present study results were in conformity with the earlier works of Kobraee *et al.* (2011) and Liu *et al.* (2012) in soybean.

UNDER PEER REVIEW

Highest number of primary branches plant^{-1} and number of secondary branches plant^{-1} was recorded at D2 (4^{nd} week of November) in NRCHB – 101(6.85 and 26.00) and lowest number of primary branches per plant was recorded at D3 (2^{nd} week of December) in PM-30 (5.09) and PM-25 (5.03 and 21.96 respectively). So, genotype with higher primary branches plant^{-1} and number of secondary branches plant^{-1} yielded high and these present results were confirmed with the finding of Akparobi (2009) in cassava. In mustard, number of siliqua increased in each branch and as the number of primary branches per plant increases, there are greater chances of getting higher number of siliqua per plant; as the siliqua number increases so does the yield level too increases.

Among different sowing dates the genotype NRCHB – 101(39.00 days) took less number of days for days to 50 per cent flowering at D1 (2^{nd} week of November) and PM-25 (43.43 days) took more number of days at D3 (2^{nd} week of December). The possible reason for decrease in flowering duration in the late sown crop (D1 2^{nd} week of November) during both the years could be that the environmental conditions for plant growth were more favourable. The crop had more time for various activities and could complete various phenological stages. However, in delayed sowing plant tends to reach reproductive and seed production stage earlier due to little aberrant environmental conditions when crop was sown on D3 2^{nd} week of December (fig2). Temperature and photoperiod have been reported as the two most important environmental factors affecting phenological development. The present results are in agreement with the findings of Khan *et al*., (1994) also similar results were obtained by Manju. D. and Harish K, S. (2017) in mustard.

Genotype PM-30 (23.88 cm^2 g^{-1}) observed maximum specific leaf area at 2^{nd} week of November followed by NRCHB – 101(22.89 cm^2 g^{-1}), while minimum SLA noticed in PM-25(22.23 cm^2 g^{-1}) at 2^{nd} week of December at pod formation stage. Higher specific leaf area (SLA) indicates distribution of dry weight over large leaf area and also the presence of a more number of palisade cell layers in leaves. As palisade cell number increases, the amount of photosynthates fixed does also increases causing higher yield levels. These results were similar with the earlier results of Kaston and Rancut (2009) in soybean.

Genotype NRCHB – 101at 2^{nd} week of November had maximum CGR (18.12 g m^{-2} day^{-1}) owned higher yield levels and genotype which showed lower value for CGR (PM-25) at 2^{nd} week of December (14.59 g m^{-2} day^{-1}) had lower yield levels. The rapid increase in CGR in the genotypes

UNDER PEER REVIEW

was due to higher production of dry matter due to increased photosynthetic activity at grand growth stage which was also coupled with increased rate of cell multiplication..

The genotype NRCHB-101 recorded highest net assimilation rate (14.29 g g^{-1} day^{-1} in) under early date of sowing D1 (2^{nd} week of November) followed by PM-30 under early date of sowing D1 (2^{nd} week of November) (13.64 g g^{-1} day^{-1}). Further, the genotype PM-25 recorded significantly lowest net assimilation rate (10.80 g g^{-1} day^{-1}) under late showing D3 (2^{nd} week of December). Net assimilation rate (NAR) of any plant denotes increase in plant dry weight per unit leaf area per unit time. In present investigation it was observed that there was significant difference among date of sowing and genotypes used for study at all their growth stages.

Effect of sowing date on yield parameters

Number of siliqua $plant^{-1}$, number of seeds $siliqua^{-1}$ and siliqua length was significantly affected by both sowing dates and genotypes. Mustard sown on 2^{nd} week of November has obtained significantly higher number of siliqua $plant^{-1}$, number of seeds $siliqua^{-1}$ and siliqua length followed by 4^{th} week of November sowing crop. Lowest was observed on 2^{nd} week of December. This might be due to favourable weather condition and translocation of more photosynthates from source to sink resulted in higher in early sowings than delayed ones. Similar results were suggested by Chand *et al*. (2000), Aziz *et al*. (2011) and Sharif *et al*. (2016). Among genotypes NRCHB-101 (473.85, 12.52 and 6.57 cm) recorded highest siliqua $plant^{-1}$, number of seeds $siliqua^{-1}$ and siliqua length repectively and lowest recorded in PM-25 (138.28, 10.60, 5.07 cm respectively) table 1, 2 and 3.

