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RESEARCH PAPER

Effect of sowing time and planting geometry on growth and yield of pigeonpea in northern dry zone (Zone 3) of Karnataka

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Abstract: A field experiment was conducted at College of Agriculture, Vijayapura, to study the effect of sowing time and planting geometry on growth and yield of pigeonpea in Northern Dry Zone (Zone 3) of Karnataka during 2015-16. There were 16 treatments consisting of combinations of four sowing times *viz.,* June II fortnight, July I fortnight, July II fortnight and August I fortnight and four planting geometries *viz.,* 90 cm x 20 cm, 120 cm x 20 cm, 150 cm x 20 cm and 180 cm x 20 cm. The experiment was laid out in split-plot design and replicated thrice. The experimental results revealed that, the growth and yield of pigeon pea were significantly influenced by sowing time. Pigeonpea sown during June II fortnight recorded significantly higher grain yield (1311 kg ha^{-1}) compared to pigeonpea sown during July I fortnight (1151 kg ha^{-1}), July II fortnight (212 kg ha^{-1}) and August I fortnight (264 kg ha^{-1}). Similarly, different planting geometries influenced the grain yield of pigeonpea significantly. Pigeonpea sown at planting geometry of 90 cm x 20 cm produced significantly higher grain yield of 859 kg ha^{-1} as compared to other planting geometries, but it was on par with 120 cm x 20 cm (777 kg ha^{-1}) planting geometry. Interactions of sowing time and planting geometries influenced both the grain yield and economics of pigeonpea. Pigeonpea sown during June II fortnight with planting geometry of 90 cm x 20 cm recorded significantly higher grain yield (1537 kg ha^{-1}), net returns (₹ 1,15,664 ha^{-1}) and benefit cost ratio (6.10) over other interactions, but it was on par with crop sown during same period with 120 cm x 20 cm planting geometry (1400 kg ha^{-1}, ₹ 1,03,304 ha^{-1} and 5.56, respectively).

Key words: Planting geometry, Pigeonpea, Sowing time, Yield

Introduction

In Indian agriculture, pulses are gaining more important position. After green revolution, India became self-sufficient in case of food grain production. However, India still lagging behind in case of pulses production and is dependent on imports from other countries for the domestic consumption. Among the pulses, pigeonpea is the second most important pulse crop after chickpea. It is a major source of dal, which is important constituent in the food habit of Indian people. A variability of 23.3 per cent protein in pigeonpea makes it an important source for supplementing the energy rich cereal diet (Anon., 2010). In India, pigeonpea is grown in an area about 3.73 million ha producing 2.81 million tonnes with an average productivity of 764 kg ha^{-1} (Anon., 2015). India has a virtual monopoly in pegionpea production by contributing 90 per cent of world's total production. In India, it is mainly grown in Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat, Telangana and Tamil Nadu. These states constitute 90 per cent of the area and production of pegionpea. It is the most important pulse crop of Karnataka having an area of 7.12 lakh ha with a production of 5.07 lakh tonnes at an average productivity of 712 kg ha^{-1} (Anon., 2015).

The yield of this crop is greatly influenced by number of factors such as agronomic, pathogenic, entomological, genetic and their interaction with environment. Among the different agronomic practices, choice of a suitable planting geometry and sowing time for a particular genotype are the most important factors responsible for enhancing the grain yield. Time of sowing, a non-monetary input, has a considerable influence on growth and yield of this crop. It ensures the complete harmony between vegetative and reproductive phases on one hand and climatic rhythm on the other hand. Sowing time determines the time available for vegetative growth before flowering which is mainly influenced by photoperiod. The new plant types possess substantially different growth pattern and are sensitive to planting geometry. To choice of a suitable geometry and population for a particular genotype are the important factors, which influence the crop yield. Adaptation of proper planting geometry to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield.

