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Yield and Nutrient Uptake of Pigeonpea [*Cajanus cajan* (L.)] as Influenced by Sowing Window, Nutrient Dose and Foliar Sprays

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ABSTRACT

A field experiment was conducted during the *rabi* seasons of 2012-13 and 2013-14 to study the influence of sowing window, nutrient dose and foliar spray on yield and nutrient uptake of pigeonpea on sandy loam soil which was low in available nitrogen, medium in available phosphorus and available potassium. The experiment was conducted in a split-split plot design, consisting of three sowing windows in main plots, three nutrient doses in sub-plots and two foliar sprays in sub-sub plots. Crop sown during II FN of September produced significantly higher seed and stalk yield, nutrient content and uptake. Application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} improved seed yield, stalk yield, nutrient content and uptake of redgram. Higher seed yield, stalk yield and nutrient uptake by the crop was recorded with foliar application of NAA (25 ppm) and DAP (2 per cent) applied at 60 and 80 DAS. Interaction between sowing window and nutrient doses, sowing window and foliar sprays were significant in influencing yield of pigeonpea.

Key words: Foliar sprays, Nutrient dose, Nutrient uptake, Sowing window, Yield.

INTRODUCTION

Pulses form an important group of food crops for nutritional security, sustainable crop production and soil health. Pigeonpea has the special morphological characters with respect to deep rooting and drought tolerance that have made this crop adaptable for growing in wide range of unfavourable conditions with uncertain rainfall and varied soil depth. One of the significant achievements in the field of grain legume cultivation in India is that pigeonpea can be grown as *rabi* crop (Sengupta and Roy, 1982) particularly in the areas where winter is mild and short like Andhra Pradesh, West Bengal and Bihar. Thus, among the various agronomic practices, sowing date has more influence on yield than any other production factor. Appropriate sowing window causes optimal utilization of climatic factors such as temperature, humidity and day length. Early sowing in the season may encourage higher vegetative growth which may initiate various diseases and insect pests, whereas delayed sowing may shrink the vegetative phase, which in turn reduces dry matter accumulation leading to poor partitioning to reproductive parts and ultimately poor realization of the potential yield. The low yield of pigeonpea is mainly attributed to inadequate and imbalance application of nutrients. The prominent effect of foliar application of nutrients and growth regulator at pre flowering and flowering stage was on reduction in flower shed and flower drop percentage.

Hence, the present study was carried out to study the influence of sowing window, nutrient doses and foliar application on yield and nutrient uptake by the crop.

MATERIALS AND METHODS

A field experiment was conducted at S. V. Agricultural College, Tirupati campus of ANGRAU (A.P) during *rabi* seasons of 2012-13 and 2013-14 to study the influence of sowing window, nutrient dose and foliar sprays on yield and nutrient uptake of pigeonpea. The soil of the experimental field was sandy clay loam in texture, low in available N, medium in available P and available K. Pigeonpea variety LRG-41 was used for experimentation. The experiment was laid in split-split design with three sowing times [II FN of September (T_1), I FN of October (T_2) and II FN of October (T_3)] in main plots , three nutrient doses [10-40-0 kg N, P_2O_5 and K_2O ha^{-1} (N_1), 20-50-10 kg N, P_2O_5 and K_2O ha^{-1} (N_2) and 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3)] in subplots and two foliar sprays [NAA (25 ppm) and DAP (2 per cent) applied at 60 DAS (F_1) and NAA (25 ppm) and DAP (2 per cent) applied at 60 and 80 DAS (F_2)] in sub-sub plots. Healthy and well matured seeds were sown in furrows opened by hand hoes at a spacing of 45 cm x 15 cm. The herbicide imazethapyr was sprayed as pre emergence application @ 1.5 ml l^{-1} of water to all the plots on the second day after sowing, using a sprayer with flat fan nozzle with a spray

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solution of 500 l ha^{-1}. Hand weeding was done twice at 35 and 70 days after sowing. Three nutrient levels were applied to sub plots as per the prescribed treatments assigned. Entire quantities of N, P_2O_5 and K_2O were applied by placement method at the time of sowing. At harvest, seed and stalk yields were recorded on a whole-plot basis after discarding border plants and were expressed as seed and stalk yield in kg ha^{-1}. Nitrogen, phosphorus and potassium contents in plants were analyzed by the standard procedure outlined by Jackson (1973). The uptake of nitrogen, phosphorus and potassium at harvest were calculated and expressed in kg ha^{-1} by multiplying the nutrient content with

Table 1: Seed and stalk yield (kg ha^{-1}) of *rabi* pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays (pooled data over two years).

