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Response of Castor (*Ricinus communis* L.) To Varying Weather Variables and Crop Geometry with Levels of Nitrogen under Rabi Season

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A B S T R A C T

A field experiment was conducted on loamy sand soil during *rabi* season of 2011-12 and 2012-13 to find out the response of three weather variables (15^{th} September, 30^{th} September and 15^{th} October) and three crop geometry (150 cm x 60 cm, 120 cm x 60 cm and 90 cm x 60 cm) with two levels of nitrogen (80 kg and 120 kg ha^{-1}) on growth, yield attributes and yield of castor (*Ricinus communis* L.). In general, growth and yield attributes decreased with delay in sowing from 15^{th} September to 30^{th} October. The growth characters *viz.*, plant height, number of branches per plant and numbers of nodes up to primary spike as well as yield attributing parameters *viz.*, length of primary spike, number of capsules per primary spike, number of effective spikes per plant, seed yield per primary spike and per plant as well as seed yield of first and second pickings were significantly higher under early sown crop *i.e.* 15^{th} September than late sown crop *i.e.* 15^{th} October. The growth parameters *viz.*, plant height and number of nodes up to primary spikes was significantly higher under crop geometry 90 cm x 60 cm than 150 cm x 60 cm crop geometry. While, number of branches per plant was the significantly maximum under crop geometry at 150 cm x 60 cm. Significantly the higher values of yield attributes were recorded under crop geometry of 150 cm x 60 cm as compared to crop geometry of 90 cm x 60 cm. Both the wider crop geometry *i.e.* 150 cm x 60 cm and 120 cm x 60 cm were at par and recorded significantly higher seed and stalk yields as well as productivity per day than crop geometry of 90 cm x 60 cm. Fertilizing the castor crop with 120 kg N ha^{-1} significantly increased growth and yield parameters as well as seed and stalk yields of castor than 80 kg N ha^{-1}. Interaction effect between dates of sowing and crop geometry was significant and D_1xG_1 *i.e.* crop sown on 15^{th} September at 150 cm x 60 cm crop geometry recorded the maximum number of branches per plant, number of effective spikes per plant, seed yield per plant, seed yield of first and second pickings.

Introduction

Castor is an important non-edible oilseed crop grown during the monsoon season mainly for its seed, from which 40–50% oil is extracted. It does well both under dry land or rainfed farming and limited irrigation due to deep root-system. Its cultivation is becoming popular in north-western part of the country owing to its better performance under stress conditions and higher export potential. Newly developed genotypes of castor are different from the traditional ones in terms of morphology, duration, growth response, and productivity (Kumar *et al.*, 2003; Raghavaiah *et al.*, 2003). They also respond differently to different agro-climatic conditions. In north-western part of the country, some of rainy-season sown castor genotypes continue to produce flowers and fruits till April- May. During this period, these genotypes produce considerable amount of litter in the form of leaves, flowers, pods and twigs resulting in significant contribution to soil organic carbon content and soil organic carbon content related changes in physico-chemical properties of soil. Plant density and N requirement of genotypes vary substantially with management practices and agro-climatic conditions. Considering these factors, the present study was undertaken to evaluate the performance of 2 genotypes under different inter-row spacing and N levels in terms of productivity, economics and changes in soil physicochemical properties over the experimental period.

Materials and Methods

A fixed plot field investigation was conducted at S. D. Agricultural University, Sardarkrushinagar (Gujarat) during the *rabi* seasons of 2011-12 and 2012-13 on sandy-loam soils, having 185, 41.50 and 289 kg/ha available N, P and K respectively. The initial soil organic carbon content, pH and bulk density were 0.19%, 7.82 and 1.31 Mg/m^3 respectively. Treatment combinations comprising 3 dates of sowing (15th September, 30th September and 15th October) and three crop geometry (150 cm x 60 cm, 120 cm x 60 cm and 90 cm x 60 cm) with two levels of nitrogen (80 kg and 120 kg ha^{-1}) were laid out in a 4 times replicated split-split-plot design, where dates of sowing were allotted to main plots, crop geometry in sub plots and N levels to sub-sub plots. The crop was sown according to dates of sowing. The crop received 25 kg each of P2O5 and 20 kg sulphur at the time of field preparation. As per treatment, half dose of nitrogen was applied as basal dose and remaining quantity of nitrogen was applied as top dressing in two equal splits at 35 and 70 DAS in form of urea. The crop received 2 weedings, at 20 and 40 days after planting, and there was no need of weeding the crop thereafter. Crop received 6 irrigations during each crop season. The crop was harvested by picking of matured spikes at different growth stages. The oil content in seed was determined using nuclear magnetic resonance. Five plants were tagged randomly in the net plot area for sampling in each plot at 50 days and were used for recording growth and yield attributes of the crop under different treatments. Economics such as net returns and benefit: Cost ratios were worked out at the existing market rate. The experiment was conducted on the same site without any change in the layout plan. Bulk density, pH and soil organic carbon and available N content of soil were determined at the beginning of experiment and after harvesting of crop. For this purpose, soil samples were drawn from each treatment and analysed for these physico-chemical properties.