Material and methods

A field experiment was conducted at College of Agriculture, Vijayapura, to study the effect of date of sowing and planting geometry on growth and yield of pigeonpea in Northern Dry Zone of Karnataka during *kharif* 2015-16 under rainfed conditions. The experiment was laid out in a split plot design with three replications. There were four sowing times as main plots viz., June II fortnight (D_1), July I fortnight (D_2), July II fortnight (D_3) and August I fortnight (D_4) and four planting geometries as sub plots *viz.,* 90 cm x 20 cm (S_1), 120 cm x 20 cm (S_2), 150 cm x 20 cm (S_3) and 180 cm x 20 cm (S_4). The soil of the experimental site was medium deep black with pH 7.69 and 0.41% organic carbon. The available N, P_2O_5 and K_2O contents were 104.0, 22.5 and 357.2 kg ha^{-1}, respectively. During the experimentation, a total rainfall of 651.1 mm in 35 rainy days was received. The rainfall received during the period from May to end of October was 568 mm, while 83.1 mm rainfall was received during rest of the period. Higher rainfall was received during June and September months (100.7 and 257.2 mm, respectively). The data collected from the experiment at different growth stages were subjected to statistical analysis as described by Gomez and Gomez (1984).The level of significance used for 'F' and 't' tests was P=0.05. Critical difference (CD) values were calculated at 5 per cent probability level wherever the 'F' test was found to be significant.

Results and discussion

Effect of sowing time

The grain yield of pigeonpea decreased significantly with every fortnight delay in sowing time and the reduction was more conspicuous from July I fortnight to August I fortnight than from June II fortnight to July I fortnight. Crop sown during June II fortnight recorded significantly higher grain yield (1311 kg ha^{-1}) over July I fortnight (1151 kg ha^{-1}) which in turn was significantly superior than July II fortnight (212 kg ha^{-1}) and August I fortnight (264 kg ha^{-1}) sowing dates. The extent of yield reduction was 12.2% with July I fortnight, 83.8% with July II fortnight and 79.9% with August I fortnight sowings compared to June II fortnight (Table 1).

Significantly higher grain yield obtained with the crop sown during June II fortnight might be due to higher growth and yield attributing characters *viz.,* plant height (161.6 cm), number of primary branches plant^{-1} (15.1), total dry matter accumulation (203.8 g), leaf area index at 135 DAS (2.18), number of pods plant^{-1} (197.3) and grain yield plant^{-1} (61.8 g) as compared to other sowing times (Table 2). Higher growth and yield attributes with early sowing during June II fortnight might be due to availability of more time for growth and development of pigeonpea as indicated by more days taken to 50% flowering and also availability of adequate natural resources *viz.,* solar radiation, soil moisture and nutrients. Malik and Ashok (2014), Patel *et al.* (2000) and Hari Ram *et al.* (2011) were also observed higher grain yield and number of pods per plant with early sowing compared to delayed sowing dates.

Effect of planting geometry

Planting geometry of 90 cm x 20 cm recorded significantly higher grain yield (859 kg ha^{-1}) over planting geometries of 150 cm x 20 cm (663 kg ha^{-1}) and 180 cm x 20 cm (639 kg ha^{-1}), however, it was on par with planting geometry of 120 cm x 20 cm

Table 1. Yield and economics of pigeonpea as influenced by sowing times and planting geometry

