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YIELD ATTRIBUTES AND QUALITY OF COWPEA AS INFLUENCED BY NITROGEN AND PHOSPHORUS LEVELS ON MEDIUM BLACK SOIL OF GUJARAT

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SUMMARY

A field experiment was conducted during 2012 to study the yield attributes and quality of cowpea (GC-5) as influenced by nitrogen and phosphorus levels on medium black soil of Gujarat. The experiment consisted of four treatments of nitrogen levels (control, 20, 30 and 40 kg/ha) and four treatments of phosphorus levels (control, 40, 60 and 80 kg P_2O_5/ha) thereby making 16 treatment combinations tested in factorial randomized block design with three replications. The results indicated that the application of nitrogen @ 40 kg/ha gave the maximum and significantly higher number of pods per plant, number of seeds per pod, test weight, seed yield, straw yield, biological yield, protein content, chlorophyll content and remained at par with 20 and 30 kg N/ha over control. The maximum net returns and BCR were found with the application of 20 kg N/ha. Results further indicated that the application of phosphorus @ 80 kg/ha gave the maximum and significantly higher number of pods per plant, number of seeds per pod, test weight, seed, straw, biological yields, protein content, chlorophyll content and remained at par with 40 and 60 kg P_2O_5/ha over control. The maximum net returns and BCR were found with the application of 40 kg P_2O_5/ha. The combined application of nitrogen and phosphorus levels @ 20 and 40 kg P_2O_5/ha was significantly higher in terms of seed and straw yield over rest of the treatments.

Key words : Yield, quality, BCR, cowpea, nitrogen, phosphorus

Cowpea [*Vigna unguiculata* (L.) Walp.], commonly known as *lobia*, is one of the important pulse crops grown for grain, forage and green manuring. The crop gives such a heavy vegetative growth and covers the ground so well that it checks the soil erosion in problem areas and can later be ploughed down for green manure. It has considerable promise as an alternative pulse crop. Cowpea is highly responsive to fertilizer application. Among the various constraints to low productivity of cowpea, inadequate use of fertilizers and lack of improved package of practices are important.

Nitrogen plays an important role in various metabolic processes of plant. Nitrogen is an essential constituent of protein, chlorophyll and is present in many other compounds, helps in plant metabolism, such as nucleotides, phosphatides, alkaloids, enzymes, hormones, vitamins, etc. It imparts dark-green colour of plants, produces rapid early growth, improves capacity to fix atmospheric nitrogen symbiotically and it responds to small quantity of nitrogenous fertilizers applied as starter dose. Application of 15-20 kg N/ha has been found optimum to get better production response in cowpea.

Phosphorus is an essential constituent of nucleic acids and stimulates root growth as well as increases nodule activity in plant. Phosphorus is also an essential constituent of nucleic acids such as ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), adenosine diphosphate (ADP) and adenosine triphosphate (ATP), nucleoproteins, amino acids, proteins, phosphotides,

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phytin, several co-enzymes viz., thiamine, pyrophosphate and pyrodoxyl phosphite. Application of balanced fertilizers up to 25 kg N and 50 kg P_2O_5/ha recorded higher seed and straw yield of cowpea over no fertilization (Patel *et al*., 2003). Similar response with application of 20 kg N and 60 kg P_2O_5/ha was observed by Vikrant *et al*. (2005). Therefore, the present study indicates interaction effect of nitrogen and phosphorus levels on medium black soil of Gujarat for cowpea.

MATERIALS AND METHODS

A field experiment was conducted during 2012 at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh in a factorial randomized block design with three replications. The soil was medium black in texture, alkaline in reaction (pH 7.8), medium in organic carbon (0.57 %), low available nitrogen (237.0 kg/ha), medium available phosphorus (32.5 kg P_2O_5/ha) and medium in potassium (269.0 kg K_2O/ha) content. The maximum and minimum temperature during the crop growth and development period ranged between 27.5 to 40.5°C and 9.4 to 24.5°C. The ***rabi*** season remained cold particularly during second week of December to first week of February (50th to 6th standard week) with maximum temperature below 30.9°C and minimum temperature above 9.4°C. The range of average relative humidity, bright sun shine, wind speed and daily evaporation was 25.6-57.2 per cent, 4.8-10.2 h, 2.4-7.8 km/h and 3.8-10.7 mm, respectively.