Results and Discussion

Effect of dates of sowing

It is evident from Table 1.1 that the plant population at 30 DAS and at harvest was not influenced significantly due to different dates of sowing during the course of investigation and in pooled data.

The results presented in Table 1.1 revealed that the effect of dates of sowing on number of branches per plant was significant. Number of branches per plant reduced significantly with each delay in sowing from 15th September to 15th October. Significantly the maximum number of branches per plant of 8.00, 7.52 and 7.76 were recorded when crop was sown on 15th September during 2011-12, 2012-13 and in pooled data also, respectively.

However, significantly the minimum number of branches per plant of 5.67, 5.37 and 5.52 were observed under late sowing *i.e.* 15th October during both the years and also in pooled data, respectively. Plants under 15th September got more number of branches for growth and development due to favourable climatic condition which might have encouraged cell division and cell expansion and led to vigorous vegetative growth. Crop under delayed sown condition experience shorter days and lower temperatures from sowing to emergence and higher temperature during the later period of growth might be decreased vegetative growth span of crop consequently resulted in poor number of branching per plant and nodes up to primary spike. These results are analogous to those reported by DOA (1995), Raghvaiah and Sudhakara (2000), Sree and Reddy (2003), Patel *et al*., (2005) and Srivastava and Chandra (2010).

Seed yield per primary spike was significantly affected due to different dates of sowing (Table 1.1). The data revealed that crop sown on 15th September recorded the maximum seed yield per primary spike and was statistically at par with 30th September sowing but these both the early sowings *viz.*, 15th September and 30th September recorded significantly superior seed yield per primary spike than late sowing *i.e.* 15th October. The seed yield per plant was significantly affected by different sowing dates are presented in Table 1.2. Each delay in sowing from 15th September to 15th October reduced seed yield significantly. Significantly the maximum (158.83, 151.30 and 155.06 g) as well as minimum (116.51, 111.13 and 113.82 g) seed yield per plant were observed when crop sown on 15th September and 15th October during the year 2011-12, 2012-13 well as in pooled data, respectively. Both the early sowings *i.e.* 15th September and 30th September were at par and recorded remarkably higher seed yield per primary spike (Table 1.1) than late sowing *i.e.* 15th October. Whereas, seed yield per plant (Table 1.2) reduced significantly with each delay in sowing from 15th September to 15th October. Respective increase in seed yield per primary spikes were 7.32 and 17.98, 5.47 and 16.15 as well as 6.41 and 17.10 during 2011-12, 2012-13 and in pooled data due to early sowings *viz.*, 15th and 30th September than late sowing *i.e.* 15th October. Reduction in seed yield per plant was due to late sowings *viz.*, 30th September and 15th October were 9.87 and 36.23 per cent as compared to early sowing *i.e.* 15th September. Better vegetative growth in term of plant height and number of branches per plant under early sowing might have responsible for increased in yield attributes which improved seed yield per primary spike and per plant. On the contrary, less time for vegetative growth under delayed sowing might be responsible for poor vegetative growth. Moreover, poor synchronization of flowering or capsules development with lowers temperature which might have affected fertilization (Nagabhushanam and Raghavaiah 2005). The results are complete agreement with those of Baby Akula and Reddy (1998), Sesha *et al.*, (2008) and Srivastava and Chandra (2010).

An appraisal of data (Table 1.2) indicated that 100-seed weight did not differ significantly due to various dates of sowing during 2011-12, 2012-13 and also in pooled data, respectively. However, delay in sowing reduced 100-seed weight slightly. Similar findings were reported by Chauhan and Yakadri (2004).

