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Cultivar and sowing date effect on yield attributes and yield parameters of redgram (*Cajanus cajan* L.)

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Abstract
A field investigation on "Cultivar and sowing date effect on productivity of redgram (*Cajanus cajan* L.)" was conducted during *kharif*, 2019 at college farm, Agricultural College, Mahanandi of Acharya N. G. Ranga Agricultural University. The experimental site was sandy loam soil and it was neutral in reaction with a pH of 7.38, EC of 0.20 ds m^{-1}. The experiment was laid out in randomized block design with factorial concept (FRBD) having twelve treatments and three replications. The experiment comprised three redgram cultivars *viz.*, C_1: LRG-52; C_2: PRG-176 and C_3: ICPL-87119 and four sowing dates *viz.*, D_1: 2nd FN of June; D_2: 1st FN of July; D_3: 2nd FN of July and D_4: 1st FN of August. Among the cultivars tried, C_3 (ICPL-87119) recorded significantly highest range of pods $plant^{-1}$(822), seed yield (1405 kg ha^{-1}) and haulm yield (5352 kg ha^{-1}) than other cultivars, which is on par with C_1 (LRG-52) at harvest. C_1 (LRG-52) recorded more number of grains pod^{-1} (4.2) and test weight (12.9 g) over other cultivars. The highest harvest index (15.51%) was found in C_2 (PRG-176) than other cultivar, which is on par with C_3 (ICPL-87119). Among the sowing dates, D_2 (1st FN of July) produced significantly highest number of pods $plant^{-1}$ (723), test weight (12.8 g), seed yield (1432 kg ha^{-1}), haulm yield (5342 kg ha^{-1}) and harvest index (15.66%) than other rest of sowing dates at harvest, which is on par with D_1(2nd FN of June). The number of grains pod^{-1} (4.2) were significantly in D_1 (2nd FN of June), which is however on par with D_2 (1st FN of July) over other sowing dates.

Keywords: Cultivars, sowing dates, redgram, pods $plant^{-1}$, grains pod^{-1}, test weight, seed yield, haulm yield, harvest index

Introduction
Redgram [*Cajanus cajan* L.] commonly known as pigeonpea, arhar or tur. It is most drought tolerant crop among pulses with deep root system, often cross pollinated, C3 plant and short day plant. Redgram is one of the important pulse crop grown in India under different agro-climatic conditions. It is the second most important pulse crop after the gram and an important *kharif* crop within the country. India ranks first in area and production within the world with 80 and 77% of world's area and production, respectively. Pigeonpea is especially cultivated and consumed in developing countries of the globe. Pigeonpea could be a more protein made staple food. It contains 22% of protein, which is nearly 3 times that of cereals. Pigeonpea provides a major share of protein demand of vegetarian population of the country

Various factors responsible for low yield of redgram at the farmer's fields are unawareness of farmers about optimum sowing date, suitable variety, improper plant population, insufficient plant protection and imbalanced use of fertilizers. Time of seeding and appropriate variety is most important agronomic factors for realizing the yield potential of improved varieties.

Time of sowing is a non-monetary input, which will influence the growth and yield of the redgram. Sowing time has prominent influence on vegetative and reproductive stages of pigeonpea. It also depends on crop duration and vigor of genotype. Date of sowing determines time of flowering and dry matter accumulation, seed set and seed yield. Redgram is known to be sensitive to photoperiod and temperature. Early sowing produces more number of pods $plant^{-1}$ and seeds pod^{-1}, which results in higher yields. Hence, it is necessary to identify the best sowing time which are suited to changes in the environment on sustained production. Delayed sowing beyond the optimum period produced less grain yields of pigeonpea (Kumar *et al.*, 2008) [3].

Besides appropriate sowing date, cultivars are utmost importance for yield potential in any crop and for the better utilization of the resources. Cultivars may vary in productivity and are equally important in realizing the potential yield of crop.

Materials and methods

The field experiment was conducted to study the **"Cultivar and sowing date effect on productivity of redgram (*Cajanus cajan* L.)"** at college farm, Agricultural College, Mahanandi during *kharif* season of 2019. The experiment was conducted in Agricultural college farm, Mahanandi campus of Acharya N. G. Ranga Agricultural University, which is situated geographically at 15^0.51' N latitude and 78^0.61' E longitude with an altitude of 233.5 meters above the mean sea level in scarce rainfall zone of Andhra Pradesh and according to Troll's classification, it falls under Semi-Arid Tropics (SAT). The experimental site was sandy loam and it was neutral in reaction with a P^H of 7.38, EC of 0.20 ds m^{-1}, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in Randomized Block Design with factorial concept (FRBD) having twelve treatments and three replications. The experiment comprised three redgram cultivars *viz.*, C_1: LRG-52; C_2: PRG-176 and C_3: ICPL-87119 and four sowing dates *viz.*, D_1: 2nd FN of June; D_2: 1st FN of July; D_3: 2nd FN of July and D_4: 1st FN of August. The weekly mean maximum temperature during the crop period (24-06-2019 to 18-02-2020) ranged from 28.7ºC to 34.4ºC, with an average of 30.9ºC. The weekly mean minimum temperature ranged from 17.9ºC to 26.5ºC, with an average of 22.2ºC. The weekly mean relative humidity during the crop period ranged from 74.7 per cent to 98.5 per cent, with an average of 93.3 per cent. The rainfall received and number of rainy days during the crop growth period was 1355 mm and 49, respectively.