The experiment consisted of four levels of nitrogen (control, 20, 30 and 40 kg/ha) and four levels of phosphorus (control, 40, 60 and 80 kg P_2O_5/ha), thereby making 16 treatment combinations. Fertilizers were applied as per treatment through single super phosphate (SSP) and urea at the time of sowing as basal dose. The cowpea cv. 'GC-5' was sown on 27 February 2012 using seed rate of 25 kg/ha with a row spacing of 45 cm. The crop was harvested on 9 May 2012. Five irrigations were applied during growing season. Intercultural operations viz., thinning, hoeing and weeding were followed after 20 days of sowing to maintain recommended spacing and weed control. For weed management, pendimethalin 1.0 kg a. i./ha was applied as pre-emergence to control the weeds in early stages of the crop. Fully mature and developed pods from randomly selected five plants from each plot were plucked and number of seeds was counted. The average number of pods and seeds per plant was worked out. After threshing and winnowing, the weight of seeds for each net plot area was recorded in kg per plot and then converted to kg/ha.

RESULTS AND DISCUSSION

Effect of Nitrogen Levels

The results (Table 1) revealed that the application of nitrogen @ 40 kg/ha recorded significantly increased seed yield (1022 kg/ha), straw yield (2141 kg/ha), number of pods per plant, number of seeds per pod and test weight. The application of nitrogen @ 20 kg/ha showed significantly higher net returns and BCR in cowpea as compared to other treatments. Application of nitrogen @ 20 kg/ha recorded the maximum net returns (Rs. 13270/ha) and BCR (2.64) over other treatments (Table 2). The application of nitrogen @ 40 kg/ha recorded significantly increased biological yield, protein content in seed, chlorophyll content and was at par with 20 and 30 kg N/ha (Table 2). The increased supply of nitrogen and its higher uptake by plants might have stimulated the rate of various physiological processes in plant and led to increased yield parameters and resulted in increased seed and straw yields (Patel *et al*., 2003; Vikrant *et al*., 2005). The increased nitrogen content in seed might be the result of increased availability of nitrogen to plants. Higher nitrogen in seed is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. The results of present investigation are in line with those of Singh *et al*. (2006).

Effect of Phosphorus Levels

The application of phosphorus levels up to 80 kg/ha recorded significantly higher number of pods per plant, number of seeds per pod, test weight, seed yield, straw yield, biological yield, protein content, chlorophyll content and remained at par with 40 and 60 kg P_2O_5/ha over control (Tables 1 and 2). Application of 40 kg P_2O_5/ha recorded the maximum net returns (Rs. 12519/ha) and benefit : cost ratio (2.34) over all other treatments. Increase in net returns might be due to seed and straw yields (1049 and 2128 kg/ha) obtained under this treatment as compared to cost involved under this

TABLE 1
Effect of nitrogen and phosphorus levels on yield attributes of cowpea

Treatment	No. of pods/ plant	No. of seeds/ pod	Test weight (%)	Seed yield (kg/ha)	Straw yield (kg/ha)
Nitrogen (N kg/ha)					
No : Control	10.12	10.22	75.34	769	1915
N_1 : 20	11.04	11.02	85.50	1013	2125
N_2 : 30	11.38	11.18	87.32	1018	2133
N_3 : 40	11.58	11.60	88.89	1022	2141
S. Em±	0.24	0.27	1.71	26	47
C. D. (P=0.05)	0.68	0.77	4.94	74	135
Phosphorus (P_2O_5 kg/ha)					
P_0 : Control	10.35	10.25	75.17	725	1834
P_1 : 40	10.96	10.41	85.87	1049	2128
P_2 : 60	11.31	11.28	87.37	1061	2143
P_3 : 80	11.50	11.57	88.63	1070	2150
S. Em±	0.24	0.27	1.71	26	47
C. D. (P=0.05)	0.68	0.77	4.94	74	135
C. V. (%)	7.42	8.42	7.04	8.93	7.83

TABLE 2
Effect of nitrogen and phosphorus levels on biological yield, quality and economics of cowpea

Treatment	Biological yield (kg/ha)	Protein content in seed (%)	Chlorophyll content (mg/g)	Net returns (Rs./ha)	BCR
Nitrogen (N kg/ha)					
No : Control	2684	17.18	1.94	8676	2.11
N_1 : 20	3138	19.31	2.46	13270	2.64
N_2 : 30	3151	19.87	2.50	13243	2.61
N_3 : 40	3163	21.25	2.55	13198	2.58
S. Em±	63	0.76	0.04	-	-
C. D. (P=0.05)	182	2.20	0.12	-	-
Phosphorus (P_2O_5 kg/ha)					
P_0 : Control	2559	17.31	2.07	7949	2.01
P_1 : 40	3177	19.93	2.40	12519	2.34
P_2 : 60	3204	20.18	2.47	12202	2.21
P_3 : 80	3220	20.25	2.50	11744	2.08
S. Em±	63	0.76	0.04	-	-
C. D. (P=0.05)	182	2.20	0.12	-	-
C. V. (%)	7.13	6.59	6.12	-	-

treatment. It plays a pivotal role in early formation of roots, their proliferation, increased microbial activity in nodules and symbiotic biological N-fixation process. The similar results were found by Ilavarasi *et al*. (2007), Sammauria *et al*. (2009) and Niraj and Prakash (2014).

