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- Short communication

EFFECTS OF DIFFERENT SOWING SCHEDULES AND PLANTING GEOMETRY ON YIELD AND PRODUCTIVITY OF *BRASSICA JUNCEA* L.

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Abstract

A field experiment was conducted to study the effects of different sowing schedules and planting geometry on yield and productivity of Indian mustard (*Brassica juncea* L.) var. Giriraj. Among the different sowing schedules, sowing mustard crop on 2nd decade of October was found to produce significantly higher seed and biological yield. The early sowing of mustard crop recorded higher values of utilization and accumulation of various agromet indices like growing degree days (GDD), helio-thermal units (HTU) and photo-thermal units (PTU) as well as higher values of photothermal index (PTI) at different phenological stages than other treatments in comparison. Among the planting geometry significant increase in the seed and biological yield was observed in the plots sown with planting geometry of 30 cm × 10 cm which however was found to be at par with 30 cm × 20 cm. The maximum and minimum temperature and thermal indices at vegetative and reproductive stages had a significant correlation on seed yield of mustard crop during the three years of experimentation. Similarly, heat use efficiency was also significantly related with seed and biological yield of mustard.

Rapeseed mustard is an important oilseed crop among all edible oilseed crops grown in India. Optimum sowing time plays an important role to fully exploit the genetic potentiality of the crop. Decline in physiological traits along with the seed yield, seed weight owing to negative physiological response condition during the post anthesis/seed filling stages under high temperature condition has also recently been reported in *Brassica juncea* by Sharma *et al*. (2013). The crop phenology and yield of crops are advertently affected by through changes in global climate which results in modifications in spatial and temporal trends of temperature (Jalota and Vashisht 2016).

The selection of proper sowing date and planting geometry are the major non-monetary agronomic manipulations that can be adjusted well to avail the favourable environment for the growth of mustard crop. Delayed sowing affects growth and causes early maturity resulting in drastic yield reduction mainly due to rising temperature during maturity phase.

Plants have a definite temperature requirement to attain phenological stages. Growing degree days (GDD), determine occurrence of various phenological events in the life cycle of a plant. Heat units have frequently been used as weather based parameter for assessing crop phenology and yield.

Keeping these in view, present investigations were conducted to study the effect of weather parameters on Indian mustard under variable sowing times and intra row spacings under low altitude subtropical conditions of Jammu.

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The field experiment was conducted from *rabi* season 2014-15 up to *rabi* season of 2016-17 at Research Farm of the Division of PBG, SKUAST-Jammu, Chatha, J&K (UT) which is located at (32^0 40’ N latitude, 74^0 58’ E longitude and at 332 m amsl and is situated in low altitude sub-tropical Shiwalik foot-hills of lower Himalayas. The area receives a good amount of winter rainfall from western disturbances and cyclonic rains during winter and spring months. The soil of experimental site was slightly alkaline in reaction (pH 7.08), low in organic carbon (0.38%) and nitrogen (215.30 kg/ha), medium in available phosphorus (12.4 kg/ha) and potassium (145 kg/ha).

The experiment consisted of 15 treatments which were arranged in split plot design with three main plots and five sub-plots with three replications. The main plots consisted of three sowing schedules *viz.* 2^{nd} decade of October i.e. 10-20 October (D_1), 3^{rd} decade of October i.e. 20-30 October (D_2) and 1^{st} decade of November i.e. 1-10 November (D_3). The sub plots consisted of five different planting geometries, i.e. 30 cm × 10 cm (P_1), 30 cm × 20 cm (P_2), 30 cm ×30 cm (P_3), 45 cm × 15 cm (P_4) and 45 cm × 30 cm (P_5), respectively. Indian mustard variety ‘Giriraj’ was sown using 5 kg seed/ha during all the three years of experimentation. Recommended dose of 60:30:15:20 kg/ha of $N:P_2O_5:K_2O$: S was uniformly applied to all the treatments using urea, diammonium phosphate, muriate of potash and gypsum, respectively as fertilizers. Full dose of phosphorus, potassium, sulphur and half dose of nitrogen were applied at the time of sowing as basal dose whereas rest of the nitrogen was given in 2 split doses. Indian mustard crop was raised as per standard package and practices and harvested at variable dates ranging from second fortnight of March to first week of April at their respective physiological maturity.

The different agro-meteorological indices were calculated as detailed below:

Growing degree days (GDD), Helio thermal units (HTU) and Photothermal units (PTU) are calculated following the formula of Nuttonson (1955), Rajput (1980) and Nuttonson (1956), respectively. The photothermal Index (PTI) and the heat use efficiency (HUE) was computed by using the expression as belows:

$$\text{Photothermal index (PTI)} = \frac{\text{Accumulated GDD (}^{o}\text{C day)}}{\text{Days to accomplish the phenophase (day)}} \quad {}^{o}\text{C day/day}$$

$$\text{Heat use efficiency (HUE)} = \frac{\text{Accumulated seed yield/dry matter (kg/ha)}}{\text{Accumulated GDD (}^{o}\text{C/day)}} \quad \text{kg/ha/}^{o}\text{C/day)}$$

The treatment-wise data recorded for different crop parameters were subjected to statistical analysis according to split plot design as per the standard procedure (Cochran and Cox 1963).