Oil yield reduced significantly with each delay in sowing from 15th September to 15th October (Table 1.2). The significantly maximum oil yield of 1114, 1015 and 1065 kg ha^{-1} was recorded under 15th September sowing during 2011-12, 2012-13 and in pooled data also. But it was the significantly lowest when crop was sown on 15th October. However, oil yield increased remarkably with each successive early in sowing from 15th October to 15th September (Table 1.2). The magnitude of increase in oil yield was to the tune of 13.0 and 40.0, 14.0 and 41.0 as well as 14.0 and 41.0 per cent with 15th September sown crop over late sown *i.e.* 30th September and 15th October crops during 2011-12, 2012-13 as well as in pooled data, respectively. The oil yield is dependent on oil content in seed and seed yield. Therefore, the higher seed yield was responsible for higher oil yield under early sown crop. Reduction, in oil yield with delayed sowing in *rabi* season was also reported by Chauhan *et al.,* (2005) and Sesha *et al.*, (2008).

Effect of crop geometry

Examination of data given in Table 1.1 indicated that varying crop geometry exhibited significant influence on plant population at 30 DAS and at harvest. Significantly the maximum plant population was observed at 30 DAS under crop geometry of 90 cm x 60 cm whereas, it was the significantly lowest under the wider spacing of 150 cm x 60 cm during both the years and in pooled data also.

Number of branches per plant in general increased with increase in spacing between two rows from 90 cm to 150 cm but significant increase was observed up to 120 cm row spacing (Table 1.1). The maximum number of branches per plant *viz.,* 7.78, 7.33 and 7.56 were recorded under crop geometry of 150 cm x 60 cm during 2011-12, 2012-13 and in pooled data, respectively and was at par with geometry of 120 cm x 60 cm. Both the wider crop geometry was significantly superior to narrow geometry of 90 cm x 60 cm. The significant effect of crop geometry was found on number of branches per plant (Table 1.1). Crop sown under wider crop geometry of 150 cm x 60 cm and 120 cm x 60 cm were at par and recorded remarkably higher number of branches per plant than with crop geometry of 90 cm x 60 cm. The per cent increase in number of branches per plant due to wider crop geometry of 150 cm x 60 cm were 3.87 and 40.69 in 2011-12, 0.83 and 40.15 during 2012-13 as well as 2.44 and 40.52 in pooled data, respectively over closer crop geometry *i.e.* 120 cm x 60 cm and 90 cm x 60 cm. Wider crop geometry provided more space around each plant resulting in more metabolic activities through better utilization of light, space, water and nutrients which might be turned in better vegetative growth in term of number of branches per plant. Dense population under closer crop geometry reduced number of branches per plant might be due to less availability of space for each plant which increased competition among the plants for available resources. These results corroborate with the findings of Lakshmamma *et al.*, (2003), Singh (2003) and Venugopal *et al.,* (2007).

Crop sown at geometry of 150 cm x 60 cm and 120 cm x 60 cm were at par and noted seed yield per primary spike of 53.87, 50.49 and 52.18 g as well as 52.01, 49.59 and 50.80 g during 2011-12, 2012-13 and in pooled data, respectively but these both the geometry were significantly higher than inter and intra row spacing of 90 cm x 60 cm. Reduction in crop geometry each from 150 cm x 60 cm to 90 cm x 60cm reduced seed yield per plant (Table 1.2) significantly. Crop sown at 150 cm x 60 cm produced the significantly maximum seed yield per plant of 175.25, 169.15 and 172.20 g during 2011-12, 2012-13 and in pooled data, respectively. However, it was the significantly lowest under crop geometry of 90 cm x 60 cm. The seed yield per primary spike (Table 1.1) and seed yield per plant (Table 1.2) were increased significantly with increase in inter row spacing up to 120 cm. The increase in seed yield per primary spike and seed yield per plant with crop geometry of 150 cm x 60 cm were to the tune of 2.72 and 7.10 and as well as 25.17 and 71.79 per cent on pooled data basis over crop geometry *viz.,* 120 cm x 60 cm and 90 cm x 60 cm, respectively**.** This was due to reflection of yield attributing characters usually achieved well under optimum availability of space, where competition within the crop plant was minimum. On the other hand, closer crop geometry might be increased competition within the crop plant which resulted in poor growth that decreased the seed yield per primary spike and seed yield per plant. The findings are in conformity with those reported by Singh (2003) and Venugopal *et al.,* (2007).