Interaction Effect of Nitrogen and Phosphorus Levels on Seed Yield

The combined application of nitrogen and phosphorus @ 20 and 40 significantly increased in terms of seed and straw yield and it remained at par with application of $N_{20}P_{60}$, $N_{20}P_{80}$, $N_{30}P_{40}$, $N_{30}P_{60}$, $N_{30}P_{80}$, $N_{40}P_{40}$, $N_{40}P_{60}$ and $N_{40}P_{80}$ over rest of the treatments (Tables 3 and 4). Nitrogen availability depends more or less on phosphorus. Phosphorus enhanced the symbiotic nitrogen (N) fixation process in legume crops and ultimately improved the uptake of nutrients. Our results are in conformity with those reported by Navale *et al.* (2000) and Badran (2003).

TABLE 3
Interaction effect of nitrogen and phosphorus on seed yield (kg/ha) of cowpea

Levels of nitrogen (kg/ha)	Levels of phosphorus (kg/ha)			
	0	40	60	80
0	640	838	941	971
20	804	1121	1061	1024
30	912	1106	1047	1004
40	898	991	1032	1057
S. Em±		51		
C. D. (P=0.05)		148		

TABLE 4
Interaction effect of nitrogen and phosphorus on straw yield (kg/ha) of cowpea

Levels of nitrogen (kg/ha)	Levels of phosphorus (kg/ha)			
	0	40	60	80
0	1767	1883	1993	2017
20	1803	2328	2217	2070
30	1800	2283	2267	2183
40	1967	2057	2097	2319
S. Em±		94		
C. D. (P=0.05)		271		

Correlation Studies

The relationship between the seed yield of cowpea and other important growth and yield attributes was studied. The data on correlation coefficient (r), coefficient of determination (R^2), regression coefficient (b) and intercept (a) are furnished in Table 5. Results revealed that plant height at 40 DAS and harvest, dry matter accumulation at 40 DAS and harvest, number of branches per plant at harvest, chlorophyll content at 40 DAS, number of nodules per plant at 40 DAS, number of pods per plant, number of seeds per pod, test weight and straw yield showed positive and significant correlation with seed yield of cowpea.

The correlation between seed yield and test weight was the highest (0.9761) followed by chlorophyll content at 40 DAS (0.9616), number of branches per plant at harvest (0.9115), number of seeds per pod (0.9076), dry accumulation at harvest (0.8792), dry accumulation at 40 DAS (0.8790), number of nodules per plant at 40 DAS (0.8107), stover yield (0.7081), number pods per plant (0.6519), plant height at harvest (0.8315) and plant height at 40 DAS (0.4926) which attributed correspondingly 95.29, 92.47, 83.09, 82.38, 77.30, 77.26, 65.72, 50.13, 42.50, 38.70 and 24.26% variation in seed yield of cowpea. These findings are more or less related with those reported by Bairwa *et al.* (2007) and Kanojia and Sharma (2008).

CONCLUSION

It is concluded that higher yield, net returns and benefit : cost ratio in terms of combined application of nitrogen and phosphorus @ 20 and 40 kg/ha were significantly higher on medium black soil of Gujarat.

TABLE 5
Intercept (a), regression coefficient (b), correlation coefficient (r) and coefficient of determination (R^2) of seed yield (dependent variable Y) with individual growth and yield attributes (independent variables Xi)

X_i	Independent variables	*a*	*b*	*r*	R^2
X_1	Plant height at 40 DAS (cm)	-660.19	27.44	0.4926**	0.2426
X_2	Plant height at harvest (cm)	-21.93	22.57	0.6221**	0.3870
X_3	Dry matter accumulation at 40 DAS	210.44	15.42	0.8790**	0.7726
X_4	Dry matter accumulation at harvest	-209.44	14.91	0.8792**	0.7730
X_5	No. of branches/plant at harvest	270.79	159.60	0.9115**	0.8309
X_6	Chlorophyll content 40 DAS	-188.55	561.12	0.9616**	0.9247
X_7	No. of nodules/plant	110.34	41.18	0.8107**	0.6572
X_8	No. of pods/plant	-12.48	55.84	0.6519**	0.4250
X_9	No. of seeds/pod	-1050.10	192.97	0.9076**	0.8238
X_{10}	Test weight (g)	-662.33	22.17	0.9761**	0.9529
X_{11}	Straw yield (kg/ha)	319.85	0.32	0.7081**	0.5013

**Significant at P=0.01 level (r_{tab}=0.708).

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