Results and discussion

The result of present investigation, cultivars and sowing dates significantly influence the number of pods $plant^{-1}$, number of grains pod^{-1}, test weight (100 seed weight), seed yield, haulm yield and harvest index presented in Table 1 and Table 2.

Among cultivars, more number of pods $plant^{-1}$ (822) were found in C_3 (ICPL-87119) over other cultivars, while less number of pods $plant^{-1}$ (355) were recorded in C_2 (PRG-176). The more number of pods $plant^{-1}$ were recorded in early sown cultivar C_3 (ICPL-87119) at all dates of sowing tried in experimentation. This might be due to genetic makeup of cultivar that has helped in improving photosynthetic activity due to increased source capacity and efficient translocation of photosynthates to the sink and similar results were reported earlier by Parameshwarappa (2002) [5] and Kashyap *et al*. (2003). Significantly more number of grains pod^{-1} (4.2) was produced in C_1 (LRG-52), while less number of grains pod^{-1}(3.2) was found in C_3 (ICPL-87119). This might be due to more production, efficient translocation of photosynthates to the sink and bold seed nature of LRG-52. The results of more number of grains pod^{-1} are in close conformity with the results of Sahajadeva *et al.* (2019) [8]. C_3 (ICPL-87119) cultivar recorded highest seed yield (1405 kg ha^{-1}) and haulm yield (5352 kg ha^{-1}) which is statistically superior over C_1 (LRG-52) and C_2 (PRG-176). Significantly highest seed and haulm yield was obtained in early sown redgram over delayed sowings. The results are in close association with the findings of Parameshwarappa (2002) [5], Pramod *et al*. (2010) [7] and Kumar *et al*. (2018) [4]. The highest harvest index (15.51) was produced in C_2 (PRG-176), which is on par with C_3 (ICPL-87119).

Among the sowing dates, significantly more number of pods $plant^{-1}$ (723) were recorded in D_2 (1st fort night of July), which is on par with D_1 (2nd fort night of June) (703), but higher number of grains pod^{-1} (3.8) was recorded in D_1 (2nd fort night of June), which is on par with D_2 (1st fort night of July) (3.7) over rest of sowing dates, while less number of pods $plant^{-1}$ (362) and number of grains pod^{-1} (3.5) were recorded by D_4 (1st fortnight of August). The early sown redgram produced more number of pods $plant^{-1}$ and number of grains pod^{-1} than delayed sowings. This might be due to early sowing, which enjoyed favorable weather conditions like light, temperature, precipitation and genetic makeup of cultivar that has helped in improving photosynthetic activity due to increased source capacity and efficient translocation of photosynthates to the sink. The similar results were reported by Vijaykumar (1997) [9]. The crop sown during D_2 (1st fort night of July) produced highest seed (1432 kg ha^{-1}) and haulm yield (5342 kg ha^{-1}), which is on par with seed (1401 kg ha^{-1}) and haulm yield (5336 kg ha^{-1}) of D_1 (2nd fort night of June) than other sowing dates, while lowest seed (799 kg ha^{-1}) and haulm yield (3503 kg ha^{-1}) were recorded by D_4 (1st fortnight of August).

This might be due to favorable weather conditions like light, temperature, precipitation, which promoted better growth and inherited genetic makeup of cultivar resulting in higher growth parameters and yield attributing characters like number of pods $plant^{-1}$. It may be the result of maximum translocation of photosynthates towards seed formation in early sown crop. The results are in same line with the results of Vijaykumar (1997) [9], Dahariya *et al*. (2018) [1] and Kumar *et al*. (2018) [4]. The highest harvest index (15.66%) was found in D_2 (1st fort night of July), which is in parity with D_1 (2nd fort night of June) (15.36%) than rest of sowing dates, while lowest harvest index was recorded by D_4 (1st fortnight of August) (13.24%). Harvest index was significantly highest in early sown crop over other sowing dates. This might be attributed to high assimilate use efficiency with increased sink capacity for a longer period of time. These results are closely in conformity with the findings of Pramila and Rajireddy (2010) [6].