Effect of genotypes and date of sowing variation on seed yield $plant^{-1}$ and seed yield ha^{-1} of mustard was found to be significant. Genotype NRCHB-101 under early date of sowing D1 (2^{nd} week of November) (9.36g and 2077.92 kg ha^{-1} respectively) recorded highest seed yield per plant.. Further, the genotype PM-25 recorded lowest seed yield $plant^{-1}$ and seed yield ha^{-1} (7.55g and 1675.66 kg ha^{-1}) under late showing D3 (2^{nd} week of December) (Fig. 3). Higher seed yield in NRCHB-101 was due to the contribution of cumulative favourable effects of the crop characteristics *viz.*, higher number of branches per plant, number siliqua per plant and number seeds per siliqua than other genotypes. Similar results were reported by Helal *et al*. (2016), Raghuvanshi *et al*. (2018) and Biswas *et al*. (2002).

UNDER PEER REVIEW

Conclusion

It is concluded that if sowing is done late in December then crop experiences higher temperature during germination and early growth phases, however, when sowing is done very late, crop experiences heat stress at later stages of plant growth causing reduction in flowering and pod growth phases resulting in decreased total dry matter, primary and secondary branch, siliqua per plant, test weight, quantity and quality of oil in seeds. Instead of 2nd week of December the ideal sowing time of mustard in Raichur region may be considered on 2nd week of November and this shift might be due to climate change and in spring season. Delay in sowing exposes mustard plants to high temperature and long days particularly affecting phenological development less fertilization and during siliqua growth phase, which accelerates crop maturity and decreases seed yield.

UNDER PEER REVIEW

References

Akparobi S. O., 2009, Effects of two agro-ecological zones on leaf chlorophyll contents of twelve cassava genotypes in Nigeria. *Middle-East J. Sci. Res.,* 4(1): 20-23.

Aziz, M. A., Chakma, R., Ahmed, M., Rahman, A. K. M. M. and Roy K., 2011, Effect of sowing dates on the growth, development and yield of mustard in the hilly areas. *J. Exp. Biosci.*, 2(1): 33-36.

Biswas, M., Alom, M. S., Mondol, N. A., Khatun, F., Banik, B. R. and Kundu, B. C., 2002, Performance of late sown rapeseed-mustard under variable management levels. *Pak. J. Biol. Sci.,* 5(10): 1017-1020.

Chand, P., Govardhan, M. and Sujatha, M., 2000, Effect of dates of sowing on performance of mustard varieties. *Res. Crops*, 1: 153-155.

Helal, M. U., Islam, N., Kadir, M. and Miah, N. H., 2016, Performance of rapeseed and mustard (*Brassica sp.*) varieties/lines in North-East region (Sylhet) of Bangladesh. *Agric. Res. Technol.,* 2(1).

Iraddi, V. S., 2008, Response of mustard (*Brassica juncea L. Czernj and Cosson*) varieties to date of sowing and row spacing in Northern transition zone of Karnataka. M.Sc. Thesis. Department of Agronomy, University of Agricultural Sciences, Dharwad, 2008, 81

Kaston, L. and Rancut, J. H., 2009, Physiology of seed yield in soybean: growth and dry matter production. *African. J. Biotechnol.*, 21: 7643-7649.

Khan, R. U., Muendel, and Chaudhry, H. H., 1994, Influence of tipping rapeseed on yield components and other agronomic characters under varying dates of planting. *Pakistan J. Botan*, 26:167-171.

Kobraee, S., Shamsi, K., and Ekhtiari, S., 2011, Soybean nodulation and chlorophyll concentration (SPAD value) affected by some of micronutrients, *Ann. Biol. Res*., 2(2): 414-422.

Liu, G., Yang, C., Xu, K., Zhang, Z., Li, D., Wu, Z., Chen, Z., 2012, Development of yield and some photosynthetic characteristics during 82 years of genetic improvement of soybean genotypes in northeast China. *Australian J. Crop Sci*., 6(10): 1416-1422.

Manju, D. and Harish, K. S., 2017, Effect of sowing date on flowering and seed set of mustard (*Brassica juncea* L.). *J. Ento. Zool. Studies*, 5(5): 1534-1537.

Mondal, R. I., Biswas, M., Ali, H. and Akbar, M. A., 1999, Response of rapeseed genotype dhali to seed rate and seeding date. *Bangladesh Journal of Agricultural Research*. 24:83-90.

Raghuvanshi, N., Kumar, V. and Dev, J., 2018, Effect of nitrogen levels on mustard (*Brassica juncea* L. Cuzern and Coss) varieties under late sown condition. *Curr. J. Appl. Sci. Technol*., 30(2): 1-8.