Various weather parameters have a prominent effect on duration of different phenological stages and especially reproductive stages. The role of these weather parametres could be well explained through accumulation of growing degree days (AGDD), helio-thermal units (AHTU) and photo-thermal units (APTU) at various phenological stages. There was a great variation in accumulation of GDD, HTU and PTU at various stages due to changes in sowing schedules of mustard crop under rainfed conditions; whereas, there was less variation in accumulation of thermal units due to different planting geometries (Table 1). Among the different sowing dates, mustard crop sown on 2^{nd} decade of October (early sown) accumulated the highest GDD, HTU and PTU values for various phenophases. Mustard crop sown with planting geometries 30x10 cm and 30x20 cm accumulated similar values of AGDD, AHTU and APTU during 50 % and 100% flowering. Similarly, the planting geometries 30 cm × 30 cm, 45 cm × 15 cm and 45 cm × 30 cm observed the similar values for accumulation of various thermal indices at different phenological stages. Early sowing resulted in absorbing sufficient thermal indices relatively more time, also the late sown crop faces comparatively higher maximum and minimum temperature especially at reproductive

Table 1. Variation in accumulated agromet indices for flowering and maturity of mustard under different dates of sowings and planting geometry (pooled data of three years).

Treatments	Agromet Indices								
	AGDD			AHTU			APTU		
	50% Flowering	100% Flowering	Physiological maturity	50% Flowering	100% Flowering	Physiological Maturity	50% Flowering	100% Flowering	Physiological maturity
Sowing windows (D)									
D_1: 2nd decade of October	776.3	891.0	1691.1	4840.1	5194.7	9335.8	8226.4	9364.9	18011.6
D_2: 3rd decade of October	715.9	798.9	1588.0	3819.0	4234.3	8342.0	7379.0	8203.3	16914.8
D_3: Ist decade of November	717.1	768.5	1529.4	3574.4	3734.7	7937.7	7307.8	7784.9	16429.5
Planting geometry (P)									
P_1: 30×10 cm	740.9	823.6	1602.8	4095.9	4406.0	8538.5	7667.0	8492.9	17118.6
P_2: 30×20 cm	740.9	823.6	1602.8	4095.9	4406.0	8538.5	7745.9	8492.9	17118.6
P_3: 30×30 cm	733.4	816.7	1602.8	4065.7	4375.8	8538.5	7591.9	8423.1	17118.6
P_4: 45×15 cm	733.4	816.7	1602.8	4065.7	4375.8	8538.5	7591.9	8423.1	17118.6
P_5: 45×30 cm	733.4	816.7	1602.8	4065.7	4375.8	8538.5	7591.9	8423.1	17118.6

Table 2. Yield, harvest index, photothermal index (PTI) and heat use efficiencies (HUE) of mustard crop at phenological stages sown under different dates of sowing and planting geometry (mean of three years).

Treatments	Yield (kg/ha)		Harvest index (%)	PTI ((°C day/day)			HUE (kg/ha/°C day)			
				Phenological stages			Phenological stages		Yield (kg/ha)	
	Seed yield	Biological yield		50% flowering	100% flowering	Physiological maturity	50% flowering	100% flowering	Seed yield HUE	Biological yield HUE
Sowing windows (D)										
D_1: 2nd decade of October	1335	5673	23.6	14.2	12.8	10.8	2.20	2.55	0.89	3.35
D_2: 3rd decade of October	977	4438	22.1	11.8	10.9	10.4	1.86	2.22	0.60	2.79
D_3: Ist decade of November	788	3843	20.7	9.6	9.3	10.2	1.62	2.01	0.50	2.51
CD (5%)	30.4	155.1	0.38							
Planting geometry (P)										
P_1: 30×10 cm	1143	5357	21.2	11.8	11.0	10.5	2.17	2.60	0.70	3.32
P_2: 30×20 cm	1133	5135	21.9	11.8	11.0	10.5	2.08	2.50	0.69	3.19
P_3: 30×30 cm	995	4394	22.5	11.9	11.0	10.5	1.80	2.16	0.61	2.73
P_4: 45×15 cm	977	4336	22.4	11.9	11.0	10.5	1.78	2.13	0.59	2.69
P_5: 45×30 cm	919	4035	22.6	11.9	11.0	10.5	1.65	1.98	0.56	2.50
CD (5%)	39.2	200.2	0.49							

stages. As a result of which the thermal units consumed by the crop reduced progressively in case of delay in sowing. Gupta *et al*. (2017) reported that the requirement of thermal units decreased for different phenological stages with delay in sowing in mustard crop under the sub-tropical conditions of Jammu. Similarly, it was reported that higher temperatures during the reproductive phase reduced the duration of the late sown *Brassica* crop (Khushu *et al.* 2008). Table 2 revealed that significantly higher seed and biological yield recorded in mustard crop sown in 2^{nd} decade of October (1335 and 5670 kg/ha). Among the different crop geometries, significantly higher seed and biological yield of mustard were observed with planting geometry of 30 cm × 10 cm (1143 and 5340 kg/ha) which were statistically at par with geometry of 30 cm × 20 cm (1133 and 5133 kg/ha). Early sowing during 2^{nd} decade of October might have resulted in better utilization of thermal energy, thermal units and thus lead to significantly higher yield along with higher attributes. The early sown crop also got longer period to utilize available resources and favourable temperature. The later sowings resulted in poor dry matter accumulation. Similar findings were reported by Gupta *et al*. (2017) who observed higher seed and biological yield of mustard in early sown crop as compared to delayed sowing.