Treatments	Grain yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	BC ratio
Date of sowing					
June II fortnight (D_1)	1311	2482	117960	95294	5.20
July I fortnight (D_2)	1151	1262	103620	81194	4.62
July II fortnight (D_3)	212	360	19103	-3084	0.86
August I fortnight (D_4)	264	421	23738	1792	1.08
S.Em±	40	166	3562	3562	0.16
C.D. at 5%	137	574	12324	12324	0.59
Planting geometry					
90 cm x 20 cm (S_1)	859	1323	77295	54989	3.44
120 cm x 20 cm (S_2)	777	1392	69968	47662	3.11
150 cm x 20 cm (S_3)	663	1008	59640	37334	2.65
180 cm x 20 cm (S_4)	639	800	57518	35212	2.56
S.Em±	33	108	2976	2976	0.13
C.D. at 5%	96	327	8686	8686	0.38
Interaction (Date of sowing x Planting geometry)					
D_1S_1	1537	2715	138330	115664	6.10
D_1S_2	1400	3259	125970	103304	5.56
D_1S_3	1177	2235	105960	83294	4.67
D_1S_4	1129	1718	101580	78914	4.48
D_2S_1	1280	1268	115230	92804	5.14
D_2S_2	1208	1464	108720	86294	4.85
D_2S_3	1028	1291	92520	70094	4.13
D_2S_4	1089	1024	98010	75584	4.37
D_3S_1	273	691	24540	2354	1.11
D_3S_2	212	299	19110	-3076	0.86
D_3S_3	225	244	20250	-1936	0.91
D_3S_4	139	206	12510	-9676	0.56
D_4S_1	345	620	31080	9134	1.42
D_4S_2	290	547	26070	4124	1.19
D_4S_3	220	264	19830	-2116	0.90
D_4S_4	200	253	17970	-3976	0.82
S.Em±	66	217	5952	5952	0.26
C.D. at 5%	193	634	17372	17372	0.77

Market price : Pigeon pea grain = ₹ 90 kg^{-1}

Table 2. Growth and yield attributes of pigeonpea as influenced by sowing time and planting geometry

Treatments	Plant height (cm)	Number of branches per plant	Days to 50 % flowering	Total dry matter accumulation	Number of pods plant^{-1}	Grain weight plant^{-1} (g)
Date of sowing						
June II fortnight (D_1)	161.6	15.1	96	203.8	197.3	61.8
July I fortnight (D_2)	130.5	13.1	91	93.2	91.2	38.1
July II fortnight (D_3)	96.3	13.2	86	83.0	61.0	21.4
August I fortnight (D_4)	91.3	12.2	85	62.0	37.5	12.5
S.Em±	4.56	0.39	0.60	2.69	4.6	2.40
C.D. at 5%	13.98	1.32	2.08	9.31	16.0	8.33
Planting geometry						
90 cm x 20 cm (S_1)	122.3	14.1	90	105.8	85.8	26.9
120 cm x 20 cm (S_2)	119.8	12.7	90	106.0	77.3	27.4
150 cm x 20 cm (S_3)	119.5	14.1	90	107.6	115.2	39.5
180 cm x 20 cm (S_4)	118.2	13.8	90	122.8	108.7	39.9
S.Em±	4.05	0.37	0.13	3.86	4.9	2.70
C.D. at 5%	NS	1.26	NS	11.25	14.19	7.86
Interaction (Date of sowing x Planting geometry)						
D_1S_1	157.6	17.5	96	188.7	166.9	45.9
D_1S_2	168.8	15.1	96	199.3	135.9	44.1
D_1S_3	159.3	15.3	97	195.0	259.6	83.5
D_1S_4	160.6	13.9	96	232.3	226.7	73.7
D_2S_1	134.4	13.8	91	90.8	88.4	32.6
D_2S_2	126.7	12.5	91	83.3	81.8	33.3
D_2S_3	135.0	14.7	92	93.0	92.0	38.4
D_2S_4	125.8	14.5	91	105.7	102.7	48.1
D_3S_1	108.0	13.8	87	83.1	57.8	19.3
D_3S_2	95.1	11.7	86	80.4	51.3	19.4
D_3S_3	89.6	15.5	86	80.5	73.4	24.2
D_3S_4	92.2	14.0	86	88.0	61.7	22.9
D_4S_1	89.0	11.1	85	60.4	30.1	9.8
D_4S_2	88.6	12.9	86	60.9	40.4	13.0
D_4S_3	93.9	12.2	85	61.7	35.7	12.0
D_4S_4	93.9	13.8	86	65.2	43.7	15.0
S.Em±	7.10	0.73	0.25	7.71	9.7	5.2
C.D. at 5%	21.29	2.13	0.73	22.51	28.4	15.74

