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Response of Cowpea (*Vigna unguiculata* L.) Genotypes to Sowing Windows and Planting Geometry under Northern Transitional Zone of Karnataka

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ABSTRACT

An experiment was carried out to study the effect of sowing dates and planting geometry on growth, yield, yield attributes and economics of two cowpea genotypes. The field trial was conducted during kharif 2013 under rainfed conditions at Main Agricultural Research Station, Dharwad. The experiment was laid out in split-split plot design with three replications. The experiment comprised of three dates of sowing (June second fortnight, July first fortnight and July second fortnight) in main plot, three row spacings (30, 45 and 60 cm) in sub plot and two genotypes (DC 15 and C -152) in sub-sub plot.

Results indicated that significantly higher seed yield (1155 kg ha^{-1}), haulm yield (2535 kg ha^{-1}), net return (₹ 32816 ha^{-1}) and B:C ratio (3.13) were recorded in cowpea sown during second fortnight of June as compared to first and second fortnight of July sowing. Similar trend was observed for growth and yield attributing parameters such as number of branches, leaf area, leaf area index, leaf area duration, total dry matter production, number of pods plant^{-1}, seed weight plant^{-1}. Among the row spacings significantly higher growth and yield attributes, seed yield (1062 kg ha^{-1}), haulm yield (2373 kg ha^{-1}), net return (₹ 28751 ha^{-1}) and B:C ratio (2.83) were recorded in 45 cm row spacing and it was on par with 30 cm as compared to 60 cm row. Genotype DC 15 recorded significantly higher growth and yield attributing parameters, seed yield (1026 kg ha^{-1}), haulm yield (2279 kg ha^{-1}), net return (₹ 27238 ha^{-1}) and B:C ratio (2.73) as compared to C-152.

Key words: *cowpea seed yield, sowing dates, planting geometry, genotypes, cowpea economics*

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) belongs to the family *Fabaceae* (*leguminosae*) and subfamily of *papillnoideae*. It is one of the important versatile food legumes and a valuable component of the traditional cropping systems in the semi-arid tropics. From the production of this crop, rural families variously derive food, animal feed, and income for their lively hood. Moreover, it will have spillover benefits to their farmlands through in situ decay of root residues, use of green manures and it has ability to fix atmospheric nitrogen in soil association with symbiotic bacteria.

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Its quick growth and rapid ground cover have made it an essential component of sustainable subsistence agriculture on marginal lands. There is now a common view that cowpea can play a significant role in farming systems where, low inputs including farm yard manure application can be justified. The climatic requirement of cowpea crop is as little as 300 mm rain spread over the growing season.

In India, cowpea is grown in an area of 3.9 million hectares with a production of 2.21 million tonnes[1]. In Karnataka, the crop is grown in an area of 0.84 lakh hectares with a production of 0.25 lakh tonnes[2]. The productivity of cowpea in Karnataka is low (360 kg ha^{-1}) as compared to the national productivity of 567 kg ha^{-1}. This clearly indicates the necessity to identify the reasons for such low productivity of cowpea in India in general and Karnataka in particular.

There are diverse cowpea genotypes demanding a site specific directed management approach the important are choice of proper planting date and a selection of best adapted genotype. With all its different uses and its different advantages, cowpea is a viable and high potential alternative crop. Due to its versatility in yielding high protein and fodder, there is a need to expand production that could be met by growing high yielding varieties. Rainfall onset and distribution has changed. This has an effect on the planting time of crops and resulted to reduced yield. Optimum sowing date is a non cash input which enhances the yield potential of the crop. Suitable time of sowing provides optimum growing conditions with favourable temperature, light, humidity and rainfall during the growth phase of the crop. This ultimately decides the selection of varieties for particular or different dates of sowing to stabilize or to get higher yields. These challenge researchers to find the most appropriate planting date using high yielding and early maturing varieties of cowpea. Introduction of such high yielding varieties has provided the scope for improving overall productivity of cowpea.