Sharghi, Y., Shirani, RAH., Ayeneh, B. A., Noormohammadi, G. and Zahedi, H., 2011, Yield and yield components of six canola (Brassica napus L.) cultivars affected by planting date and water deficit stress. *African Journal of Biotechnology*., 10:9309-9313.

Sharif, M., Haque, M. Z., Howlader, M. H. K. and Hossain, M. J., 2016, Effect of sowing time on growth and yield attributes of three mustard cultivars grown in tidal flood plain of Bangladesh. *J. Bangladesh Agric. Univ*., 14(2): 155-160.

UNDER PEER REVIEW

Soleymani A, Shahri MM, Shahrajabian MH, Naranjani L., 2010, Responses of cultivars of canola to sulfur fertilizer and plant densities under climatic condition of Gorgan region. *Iranian Journal of Food, Agriculture and Environments*., 8:298-304.

Zafar, I., Arshad, M., Ashraf, M., Mahmood, T. and Waheed, A., 2008, Evaluation of soybean (*Glycine max* L *Merrill*) germplasm for some important morphological traits using multivariate analyses. *Pakistan J. Bot*., 40(6): 2323-2328.

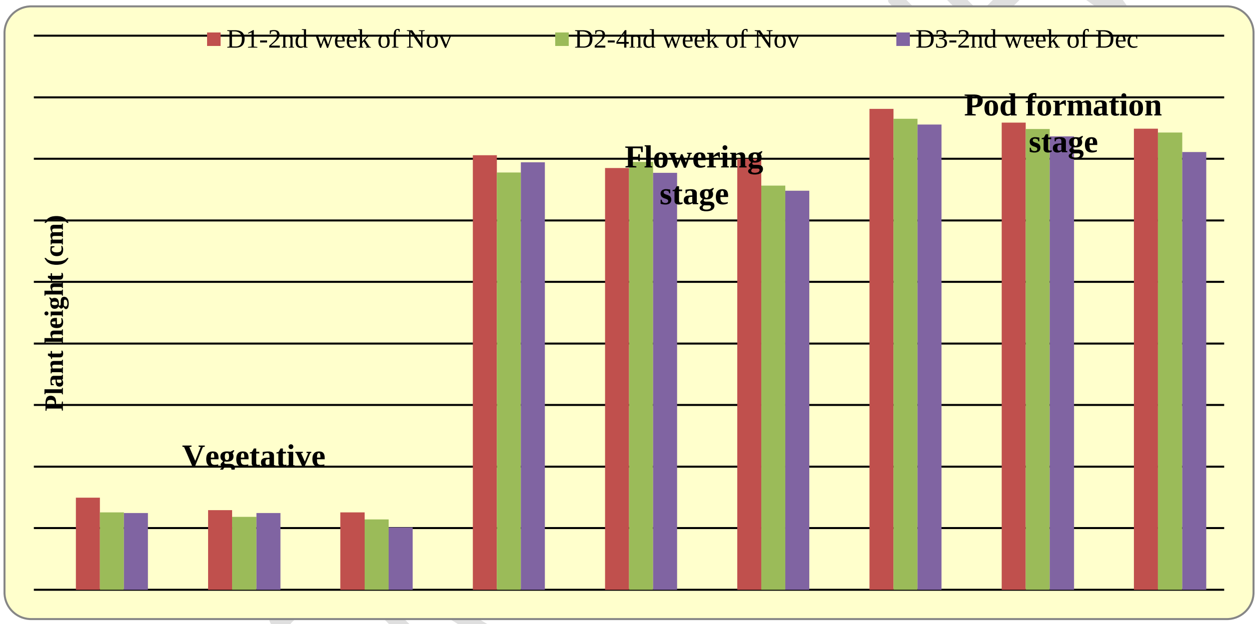

Fig 1. Effect of date of sowing on Plant height (cm) in mustard genotypes

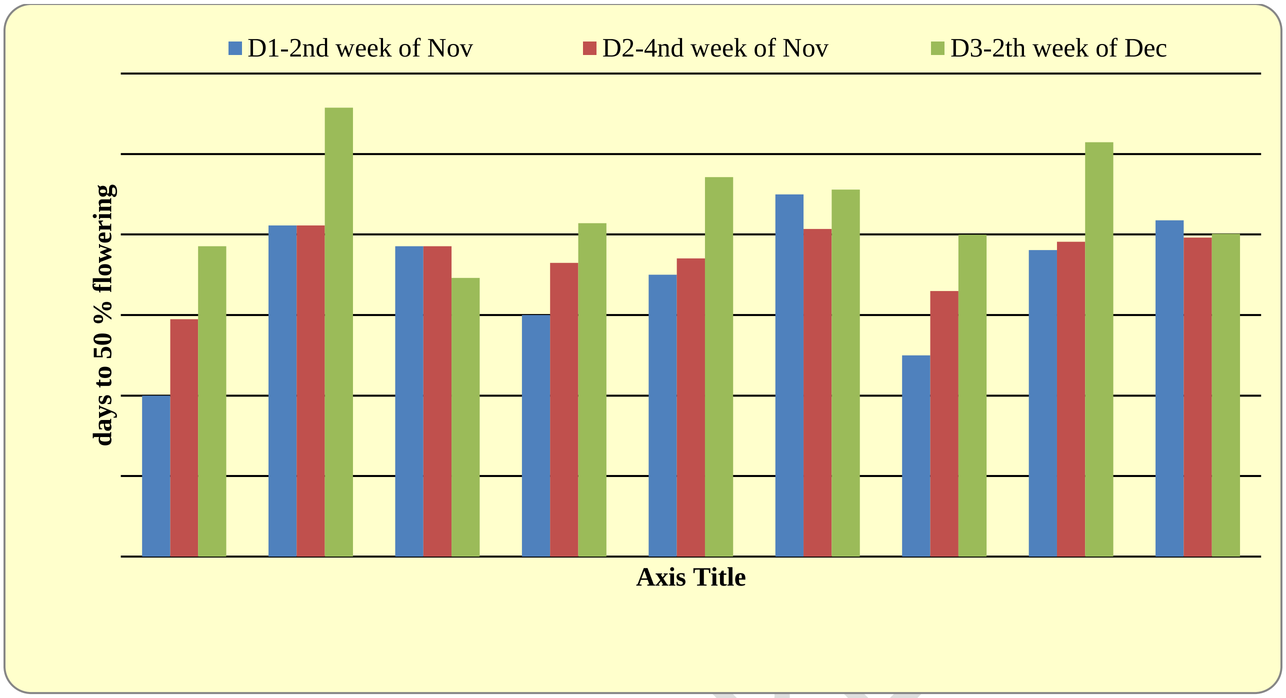

Fig2. Effect of date of sowing on days to 50 % flowering in mustard genotypes

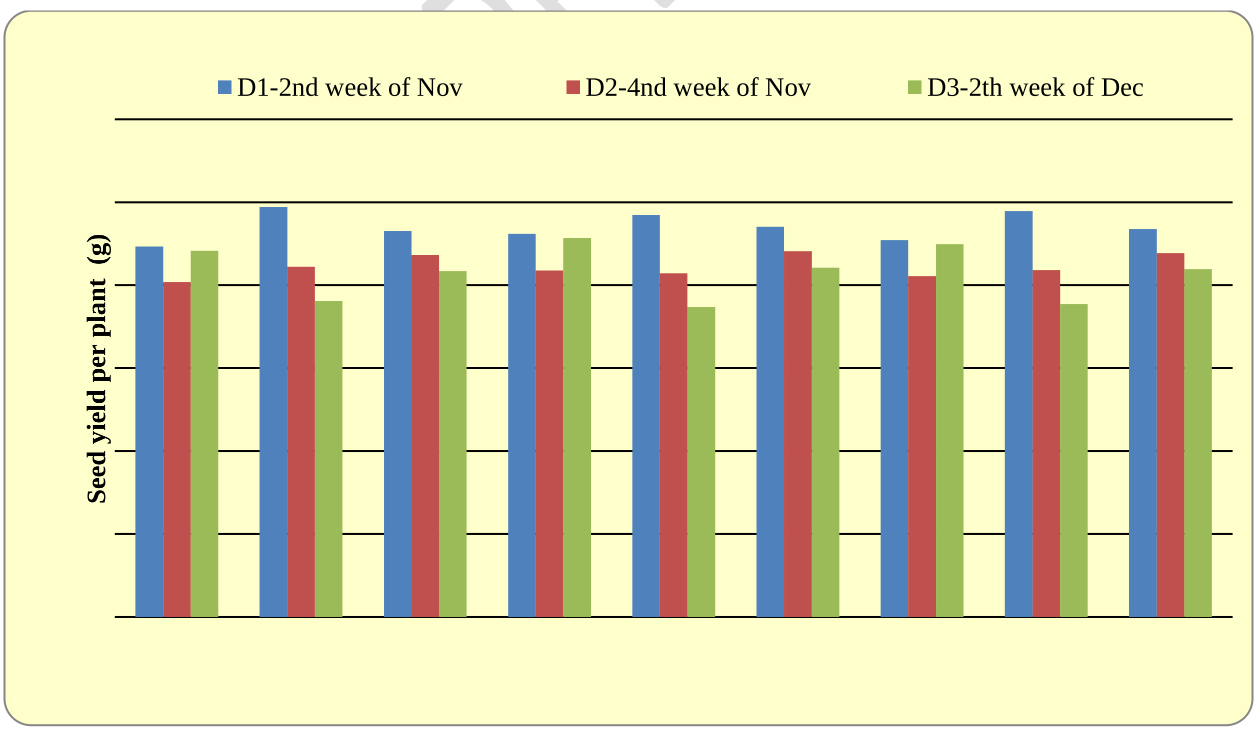

