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Response of cowpea (*Vigna unguiculata* L.) genotypes to four phosphorus levels in Gajapati district of Southern Odisha

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Abstract
The performance of three cowpea genotypes (SB-2, Rawati, Baramasi) with four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5/ha) was studied at Bagusala farm of M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati, Odisha. The treatments were laid using Factorial Randomized Block Design and replicated thrice with the individual plot size of 12m^2. The result obtained from the analysis data indicated that cowpea genotypes are significantly different. Plant growth parameters study included such as plant height, number of leaves per plant, number of branches per plant and days to first flowering. Yield parameters such as number of pods/plot and 100-seed weight (g) and both of green pod yield (kg/plot) and seed yield (kg/plot) were recorded. Results showed significant response to the application of phosphorus which equally influenced the growth and yield components as well as yield of cowpea. Baramasi genotype gave early flowering followed by SB-2 and Rawati. The effect of genotypes and phosphorus levels showed that the genotype Baramasi gave the maximum (5.22 kg) pod yield/plot in terms of pod yield/ha (4355 kg). Further, Baramasi genotype produced highest seed yield/plot (1.15 kg/plot) in terms of hectare (965 kg) and minimum was noted with the genotype Rawati (0.97 kg/plot). In case of 100-seed weight, Baramasi registered the highest response with the application of 60 kg P_2O_5/ha. Thus based on these findings, application of 60 kg P_2O_5/ha can be recommended for better cowpea growth and yield. Similarly, genotype Baramasi can be recommended for better yield for Gajapati district of south Odisha.

Keywords: Genotype, phosphorus levels, flowering, growth parameters, yield

Introduction
Cowpea (*Vigna unguiculata* L.) is a widely grown legume food crop of the tropics and sub-tropics. The crop is well adapted to poor fertility and low rainfall conditions. It is grown widely throughout the year for all forms tender pods, dry seeds, green manure and cover crops both as sole and intercrop. It improves soil fertility and physical structure and considered as a suitable crop in rotation even in dry lands. Cowpea pods are good source of fiber, minerals, calcium and vitamins particularly vitamin A and vitamin C. The nutritive value of cowpea grain, leaves and haulms is very high. The crude protein content ranges from 22 to 30% in the grain and leaves on a dry weight. The crop requires good quantity of nutrients throughout its growth periods especially phosphorus for better development of roots, higher nodulation and improved N-fixation. (Asati *et al.* 2018) [3]. However, there is insufficient research work on impact of phosphorus levels on cowpea genotypes under this agro-climatic region. Hence, the present study was conducted.

Materials and Methods
The present experiment was carried out in summer of 2018 at Bagusala Farm (23°39' N latitude, 87°42' E longitude) of M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Gajapati district, Odisha under typical sub-humid and sub-tropical climatic conditions. During the period of study, the maximum and minimum temperature were ranged from 43 to 49 °C and 15 to 18°C respectively. The crop received negligible rainfall during the period of experimentation, that is, from mid-February to mid-June, 2018. The soil of the experimental plot was clay loam in texture. The treatments were comprised of three cowpea genotypes, namely, SB-2, Rawati and Baramasi to four phosphorus levels, that is 0, 20, 40 and 60 kg P_2O_5/ha. The treatments were laid out in Factorial Randomized Block Design and replicated thrice with 12 treatment combinations. Growth and yield parameters were recorded as per standard procedures and analysed statistically.

Results and Discussion

Effect on growth attributes

Experimental observations on plant height, number of branches per plant and number of leaves per plant were recorded at 15 and 45 DAS as influenced by genotypes and phosphorus levels and their interaction effects on above growth stages which are presented in Table 1.

Plant height

The cowpea genotypes expressed variation in plant height with application of different levels of phosphorus. At 15 days after sowing (DAS), maximum plant height (17.50 cm) was recorded in Rawati followed by SB-2 (16.00 cm). Rawati recorded significantly more plant height than other two varieties. However, Baramasi was significantly inferior to other two genotypes in expression of plant height at 15 DAS. Application of 20 kg P_2O_5/ha recorded maximum height of the plant (16.25 cm) followed by 40 kg P_2O_5/ha (16.10 cm) at the same growth stage. The interaction effects between the genotypes and phosphorus levels were also significant in above growth stages. At 45 DAS, highest plant height was observed with Rawati genotype (82.80 cm) followed by Baramasi (82.60 cm) and application of 20 kg P_2O_5/ha recorded maximum plant height (84.55 cm) followed by controlled plot (82.90 cm). The interaction effects between the genotypes and phosphorus levels were also significant in above growth stages. These results are in conformity with the observations noted by Nkaa *et al*. (2014) [8], Sanginga *et al.* (2013) [10] and Namakka *et al.* (2017) [7].

Number of branches per plant

At 15 DAS, maximum branches per plant (4.65) was recorded in Rawati followed by SB-2 (4.03) and application of 20 kg P_2O_5/ha recorded maximum branches per plant (4.22) followed by 60 kg P_2O_5/ha (4.06). At 45 DAS, maximum branches were recorded by the genotype Rawati (17.23) followed by Baramasi (16.78) and the application of 20 kg P_2O_5/ha recorded maximum branches per plant (17.22) followed by 60 kg P_2O_5/ha. The interaction effects between the genotypes and phosphorus levels were also significant in above growth stages in expression of number of branches per plant. Krasilnikoff *et al*. (2003) [4] and Nyoki *et al.* (2013) [9] earlier noted significant effect between the genotypes and phosphorus levels and the results of the present study corroborate the findings of earlier researchers.