MATERIAL AND METHODS

An experiment was carried out to study the effect of sowing dates and planting geometry on growth, yield, yield attributes and economics of two cowpea genotypes. The field trial was conducted during *kharif* 2013 under rainfed conditions at Main Agricultural Research Station, University of Agricultural sciences, Dharwad. The soil of experimental site was classified under Vertisols with 7.8 pH, EC of 0.32 ds m^{-1}. The available N, P_2O_5 and K_2O status of soil was 225.5, 31.9 and 330.5 kg ha^{-1} respectively. The experiment was laid out on split-split plot design with three replications. There are eighteen treatment combinations comprised of three dates of sowing (June second fortnight, July first fortnight and July second fortnight) in main plot, three row spacings (30, 45 and 60 cm) in sub plot and two genotypes (DC 15 and C-152) in sub-sub plot. In sub plot same seed rate was used to maintain the uniform plant population in all the three row spacings by adjusting intra row spacing.

During crop period the total rainfall received was 740.4 mm distributed in 63 rainy days. The fertilizer dose of 25:50:25 N, P_2O_5 and K_2O kg ha^{-1} was applied in the form of Urea, DAP and MOP. Entire dose of fertilizers was applied as basal. At 30, 55 DAS and at harvest, five plants were randomly selected from each plot for recording growth parameters such as number of branches, leaf area (LA), leaf area index (LAI), leaf area duration (LAD) and total dry matter production. At harvest yield attributing parameters like number of pods $plant^{-1}$, pod length, seeds pod^{-1}, seed weight $plant^{-1}$, test weight, seed yield and haulm yield were recorded and analysed for evaluation and economics were recorded based on the cost of cultivation and out puts obtained.

RESULTS AND DISCUSSION

Sowing dates showed significant effects on growth and yield parameters at various growth stages. In present investigation June second fortnight sowing produced significantly higher seed yield (1155 kg ha^{-1}), haulm yield (2535 kg ha^{-1}) and harvest index (30.34 %) compared to July first fortnight sowing (1029 kg ha^{-1}) and July second fortnight sowing (686 kg ha^{-1}). Early sowing produced 11 and 41 per cent higher grain yield over late sowings respectively (Table. 3). The higher seed yield obtained in early sown crop was due to higher available soil moisture during cropping period as a result of receipt of well distributed rainfall during August and September respectively. This coincides with the flowering and pod formation stage of early sown crop. The higher seed yield in early sown crop is attributed to higher values of yield components over the late sown crop. There was significantly considerable increase in the values of important yield attributing characters like number of pods plant^{-1} (15.52) and seed weight plant^{-1} (20.72 g) in early sown crop as compared to late sown crop (Table. 2). While no significant difference was observed in pod length, number of seeds pod^{-1} and test weight due to different sowing dates. This might be because of conserved characters of genotypes which are genetically controlled. Increase in yield attributes is mainly due to the production of higher total dry matter and its partioning towards productive parts. Increased production of photosynthates is thus due to more number of primary branches (9.74), LA (106.1 dm^2), LAI (3.54) and LAD (58 days) were recorded in early sown crop (Table. 1). These results are in conformity with the findings of Rima and Nabam[6], in cowpea and Madhu[3], in mung bean.

Significant differences in seed yield were obtained due to different levels of row spacing. Maximum seed and haulm yield was recorded with 45 cm spacing (1062 and 2373 kg ha^{-1}, respectively) which was significantly higher than 60 cm spacing (774 and 1791 kg ha^{-1}, respectively) and no significant differences were observed between 45 and 30 cm spacings (1034 and 2296 kg ha^{-1}) (Table. 3). This is mainly due to increased competition among the plants within the rows for the space, light and nutrients in 60 cm row. Higher seed yield with row spacing of 45 and 30 cm could be attributed due to significant increase in the yield attributes like number of pods plant^{-1} and seed weight plant^{-1} (Table. 2). Difference in various yield components which led to significant yield differences could be traced back to significant variations in dry matter production. Higher total dry matter production (45.9 g plant^{-1}) was recorded in 45 cm row spacing over 30 (43.8 g plant^{-1}) and 60 cm row (33.7 g plant^{-1}). This is mainly because of increased LA (105.1 dm^2 plant^{-1}), LAI (3.50) and LAD (82 days) in 45 cm row over other planting geometry (Table. 1). Similar results were observed by Mureithi *et al.*[4].