(777 kg ha^{-1}) (Table 1). The higher grain yield in 90 cm x 20 cm planting geometry was also attributed to reasonably higher growth and yield parameters like plant height (122.3 cm) and number of primary branches plant^{-1} (14.1) (Table 1)and stalk yield ha^{-1} (1323 kg ha^{-1}) (Table 2). Higher grain yield with 90 cm x 20 cm and 120 cm x 20 cm planting geometries (55555 and 41, 666 plants ha^{-1} ,respectively) was mainly attributed to higher plant population accommodated per unit area compared to 150 cm x 20 cm (33,333 plants ha^{-1}) and 180 cm x 20 cm (27,777 plants ha^{-1}).

Though the individual plant performance with respect to growth and yield attributes were better in wider planting geometries (150 cm x 20 cm and 180 cm x 20 cm) as compared to closer planting geometries (90 cm x 20 cm and 120 cm x 20 cm), but they could not compensate the loss in plant population as compared to closer planting geometries. Hence, significantly lower grain yield per hectare was recorded in case of wider planting geometries as compared to closer planting geometries. Similarly, Girimallappa *et al.* (2012) reported higher grain yield at 90 cm x 20 cm compared to 120cm x 20cm and 120cm x 60cm planting geometries, while Mallikarjun *et al.* (2014) noticed higher grain yield of pigeon pea at 120cm x 90cm over 90cm x 30cm and 90cm x 60cm planting geometries.

Interaction effect of sowing time and planting geometry

Higher grain yield was obtained with the interaction of crop sown during June II fortnight with 90 cm x 20 cm planting geometry (1537 kg ha^{-1}) and which was at par with crop sown during June II fortnight at 120 cm x 20 cm (1400 kg ha^{-1}) and both were significantly superior over other interactions (Table 1). Higher grain yield with these interactions was mainly due to higher growth components like plant height (157.6 cm), primary branches plant^{-1} (17.5), leaf area index (2.08) and higher stalk yield (2715 kg ha^{-1}) and positive association between yield parameters mainly number of pods plant^{-1} (166.9) and grain weight plant^{-1} and populations compared to other interactions (Table 2). This might be due to long growing period and better utilization of available natural resources like solar radiation, soil moisture, space and nutrients by the plants as a consequence of better balance between vegetative and reproductive phases and sufficient time available for setting of pods and giving higher grain yield.

Economics

Among different sowing times, significantly higher gross returns, net returns and BC ratio were recorded when the crop was sown during June II fortnight (₹ 1,17,960 ha^{-1}, ₹ 95,294 ha^{-1} and 5.20, respectively) over other sowing times. Among different planting geometries, 90 cm x 20 cm recorded significantly higher gross returns (₹.77,295 ha^{-1}), net returns (₹ 54,989 ha^{-1}) and BC ratio (3.44) compared to other planting geometries, however, it was on par with 120x 20 cm planting geometry (₹ 69,989 ha^{-1}, ₹ 47,662 ha^{-1} and 3.11, respectively). Similar results were obtained by Tuppad *et al.* (2014) and Jamadar and Sajjan (2014). Among different interactions of sowing times and planting geometries, crop sown during June II fortnight at 90 cm x 20 cm planting geometry recorded significantly higher gross returns (₹1,38,330 ha^{-1}), net returns (₹1,15,664 ha^{-1}) and BC ratio (6.10) and which was on par with crop sown during the same period at 120 cm x 20 cm planting geometry, but they were significantly superior over interactions. Higher gross returns, net returns and B C ratio were mainly due to higher grain yield recorded by the same interactions of sowing time and planting geometries.

Conclusion

Pigeonpea crop sown during June II fortnight either at 90 cm x 20 cm or at 120 cm x 20 cm planting geometry was found to give significantly higher grain yield, net returns and benefit cost ratio as compared to delayed sowing dates of July I/II fortnight and August I fortnight and wider planting geometries of 150 cm x 20cm and 180 cm x 20cm.

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