Treatment	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
T_1- II Fortnight of September	1700	7226
T_2- I Fortnight of October	1329	4102
T_3- II Fortnight of October	1067	3253
SEm ±	36.8	52.3
CD (5%)	144	204
N_1- 10-40-0 kg N, P_2O_5 and K_2O ha^{-1}	1127	4611
N_2- 20-50-10 kg N, P_2O_5 and K_2O ha^{-1}	1379	4867
N_3- 30-60-20 kg N, P_2O_5 and K_2O ha^{-1}	1589	5102
SEm ±	10.3	6.7
CD (5%)	32	21
F_1- Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS	1297	4806
F_2- Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS	1434	4914
SEm ±	3.6	5.3
CD (5%)	11	16
$T_1N_1F_1$	1371	6951
$T_1N_1F_2$	1505	7054
$T_1N_2F_1$	1650	7198
$T_1N_2F_2$	1809	7297
$T_1N_3F_1$	1863	7372
$T_1N_3F_2$	2000	7485
$T_2N_1F_1$	976	3769
$T_2N_1F_2$	1145	3881
$T_2N_2F_1$	1245	4035
$T_2N_2F_2$	1407	4144
$T_2N_3F_1$	1521	4308
$T_2N_3F_2$	1680	4476
$T_3N_1F_1$	794	2963
$T_3N_1F_2$	974	3052
$T_3N_2F_1$	1066	3218
$T_3N_2F_2$	1097	3313
$T_3N_3F_1$	1187	3445
$T_3N_3F_2$	1285	3528
TxN		
SEm ±	17.8	11.6
CD (5%)	55	36
TxF		
SEm ±	6.2	9.2
CD (5%)	19	NS
NxF		
SEm ±	6.2	9.2
CD (5%)	19	NS
TxNxF		
SEm ±	10.8	15.9
CD (5%)	32	NS

the corresponding dry matter production. The data was analysed statistically and presented.

RESULTS AND DISCUSSION

Seed and stalk yield

There was a progressive decrease in seed and stalk yield of pigeonpea with successive delay in sowing time from II FN of September to II FN of October (Table 1). The crop sown during II FN of September (T_1) resulted in significantly higher seed and stalk yield of pigeonpea. Higher seed and stalk yield with early sowing can be attributed to longer vegetative phase leading to improvement in growth, yield attributes and yield. These results are in conformity with that of Padhi (1995) and Laxminarayana (2003). Among the fertilizer doses, the higher seed and stalk yield were recorded with application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) which was significantly superior to that of 20-50-10 kg N, P_2O_5 and K_2O ha^{-1} (N_2) and 10-40-0 kg N, P_2O_5 and K_2O ha^{-1} (N_1). The differences in seed and stalk yield might be attributed to difference in doses of N, P and K. Improvement in growth parameters might have lead to improvement in

Table 2: Nutrient content of pigeonpea at harvest as influenced by varied sowing window, nutrient doses and foliar sprays.