Fig 3. Effect of date of sowing on seed yield per plant in mustard genotypes

Table1. Effect of date of sowing on number of siliqua per plant in mustard genotypes

Sowing dates	Number of siliqua per plant											
	2019				2020				Pooled Mean			
	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean
D1-2nd week of Nov	471.42	232.20	310.03	**337.88**	476.28	226.17	304.01	**335.49**	473.85	229.18	307.02	**336.68**
D2-4th week of Nov	331.74	211.44	195.70	**246.29**	335.16	211.06	191.90	**246.04**	333.45	211.25	193.80	**246.17**
D3-2th week of Dec	275.48	136.80	139.05	**183.78**	273.59	141.12	139.50	**184.74**	274.53	138.96	139.28	**184.26**
Mean	**359.55**	**193.48**	**214.93**		**361.68**	**192.78**	**211.80**		**360.61**	**193.13**	**213.37**	
	D	**G**	**D x G**		**D**	**G**	**D x G**		**D**	**G**	**D x G**	
S.Em ±	3.219	3.219	5.575		4.694	4.694	8.131		1.940	1.940	3.361	
CD at 5%	9.649	9.649	16.713		14.074	14.074	24.377		5.817	5.817	10.075	

Table 2. Effect of date of sowing on number of seeds per siliqua in mustard genotypes

Sowing dates	Number of seeds per siliqua											
	2019				2020				Pooled Mean			
	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean
D1-2nd week of Nov	12.52	12.22	12.34	**12.36**	12.15	11.97	11.99	**12.03**	12.33	12.10	12.17	**12.20**