In present study genotype DC 15 recorded higher seed yield and haulm yield (1026 and 2279 kg ha^{-1} respectively) compared to genotype C-152 (887 and 2027 kg ha^{-1} respectively) which was 14 per cent higher as compared to C-152 (Table. 3). Such differences in genotypes with respect to seed yield have been reported by Praveen Kumar *et al.*[5], in cowpea and Madhu[3], in mung bean. The factors responsible for high seed yield are the number of pods plant^{-1} (12.99), pod length (17.13 cm), number of seeds pod^{-1} (15.56), test weight (10.14 g), and seed weight plant^{-1} (19.91 g) (Table. 2). Increase in growth parameters like total dry matter production (43.15 g plant^{-1}), LA, LAI and LAD (Table. 1)which leads to increase seed yield in DC 15 over C-152.

Significant differences were observed with regards economics of cowpea cultivation due to different sowing windows, planting geometry and genotypes. Cowpea sown during second fortnight of June recorded significantly higher gross return (` 48,230 ha$^{-1}$), net return (` 32,816 ha^{-1}) and B:C (3.13) ratio as compared to other sowing dates. 45 cm row spacing recorded significantly higher gross return (` 48,230 ha$^{-1}$), net return (` 32,816 ha^{-1}) and B:C (3.13) ratio over other planting geometry. The genotype DC 15 recorded significantly higher economics over C-152 (Table. 4). The higher net return obtained in II FN of June might be attributed to higher yield and reduced cost of cultivation.

Thus it can be inferred that high seed yield of genotype DC 15 can be obtained by early sowing with 45 cm planting geometry.

Table 1: Effect of sowing windows and planting geometry on growth attributes of cowpea genotypes at 55DAS

Treatments	Leaf area (dm^2)	Leaf area index	Leaf area duration (days)	Total dry matter production (g $plant^{-1}$)
Date of sowing (D)				
D_1 : II FN of June	106.1	3.54	58.3	21.73
D_2 : I FN of July	99.6	3.32	52.8	20.40
D_3 : II FN of July	95.1	3.17	49.7	18.67
S.Em ±	1.96	0.07	1.26	0.28
CD (P = 0.05)	7.71	0.26	4.93	1.11
Row spacing (S)				
S_1= 30 cm	100.5	3.35	53.9	21.33
S_2= 45 cm	105.2	3.50	56.3	22.71
S_3= 60 cm	95.1	3.17	50.6	16.76
S.Em ±	0.75	0.02	0.40	0.32
CD (P = 0.05)	2.30	0.08	1.24	0.99
Genotypes (G)				
G_1= DC-15	101.7	3.39	54.4	21.03
G_2= C-152	98.8	3.29	52.8	19.51
S.Em ±	0.63	0.02	0.44	0.18
CD (P = 0.05)	1.87	0.06	1.31	0.53
Interaction				
$D_1S_1G_1$	108.2	3.61	59.7	22.3
$D_1S_1G_2$	104.2	3.47	57.1	21.8
$D_1S_2G_1$	116.4	3.88	64.4	24.9
$D_1S_2G_2$	111.7	3.72	61.5	23.9
$D_1S_3G_1$	98.9	3.30	54.2	19.7
$D_1S_3G_2$	97.2	3.24	53.1	17.9
$D_2S_1G_1$	99.1	3.30	52.9	23.1
$D_2S_1G_2$	100.7	3.36	53.0	19.9
$D_2S_2G_1$	104.5	3.48	55.6	24.4
$D_2S_2G_2$	99.2	3.30	53.1	23.5
$D_2S_3G_1$	98.0	3.27	51.3	17.0
$D_2S_3G_2$	96.2	3.21	51.0	14.5
$D_3S_1G_1$	98.5	3.28	52.1	20.8
$D_3S_1G_2$	92.6	3.08	48.7	20.1
$D_3S_2G_1$	101.4	3.38	52.8	20.2
$D_3S_2G_2$	97.5	3.25	50.7	19.5
$D_3S_3G_1$	90.4	3.01	46.7	16.9
$D_3S_3G_2$	89.9	3.00	47.2	14.6
S.Em ±	1.88	0.06	1.32	0.53
CD (P = 0.05)	NS	NS	NS	NS