The data showed in Table 1.2 indicated that the differences in 100-seed weight did not reach the level of significance due to varying crop geometry during 2011-12, 2012-13 and in pooled data also, respectively. Though, the reduction in crop geometry causes negative effect on 100-seed weight. Non significant effect of crop geometry on 100- seed weight during both the years and in pooled data was recorded (Table 1.2). This might be due to 100-seed weight was a variety-specific attribute which was profoundly affected by genetic parameters, but its quantity was determined by the conditions at maturity period, so that these conditions could not change 100-seed weight (Jalilian *et al.,* 2005). There results were in accordance with the reported by Rana *et al.,* (2006) and Patel *et al.,* (2009).

Data given in Table 1.2 indicated that varying crop geometry exhibited significant response on oil yield. When crop was sown under geometry of 150 cm x 60 cm produced the maximum oil yield and was at par with 120 cm x 60 cm but these both the crop geometry were significantly superior than 90 cm x 60 cm during the period of investigation and in pooled data also. However, the significantly minimum oil yield of 907, 820 and 860 kg ha^{-1} was obtained under crop geometry of 90 cm x 60 cm during 2011-12, 2012-13 and in pooled data, respectively. However, oil yield (Table 1.2) increased with increasing in crop geometry from 90 cm x 60 cm to 150 cm x 60 cm but significant increase was found up to120 cm x 60 cm. Respective per cent increase in oil yield with crop geometry of 150 cm x 60 cm were to the tune of 1.0 and 10.0, 2.0 and 11.0 as well as 2.0 and 11.0 during 2011-12, 2012-13 as well as in pooled data also over crop geometry of 120 cm x 60 cm and 90 cm x 60 cm. The oil yield is dependent on oil content in seed and seed yield. Higher seed yield at crop geometry of 150 cm x 60 cm responsible for higher oil yield. The findings are in accordance with the results reported by Thadoda (1993), Vala *et al.,* (2000) and Patel *et al.,* (2009).

Effect of levels of nitrogen

The effect of varying levels of nitrogen on plant population at 30 DAS and at harvest were non-significant during 2011-12, 2012-13 and in pooled data also.

Data showed in Table 1.2 revealed that the differences in number of branches per plant were increased significantly with increase in nitrogen levels. Crop fertilized with 120 kg N ha^{-1} produced the significantly higher number of branches per plant during the course of investigation and in pooled data also than with 80 kg N ha^{-1}. Marked effect of nitrogen on number of branches per plant was recorded (Table 1.1). Significantly the more number of branches was noted with the application of 120 kg N ha^{-1} which was 28.50, 30.72 and 29.49 per cent higher during 2011-12, 2012-13 and in pooled data, respectively than application of 80 kg N ha^{-1}. Thus, increasing trend in number of branches per plant might be due to the reason that nitrogen hastens the metabolic activities in the plant body by synthesizing the tryptophan, a precursor, for the auxins, which in turn increased number of branches per plant. But under limited availability of nitrogen reduce cell division and elongation which ultimately reduced number of branches per plant. The results obtained in present study are in close agreement with those reported by Patel *et al.*, (2005) and Rana *et al.,* (2006).

An appraisal of data exhibited in Table 1.1 indicated that an application of 120 kg N ha^{-1} recorded significantly higher seed yield per primary spike of 53.41, 50.27 and 51.84 g during 2011-12, 2012-13 and in pooled data, respectively than that of with 80 kg N ha^{-1}. The Increase in nitrogen levels from 80 to 120 kg ha^{-1} increased seed yield per plant significantly. The seed yield per plant of 143.59, 137.04 and 140.31 g recorded with application of 120 kg N ha^{-1} which was significantly higher than that of with 80 kg N ha^{-1} during 2011-12, 2012-13 and in pooled data, respectively. The increase in level of nitrogen from 80 to 120 kg ha^{-1} increased seed yield per primary spike (Table 1.1) and seed yield per plant (Table 1.2) significantly. As compared to 80 kg N ha^{-1}, the per cent increase in seed yield per primary spike and per plant with 120 kg N ha^{-1} were 5.35 and 5.34 in 2011-12, 4.95 and 5.63 in 2012-13 as well as 5.15 and 5.47 in pooled data, respectively. This might be due to higher supply of nitrogen sustained the uptake of nitrogen at later crop growth stages which improve vegetative and reproductive growth. Inadequate availability of nitrogen might have produced poor vegetative growth as well as reproductive growth which finally led to less seed yield per primary spike and plant. The results are in complete agreement with those of Patel *et al.,* (2005) and Venugopal *et al.*, (2007).