D2-4nd week of Nov	12.49	11.92	11.98	**12.13**	12.19	11.53	11.89	**11.87**	12.34	11.72	11.94	**12.00**
D3-2th week of Dec	11.95	10.82	11.78	**11.51**	11.58	10.37	11.66	**11.20**	11.76	10.60	11.72	**11.36**
Mean	**12.32**	**11.65**	**12.03**		**11.97**	**11.29**	**11.85**		**12.15**	**11.47**	**11.94**	
	D	**G**	**D x G**		**D**	**G**	**D x G**		**D**	**G**	**D x G**	
S.Em ±	0.118	0.118	0.205		0.128	0.128	0.221		0.098	0.098	0.170	
CD at 5%	0.355	0.355	NS		0.383	0.383	NS		0.295	0.295	0.511	

Table 3. Effect of date of sowing on siliqua length (cm) in mustard genotypes

Sowing dates	Siliqua length (cm)		
	2019	2020	Pooled Mean

UNDER PEER REVIEW

	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean	NRCHB-101	PM-25	PM-30	Mean
D1-2nd week of Nov	6.46	5.72	5.56	**5.92**	6.69	5.78	5.45	**5.97**	6.57	5.75	5.51	**5.94**
D2-4nd week of Nov	5.89	5.14	5.97	**5.67**	6.08	5.11	5.99	**5.73**	5.98	5.12	5.98	**5.70**
D3-2th week of Dec	5.32	5.04	5.46	**5.27**	5.51	5.10	5.35	**5.32**	5.41	5.07	5.41	**5.30**
Mean	**5.89**	**5.30**	**5.67**		**6.09**	**5.33**	**5.60**		**5.99**	**5.32**	**5.63**	
	D	**G**	**D x G**		**D**	**G**	**D x G**		**D**	**G**	**D x G**	
S.Em ±	0.029	0.029	0.051		0.087	0.087	0.151		0.038	0.038	0.066	
CD at 5%	0.088	0.088	0.153		0.262	0.262	0.453		0.114	0.114	0.198	

UNDER PEER REVIEW