NS= Non Significant

Table 2: Effect of sowing windows and planting geometry on yield attributes of cowpea genotypes

Treatments	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	Test weight (g)
Date of sowing (D)				
D_1 : II FN of June	15.22	16.25	14.56	10.02
D_2 : I FN of July	13.38	16.15	14.35	10.00
D_3 : II FN of July	9.43	16.08	14.33	9.72
S.Em $\pm$	0.18	0.08	0.06	0.09
CD (P = 0.05)	0.72	NS	NS	NS
Row spacing (S)				
S_1= 30 cm	13.43	16.18	14.46	9.91
S_2= 45 cm	13.59	16.19	14.41	9.94
S_3= 60 cm	11.02	16.12	14.37	9.88
S.Em $\pm$	0.22	0.07	0.07	0.05
CD (P = 0.05)	0.68	NS	NS	NS
Genotypes (G)				
G_1= DC-15	12.99	17.13	15.56	10.14
G_2= C-152	12.37	15.19	13.26	9.68
S.Em $\pm$	0.08	0.08	0.05	0.04
CD (P = 0.05)	0.25	0.25	0.16	0.12
Interaction				
$D_1S_1G_1$	16.3	17.2	15.8	10.2
$D_1S_1G_2$	15.7	15.3	13.2	9.8
$D_1S_2G_1$	16.9	17.2	15.8	10.2
$D_1S_2G_2$	16.3	15.6	13.5	9.9
$D_1S_3G_1$	13.4	17.1	15.7	10.1
$D_1S_3G_2$	12.7	15.1	13.2	10.0
$D_2S_1G_1$	14.0	17.1	15.4	10.1
$D_2S_1G_2$	13.5	15.5	13.4	9.9
$D_2S_2G_1$	14.6	17.1	15.3	10.2
$D_2S_2G_2$	13.7	15.1	13.2	9.9
$D_2S_3G_1$	12.6	17.0	15.6	10.1
$D_2S_3G_2$	11.8	15.1	13.2	9.9
$D_3S_1G_1$	10.8	17.1	15.8	10.2
$D_3S_1G_2$	10.2	15.0	13.1	9.4
$D_3S_2G_1$	10.3	17.1	15.3	10.2
$D_3S_2G_2$	9.7	14.9	13.3	9.3
$D_3S_3G_1$	7.9	17.3	15.3	10.1
$D_3S_3G_2$	7.7	15.1	13.2	9.2
S.Em $\pm$	0.25	0.25	0.16	0.13
CD (P = 0.05)	NS	NS	NS	NS

NS= Non Significant

Table 3: Effect of sowing windows and planting geometry on seed weight, seed yield, haulm yield and harvest index of cowpea genotypes