Effect of varying levels of nitrogen on 100-seed weight (Table 1.2) was not reach the level of significant during both the years as well as in pooled data. But increase in nitrogen levels showed it beneficial effect on 100-seed weight. Increase the levels of nitrogen from 80 to 120 kg ha^{-1} increased oil yield significantly. The oil yield of 1029, 934 and 981 kg ha^{-1} was produced by 120 kg N ha^{-1} which was significantly higher than the application of 80 kg N ha^{-1} during 2011-12, 2012-13 and in pooled data, respectively. Unlike these, oil yield was significantly higher with 120 kg N ha^{-1} than 80 kg N ha^{-1}. The magnitude of increase in oil yield with application of 120 kg N ha^{-1} was 14.20 per cent than 80 kg N ha^{-1}. Oil yield is dependent on oil content in seed and seed yield. Increase in seed yield with increase in nitrogen levels might be increased the oil yield. The results obtained in present study are in close agreement with those reported by Thadoda (1993), Sree and Reddy (2003), Kathmale *et al.*, (2008) and Patel *et al.*, (2010).

Significant interaction effects

The data presented in Table 1.1.1 indicated that the significant interaction effect was observed due to dates of sowing and crop geometry. The significantly highest number of branches per plant of 9.81, 9.04 and 9.42 were recorded when crop sown on 15th September with crop geometry of 150cm × 60cm (D_1G_1) during 2011-12, 2012-13 and in pooled data, respectively. Each delay in sowing from 15th September to 15th October reduced number of branches per plant significantly in wider spacing *i.e.* 150cm × 60cm. Whereas, under closer spacing *viz.*, 90 cm x 60 cm both the late sowings remain at par and recorded significantly lower number of branches per plant than early sowing *i.e.* 15th September. Under crop geometry of 120 cm × 60 cm differences between both the early sowings were at par but significantly higher than late sowing.

Table.1 Plant population of rabi castor at 30 DAS, number of branches per plant and seed yield per primary spike (g) as influenced by varying crop geometry and dates of sowing with levels of nitrogen

Treatments		Plant population per hectare at 30 DAS			Number of branches per plant			Seed yield per primary spike (g)		
		2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Dates of sowing (D)										
(D_1)	15th September	14423	14411	14417	8.00	7.52	7.76	56.18	52.42	54.30
(D_2)	30th September	14338	14226	14282	7.13	6.94	7.04	52.35	49.70	51.03
(D_3)	15th October	14323	14178	14250	5.67	5.37	5.52	47.62	45.13	46.37
	S.Em.±	206	231	201	0.15	0.15	0.15	1.15	1.17	1.16
	C.D. at 5 %	NS	NS	NS	0.53	0.53	0.53	3.98	4.02	3.99
	C.V. (%)	7.02	8.10	7.00	10.78	11.37	11.06	10.85	11.63	11.20
Crop geometry (G)										
(G_1)	150cm X 60cm	10988	10862	10925	7.78	7.33	7.56	53.87	50.49	52.18
(G_2)	120cm X 60cm	13697	13550	13623	7.49	7.27	7.38	52.01	49.59	50.80
(G_3)	90cm X 60cm	18399	18403	18401	5.53	5.23	5.38	50.27	47.17	48.72
	S.Em.±	238	317	265	0.14	0.13	0.13	0.95	0.89	0.92
	C.D. at 5 %	704	938	786	0.40	0.37	0.39	2.81	2.64	2.72
	C.V. (%)	8.10	10.87	9.08	9.54	9.30	9.42	8.93	8.89	8.89
Nitrogen levels (N)										
(N_1)	80 kg ha^{-1}	14345	14262	14303	6.07	5.73	5.90	50.70	47.90	49.30
(N_2)	120 kg ha^{-1}	14378	14282	14330	7.80	7.49	7.64	53.41	50.27	51.84
	S.Em.±	223	215	214	0.12	0.11	0.12	0.83	0.81	0.82
	C.D. at 5 %	NS	NS	NS	0.35	0.33	0.34	2.41	2.34	2.37
	C.V. (%)	9.30	9.06	8.95	10.37	10.32	10.34	9.60	9.87	9.71
Sig. Interaction		-	-	-	DxG	DxG	DxG	-	-	-

Table.2 Seed yield per plant (g), 100-seed weight (g) and oil yield (kg ha-1) as influenced by varying crop geometry and dates of sowing with levels of nitrogen on rabi castor