	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Times of sowing						
T_1-II Fortnight of September	1.33	1.32	0.212	0.195	0.755	0.729
T_2-I Fortnight of October	1.28	1.24	0.182	0.160	0.683	0.662
T_3-II Fortnight of October	1.16	1.11	0.165	0.145	0.616	0.640
SEm±	0.013	0.011	0.005	0.003	0.011	0.005
CD (P=0.05)	0.05	0.04	0.020	0.013	0.043	0.018
Nutrient levels						
N_1-10-40-0 kg N, P_2O_5 and K_2O ha^{-1}	1.19	1.17	0.159	0.142	0.619	0.637
N_2-20-50-10 kg N, P_2O_5 and K_2O ha^{-1}	1.26	1.23	0.185	0.166	0.683	0.673
N_3-30-60-20 kg N, P_2O_5 and K_2O ha^{-1}	1.32	1.28	0.214	0.192	0.752	0.721
SEm±	0.015	0.012	0.005	0.004	0.020	0.008
CD (P=0.05)	0.05	0.04	0.016	0.012	0.060	0.025
Foliar applications						
F_1-Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS	1.24	1.22	0.183	0.163	0.683	0.675
F_2-Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS	1.28	1.23	0.190	0.171	0.686	0.678
SEm±	0.013	0.011	0.003	0.003	0.011	0.005
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 3: Nitrogen uptake at harvest (kg ha^{-1}) of pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays.

	Nitrogen uptake	
	2012-13	2013-14
Times of sowing		
T_1-II Fortnight of September	191.6	190.8
T_2-I Fortnight of October	116.3	111.8
T_3-II Fortnight of October	66.2	63.8
SEm±	1.27	2.23
CD (P=0.05)	5.0	8.7
Nutrient levels		
N_1-10-40-0 kg N, P_2O_5 and K_2O ha^{-1}	107.0	105.6
N_2-20-50-10 kg N, P_2O_5 and K_2O ha^{-1}	125.4	122.2
N_3-30-60-20 kg N, P_2O_5 and K_2O ha^{-1}	141.6	138.7
SEm±	1.71	1.43
CD (P=0.05)	5.3	4.4
Foliar applications		
F_1-Foliar spray of NAA (25ppm) and DAP (2%) at 60 DAS	120.1	119.3
F_2-Foliar spray of NAA (25ppm) and DAP (2%) at 60 and 80 DAS	129.3	125.0
SEm±	1.97	2.11
CD (P=0.05)	5.9	NS

Table 4: Phosphorus and potassium uptake at harvest (kg ha^{-1}) of pigeonpea as influenced by varied sowing window, nutrient doses and foliar sprays.

		Phosphorus uptake								Potassium uptake							
		2012-13				2013-14				2012-13				2013-14			
		F_1	F_2	Mean for T	Mean for N	F_1	F_2	Mean for T	Mean for N	F_1	F_2	Mean for T	Mean for N	F_1	F_2	Mean for T	Mean for N
T_1	N_1	23.0	24.7	30.7	14.4	21.5	21.3	28.3	12.9	87.5	92.0	109.2	55.6	87.2	92.3	105.5	56.9
	N_2	28.6	31.5			27.5	30.6			105.3	111.1			103.5	108.2		
	N_3	37.1	39.3			33.0	35.7			127.5	131.6			117.7	123.9		
T_2	N_1	12.0	13.8	16.5	18.6	10.6	12.1	14.5	17.0	49.2	52.5	61.9	68.3	51.8	53.2	59.6	66.9
	N_2	16.1	16.7			13.0	14.8			61.1	62.7			58.0	59.3		
	N_3	19.5	21.1			17.7	18.9			71.4	74.7			66.0	69.3		
T_3	N_1	6.3	6.8	9.5	23.7	5.5	6.5	8.4	21.3	24.7	27.8	35.3	82.4	26.6	30.3	36.9	78.2
	N_2	8.7	10.2			7.6	8.8			33.7	36.1			34.9	37.5		
	N_3	11.8	13.3			10.5	11.8			42.6	46.5			44.5	47.5		
Mean for F		18.1	19.7	-	-			-	-	67.0	70.5	-	-	65.6	69.1	-	-