Treatments	Seed weight plant^{-1}(g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
Date of sowing (D)				
D_1 : II FN of June	20.72	1155	2535	30.34
D_2 : I FN of July	20.05	1029	2350	29.92
D_3 : II FN of July	17.15	686	1574	28.86
S.Em ±	0.14	18.75	52.31	0.11
CD (P = 0.05)	0.56	73.64	205.38	0.43
Row spacing (S)				
S_1= 30 cm	19.99	1034	2296	30.17
S_2= 45 cm	19.96	1062	2373	29.98
S_3= 60 cm	17.98	774	1791	28.98
S.Em ±	0.11	11.88	32.29	0.08
CD (P = 0.05)	0.34	36.62	99.50	0.23
Genotypes (G)				
G_1= DC-15	19.91	1026	2279	29.98
G_2= C-152	18.70	887	2027	29.43
S.Em ±	0.10	5.13	14.43	0.08
CD (P = 0.05)	0.31	15.24	42.88	0.23
Interaction				
$D_1S_1G_1$	22.0	1303	2712	31.7
$D_1S_1G_2$	20.5	1100	2478	29.9
$D_1S_2G_1$	22.4	1343	2830	31.4
$D_1S_2G_2$	20.7	1180	2597	30.4
$D_1S_3G_1$	19.9	1071	2399	29.5
$D_1S_3G_2$	18.9	933	2196	29.1
$D_2S_1G_1$	21.5	1228	2736	30.5
$D_2S_1G_2$	19.9	1030	2384	29.7
$D_2S_2G_1$	22.0	1233	2809	30.1
$D_2S_2G_2$	19.8	1053	2358	30.4
$D_2S_3G_1$	19.0	877	2045	29.5
$D_2S_3G_2$	18.0	750	1768	29.2
$D_3S_1G_1$	18.2	813	1831	29.6
$D_3S_1G_2$	17.8	727	1634	29.5
$D_3S_2G_1$	18.0	842	1946	28.8
$D_3S_2G_2$	16.8	720	1697	28.6
$D_3S_3G_1$	16.2	523	1205	28.6
$D_3S_3G_2$	15.9	489	1132	27.9
S.Em ±	0.31	15.39	43.30	0.23
CD (P = 0.05)	NS	NS	NS	NS

NS= Non Significant

Table 4: Effect of sowing windows and planting geometry on economics of cowpea genotypes

Treatments	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Date of sowing (D)			
D_1 : II FN of June	48230	32816	3.13
D_2 : I FN of July	43022	26403	2.59
D_3 : II FN of July	28686	13839	1.93
S.Em ±	789	789	0.05
CD (P = 0.05)	3097	3097	0.20
Row spacing (S)			
S_1= 30 cm	43179	27552	2.75
S_2= 45 cm	44378	28751	2.83
S_3= 60 cm	32382	16755	2.06
S.Em ±	498	498	0.03
CD (P = 0.05)	1536	1536	0.10
Genotypes (G)			
G_1= DC-15	42865	27238	2.73
G_2= C-152	37094	21468	2.37
S.Em ±	213	213	0.01
CD (P = 0.05)	634	634	0.04
Interaction			
$D_1S_1G_1$	54303	38889	3.52
$D_1S_1G_2$	45983	30569	2.98
$D_1S_2G_1$	55997	40583	3.63
$D_1S_2G_2$	49278	33864	3.20
$D_1S_3G_1$	44759	29345	2.90
$D_1S_3G_2$	39063	23649	2.53
$D_2S_1G_1$	51309	34690	3.09
$D_2S_1G_2$	43107	26488	2.59
$D_2S_2G_1$	51580	34961	3.10
$D_2S_2G_2$	44020	27401	2.65
$D_2S_3G_1$	36703	20084	2.21
$D_2S_3G_2$	31414	14795	1.89
$D_3S_1G_1$	33998	19151	2.29
$D_3S_1G_2$	30374	15527	2.05
$D_3S_2G_1$	35237	20390	2.37
$D_3S_2G_2$	30158	15311	2.03
$D_3S_3G_1$	21897	7050	1.47
$D_3S_3G_2$	20452	5605	1.38
S.Em ±	640	640	0.04
CD (P = 0.05)	NS	NS	NS

NS= Non Significant

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