Statistically significant interaction existed among the cultivars and sowing dates on number of pods $plant^{-1}$, number of grains pod^{-1}, seed yield, haulm yield and harvest index. The C_3D_2 (1115) treatment recorded more number of pods $plant^{-1}$, which is on par with C_3D_1 (1065) treatment than other treatments, while less number of pods $plant^{-1}$ (155) were produced in C_2D_4. The C_1D_1 and C_1D_2 treatment recorded more number of grains pod^{-1} (4.3), which is on par with C_1D_3 (4.1) treatment, while less number of grains pod^{-1} was produced in C_3D_4 and C_3D_3 (3.2) treatments over other treatment combinations. The C_3D_2 (1914 kg ha^{-1}) treatment recorded highest seed yield, which is on par with C_3D_1 (1879 kg ha^{-1}) treatment. The C_1D_2 (6058 kg ha^{-1}) recorded highest haulm yield, which is on par with C_3D_2 (5995 kg ha^{-1}) and C_3D_1 (5936 kg ha^{-1}) while C_2D_4 (550 kg ha^{-1}) and C_2D_3 (2545 kg ha^{-1}) recorded lowest seed and haulm yield, respectively. The treatment C_2D_3 (18.03%) recorded highest harvest index, which is on par with C_3D_2 (17.78%) and C_3D_1 (17.49%), while lowest harvest index was recorded in C_1D_3 (8.53%).

Table 1: Cultivar and sowing date effect on yield attributes of redgram.

Treatments	Number of pods plant^{-1}	Number of grains pod^{-1}	Test weight (g)
Cultivars (C)			
C_1 : LRG-52	550	4.2	12.9
C_2 : PRG-176	355	3.6	12.2
C_3 : ICPL-87119	822	3.2	11.8
SE (m)±	15.2	0.02	0.23
CD (p = 0.05)	45	0.1	0.7
Sowing date (D)			
D_1 : 2nd FN of June	703	3.8	12.6
D_2 : 1st FN of July	723	3.7	12.8
D_3 : 2nd FN of July	515	3.6	12.0
D_4 : 1st FN of August	362	3.5	11.8
Cultivars			
SE (m)±	17.6	0.03	0.26
CD (p = 0.05)	52	0.1	0.8
(Interaction) C X D			
SE (m)±	30.5	0.05	0.45
CD (p = 0.05)	89	0.1	NS

Table 2: Interaction among cultivars and sowing dates on number of pods plant^{-1}.

Treatment	Number of Pods plant^{-1}				
	D_1	**D_2**	**D_3**	**D_4**	**Mean**
C_1	610	617	387	589	550
C_2	434	437	392	155	355
C_3	1065	1115	764	343	822
Mean	703	723	515	362	

Table 3: Interaction among cultivars and sowing dates on number of grains pod^{-1}.

Treatment	Number of grains pod^{-1}				
	D_1	**D_2**	**D_3**	**D_4**	**Mean**
C_1	4.3	4.3	4.1	3.9	4.2
C_2	3.8	3.6	3.5	3.4	3.6
C_3	3.3	3.3	3.2	3.2	3.2
Mean	3.8	3.7	3.6	3.5	

Table 4: Cultivar and sowing date effect on yield parameters of redgram.

Treatments		Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index (%)
Cultivars (C)				
C_1 :	LRG-52	1002	5001	12.74
C_2 :	PRG-176	986	3329	15.51
C_3:	ICPL-87119	1405	5352	14.92
SE (m)±		14.2	54.8	0.2
CD (p = 0.05)		42	161	0.60
Sowing date (D)				
D_1:	2nd FN of June	1401	5336	15.36
D_2:	1st FN of July	1432	5342	15.66
D_3:	2nd FN of July	893	4061	13.30
D_4:	1st FN of August	799	3503	13.24
Cultivars				
SE (m)±		16.4	63.2	0.2
CD (p = 0.05)		48	185	0.69
(Interaction) C X D				
SE (m)±		28.4	109.5	0.4
CD (p = 0.05)		83	321	1.2

Table 5: Interaction among cultivars and sowing dates on seed yield (kg ha^{-1}).

Treatments	Seed yield				
	D_1	**D_2**	**D_3**	**D_4**	**Mean**
C_1	1153	1183	591	1080	1002
C_2	1170	1200	1025	550	986
C_3	1879	1914	1063	766	1405
Mean	1401	1432	893	799	

Table 6: Interaction among cultivars and sowing dates on haulm yield (kg ha^{-1}).

Treatments	Haulm yield				
	D_1	**D_2**	**D_3**	**D_4**	**Mean**
C_1	5920	6058	4788	3237	5001
C_2	4153	3942	2545	2678	3329
C_3	5936	5995	4850	4593	5352
Mean	5336	5342	4061	3503	

Table 7: Interaction among cultivars and sowing dates on harvest index (%).

Treatments	Harvest index				
	D_1	**D_2**	**D_3**	**D_4**	**Mean**
C_1	12.55	12.81	8.53	17.06	**12.74**
C_2	15.63	16.37	18.03	11.59	**15.51**
C_3	17.49	17.78	13.34	11.07	**14.92**
Mean	**15.36**	**15.66**	**13.30**	**13.24**	

Conclusion

The cultivar C_3 (ICPL-87119) recorded higher seed and haulm yield over other cultivars. Among the sowing dates, D_2 (1st fort night of July) gave better yields, which is on par with D_1 (2nd fort night of June) over other sowing dates. Cultivar C_3 (ICPL-87119) sown on D_2 (1st fort night of July) produced significant higher yields, which is on par with sown on D_1 (2nd fort night of June) than other combinations.

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