	2012-13		2013-14		2012-13		2013-14	
	SEm ±	CD (P =0.05)	SEm ±	CD (P =0.05)	SEm ±	CD (P = 0.05)	SEm ±	CD (P = 0.05)
T	0.48	1.9	0.32	1.2	1.10	4.3	1.21	4.7
N	0.55	1.7	0.32	1.0	2.56	7.9	1.30	4.0
F	0.37	1.1	0.41	1.7	1.91	NS	1.14	NS
TN	0.95	2.9	0.56	1.2	4.43	NS	2.25	6.9
TF	0.65	NS	0.72	NS	3.31	NS	1.98	NS
NF	0.65	NS	0.72	NS	3.31	NS	1.98	NS
TNF	1.12	NS	1.24	NS	5.73	NS	3.42	NS

yield attributes and hence the higher yield at higher nutrient level (Meena *et al.,* 2013 and Umesh *et al.,* 2013). Foliar spray of NAA (25 ppm) and DAP (2%) twice at 60 and 80 DAS (F_2) resulted in significantly higher seed and stalk yield (Table 2) relative to that due to the same foliar spray once at 60 DAS (F_1). It was probable that application of NAA might have induced large number of new sinks leading to greater activity of carboxylating enzymes and rate of protein synthesis. This resulted in higher photosynthetic rate, translocation and accumulation of metabolites in the sink and eventually greater seed production (Kalpana and Krishnarajan, 2003). Interaction of sowing times and nutrient levels significantly increased the seed and stalk yield of pigeonpea. It appears that, early sowing with higher nutrient dose (T_1N_3) had improved growth parameters (plant height, leaf area, dry matter production and crop growth rate) and yield attributes (number of pod bearing branches plant^{-1}, number of pods branch^{-1}, number of seeds pod^{-1} and test weight) leading to higher seed and stalk yield. Significantly, higher seed yield was with crop sown during II FN of September receiving two foliar sprays at 60 and 80 DAS (T_1F_2) due to N and P_2O_5 availability from flower primordia initiation to seed maturity as DAP was applied through foliar application. Highest nutrient level along with foliar application twice (N_3F_2) resulted in higher seed yield. Earliest sown crop receiving higher nutrient dose and two foliar applications ($T_1N_3F_2$) resulted in the highest seed yield of *rabi* pigeonpea due to efficient use of natural resources and applied nutrients.

Nutrient content and uptake

The higher nitrogen, phosphorus and potassium content of plant (Table 2) were recorded when the crop was sown during II FN of September (T_1) followed by that with that of I FN of October sown crop during both the years. Longer duration of the crop due to early sowing allowed the crop to absorb nutrients for a longer period of time leading to higher concentration of nutrients in the plant. These results are in accordance with those of Gill (2013). Application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) resulted in significantly higher nutrient content relative to the lower doses of nutrients applied. The results are in line with those of Singh and Singh (2011). Foliar application did not significantly influence the nutrient content of plant during both the years of investigation.

The higher nutrient (nitrogen, phosphorus and potassium) uptake was with the earliest sown crop during II FN of September (T_1) during both the years (Table 3 and 4). Higher nutrient uptake with early sown crop was due to the longer vegetative lag phase of the crop that has lead to efficient use of growth resources and hence higher dry matter production. Application of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (N_3) resulted in the highest nutrient uptake, which was significantly higher than with 20-50-10 kg N, P_2O_5 and K_2O ha^{-1} (N_2) in both the years. Increase in nutrient uptake by redgram at higher nutrient doses can be attributed to higher yield coupled with slight improvement in nutrient concentration in seed and non-seed parts. These results are in accordance with Umesh and Shankar (2013). With regard to foliar sprays, nitrogen uptake during first year and phosphorus uptake during both the years, were the highest with NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS (F_2). With regard to interaction, the highest phosphorus uptake during both the years of study and potassium uptake during second year of study were with crop sown during II FN of September along with the nutrient dose of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} (T_1N_3), which was significantly higher than that due to rest of the combinations.

CONCLUSION

From the present investigation it can be concluded that crop sown during II FN of September with nutrient dose of 30-60-20 kg N, P_2O_5 and K_2O ha^{-1} and foliar application of NAA (25 ppm) and DAP (2 per cent) foliar spray at 60 and 80 DAS resulted in better seed and stalk yield, nutrient content and uptake under the prevailing condition.

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