Mustard crop sown during 2^{nd} decade of October recorded higher values of PTI at 50 and 100% flowering and physiological maturity stage than the later two sowing schedules (Table 2). PTI values to the tune of 14.2, 11.8 and 9.6 ^{o}C day/day were observed during 50% flowering stage at D_1, D_2 and D_3 sowing schedules, respectively. However, the values recorded for PTI values decreased from earlier phenological stages to physiological stages in all the three sowing schedules; being higher at 50% flowering and lower at physiological stages. This might be due to gradual decrease in day and night temperature of that particular phenophase as the sowing was delayed (Neog *et al*. 2008).

Heat use efficiency gradually increased from initial to later growth stages (Table 2). Heat use efficiencies of seed and biological yields were highest in the mustard crop sown in 2^{nd} decade of October (0.89 and 3.35 kg/ha/^{o}C day). Among the various planting densities, the highest values of seed yield heat use efficiency (SYHUE) and biological yield heat use efficiency (BYHUE) i.e. 0.70 and 3.32 kg/ha/^{o}C day, respectively were recorded in 30 cm × 10 cm. The consequent delay in sowing of mustard crop from 2^{nd} decade of October resulted in decrease in the heat use efficiency of phenophases and subsequently SYHUE and BYHUE. Similar findings were also reported with accumulation of maximum heat use efficiency in early sown crops (Kaur *et al.* 2016).

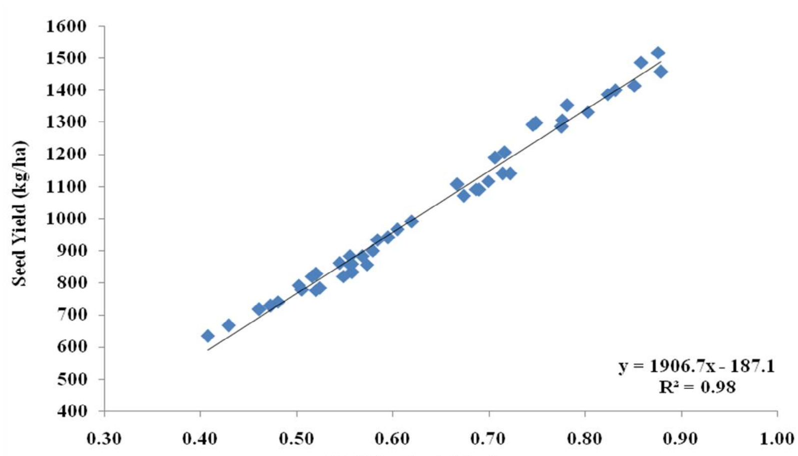

Fig. 1. Relationship between heat use efficiency and seed yield of mustard crop during three years of study.

A unit increase in maximum and minimum temperature during reproductive stage of mustard reduced the seed yield by 194 and 169 kg/ha in mustard crop, respectively. Similar types of findings were also reported by Gupta *et al.* (2017) in mustard crop at Jammu. The accumulated growing degree days (AGDD) from sowing to physiological maturity of mustard crop was

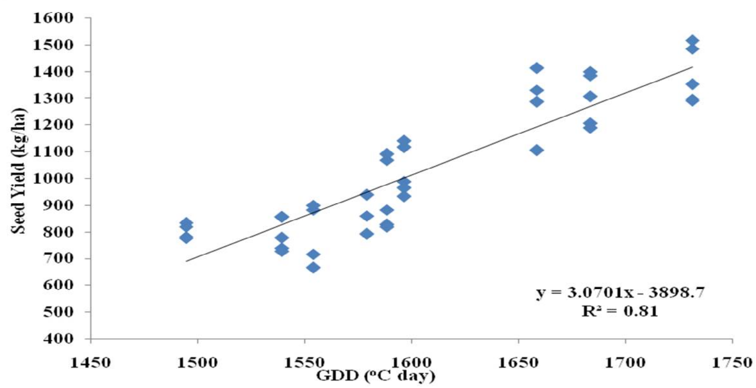

Fig. 2. Relationship between AGDD and seed in yield of mustard crop during three years of study

correlated with seed yield of mustard for pooled data of three years. It was observed from Fig. 2 that there was a positive relationship between seed yield of mustard and AGDD with a higher r^2 value to the tune of 0.81. The relationship between seed yield of mustard and heat use efficiency was also calculated for pooled data of three years. A positive and linear relationship between seed yield of mustard and heat use efficiency was observed with 98 % accuracy (Fig. 1).

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