Treatments		**Seed yield per plant (g)**			**100-seed weight (g)**			**Oil yield (kg ha^{-1})**		
		2011-12	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**	**2011-12**	**2012-13**	**Pooled**
Dates of sowing (D)										
(D_1)	15th September	158.83	151.30	155.06	29.95	29.84	29.90	1114	1015	1065
(D_2)	30th September	144.51	137.75	141.13	28.14	28.03	28.09	985	889	937
(D_3)	15th October	116.51	111.13	113.82	26.78	26.46	26.62	797	719	758
	S.Em.±	3.01	3.35	3.18	0.72	0.76	0.74	31	33	32
	C.D. at 5 %	10.38	11.57	10.97	NS	NS	NS	106	115	111
	C.V. (%)	10.53	12.32	11.40	12.45	13.25	12.79	15.63	18.66	17.03
Crop geometry (G)										
(G_1)	150cm X 60cm	175.25	169.15	172.20	28.61	28.44	28.53	1001	912	957
(G_2)	120cm X 60cm	140.96	134.19	137.57	28.44	28.22	28.33	989	891	940
(G_3)	90cm X 60cm	103.64	96.84	100.24	27.82	27.67	27.75	907	820	863
	S.Em.±	2.46	2.48	2.45	0.53	0.53	0.53	26	25	26
	C.D. at 5 %	7.27	7.35	7.27	NS	NS	NS	78	76	77
	C.V. (%)	8.60	9.12	8.80	9.23	9.18	9.18	13.42	14.28	13.78
Nitrogen levels (N)										
(N_1)	80 kg ha^{-1}	136.31	129.74	133.03	27.84	27.58	27.71	902	815	859
(N_2)	120 kg ha^{-1}	143.59	137.04	140.31	28.74	28.65	28.69	1029	934	981
	S.Em.±	2.29	2.32	2.30	0.43	0.44	0.43	26	23	24
	C.D. at 5 %	6.62	6.73	6.65	NS	NS	NS	74	67	70
	C.V. (%)	9.82	10.46	10.09	9.08	9.45	9.22	15.90	15.93	15.85
Sig. Interaction		D x G	D x G	D x G	-	-	-			

Table.3 Interaction effect of crop geometry and date of sowing on number of branches plant per plant during 2011-12, 2012-13 and in pooled results

Dates of sowing /Geometry	2011-12			2012-13			Pooled		
	G_1	G_2	G_3	G_1	G_2	G_3	G_1	G_2	G_3
D_1	9.81	8.10	6.10	9.04	7.93	5.60	9.42	8.01	5.85
D_2	8.35	7.83	5.23	7.96	7.73	5.14	8.15	7.78	5.18
D_3	5.27	6.54	5.20	5.00	6.15	4.95	5.14	6.35	5.08
S.Em.±	0.23			0.22			0.23		
C.D. at 5 %	0.69			0.64			0.67		
C.V. (%)	9.54			9.30			9.42		

Table.4 Interaction effect of crop geometry and date of sowing on seed yield per plant (g) during 2011-12, 2012-13 and in pooled results

Date of sowing / Geometry	2011-12			2012-13			Pooled		
	G_1	G_2	G_3	G_1	G_2	G_3	G_1	G_2	G_3
D_1	201.17	161.11	114.20	193.64	153.35	106.90	197.41	157.23	110.55
D_2	181.97	147.01	104.56	175.37	139.05	98.83	178.67	143.03	101.69
D_3	142.61	114.77	92.15	138.43	110.16	84.80	140.52	112.46	88.48
S.Em.±	4.25			4.30			4.25		
C.D. at 5 %	12.60			12.74			12.59		
C.V. (%)	8.60			9.12			8.80		

Significant interaction effect was recorded between dates of sowing and crop geometry during 2011-12, 2012-13 and in pooled data also (Table 1.1.2). The significantly maximum seed yield per plant was recorded when crop sown on 15th September with geometry of 150 cm x 60 cm (D_1G_1). Significantly the lowest seed yield per plant was recorded when crop was sown 15th October at 90 cm x 60 cm crop geometry (D_3G_3) during both the years as well as in pooled data except in 2011-12. Each delay in sowing with reduced inter row spacing from 150 cm to 90 cm decreased seed yield per plant significantly during course of investigation and in pooled data except during 2011-12 where difference between late sowings *i.e.* 30th September or 15th October as well as crop geometry of 90 cm x 60 cm were non significant.

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