Number of leaves per plant

Different genotypes expressed variation in production of number of leaves per plant as noted with different phosphorus levels. At 15 DAS, maximum number of leaves per plant (14.75) was recorded in the genotype Rawati followed by SB-2 (13.08) and application of 20 kg P_2O_5/ha recorded maximum leaves of the plant (14.06). Rawati produced significantly more number of leaves per plant than other two genotypes. However, at 45 DAS maximum number of leaves were recorded with Baramasi (53.46) followed by Rawati (50.71) and at this stage of growth Baramasi was significantly superior to rest of the genotypes. Further, the application of 60 kg P_2O_5/ha recorded maximum leaves of the plant (54.84) during advanced stage of growth that is 45 DAS and it significantly recorded maximum number of leaves than other phosphorus levels. Significant difference was also noted in interaction between cowpea genotypes and phosphorus levels. These results are in agreement with observations recorded by Mawo *et al*. (2016) [5], Musa *et al.* (2017) [6] and Ibrahim *et al.* (2018) [3].

Table 1: Response of cowpea genotypes to phosphorus levels on growth attributes at different growth stages

Treatments	Plant height (cm)		Number of Branches		Number of leaves	
Genotypes	15 DAS	45 DAS	15 DAS	45 DAS	15 DAS	45 DAS
SB-2	16.00	78.35	4.03	14.95	13.08	46.86
Rawati	17.50	82.80	4.65	17.23	14.75	50.70
Baramasi	13.80	82.60	2.90	16.78	10.45	53.46
SEm ±	0.13	0.42	0.04	0.07	0.07	0.28
CD (P=0.05)	0.39	1.25	0.12	0.22	0.21	0.82
Phosphate levels (kg/ha)						
0	14.80	82.90	3.42	15.97	11.46	48.08
20	16.25	84.55	4.22	17.22	14.06	51.11
40	16.10	77.00	3.73	15.13	12.51	47.33
60	16.00	80.50	4.06	16.95	13.00	54.84
SEm ±	0.17	0.56	0.05	0.10	0.09	0.37
CD (P=0.05)	0.52	1.66	0.16	0.30	0.28	1.09
Interaction of genotype x phosphorus level						
SEm ±	0.53	1.70	0.16	0.31	0.28	1.12
CD (P=0.05)	1.57	5.00	0.48	0.90	0.84	3.28
CV (%)	10.2	6.3	12.9	5.7	6.8	6.7

Days to first flowering

Each of the genotypes showed considerable variation in days to first flowering. The minimum days to first flowering were recorded in Baramasi genotype (48.5 DAS). SB-2 genotype exhibited first flower at 56 DAS and Rawati genotype took 56.5 days after sowing. Moreover, application of 60 kg P_2O_5/ha showed early flowering which was statistically at par with 20 kg P_2O_5/ha. Significant effect observed in the interaction between genotypes and phosphorus levels on days to first flowering. These results are in conformity with the findings of Adigun *et al.* (2014) [1] and Shweta and Singh (2017) [14] as they recorded variation in expression of first flowering among cowpea genotypes.

Effect on yield components

The data on number of pods per plot, 100-seed weight (g), pod yield (kg/plot)**,** seed yield (kg/plot) obtained from cowpea genotypes and with different phosphorus levels were presented in Table 2 and 3.

Number of pods/plot

Maximum number of pods/plot was noticed with the genotype Baramasi (914.33) and it was significantly superior to other two genotypes, namely SB-2 and Rawati. Shilpa (2015) [13]

noted variation among cowpea genotypes. The maximum number of pods/plot was noted with the application of 60 kg P_2O_5/ha (1036.66) and it was significantly more than other phosphorus levels. Significant difference was noted in interaction of genotypes and phosphorus levels in expression of number of pods/plot. Singh *et al.* (2011) [15] clearly indicated beneficial impact of phosphorus application up to 60 kg P_2O_5/ha.

100-seed weight

The 100-seed weight of the cowpea was influenced by genotypes as the genotype Baramasi had significantly higher 100-seed weight (12.97 g) than other two genotypes, namely, SB-2 and Rawati (10.91g and 9.35 g). Similar results were obtained earlier by Shilpa *et al.* (2015) [13]. In case of application of phosphorus, 60 kg P_2O_5/ha recorded the maximum value of 100-seed weight (11.70 g) which was significantly superior to other phosphorus levels. The interaction effects between the genotypes and phosphorus levels were also significant. The results corroborate the findings of Urabi *et al.* (2015) [16] and Musa *et al*. (2017) [6].

Table 2: Response of cowpea genotypes to phosphorus levels on days to first flowering and yield attributes.

Treatments	Days to first flowering	Number of pods/plot	100-seed weight (g)
Genotypes			
SB-2	56.0	892.58	10.91
Rawati	56.5	869.16	9.35
Baramasi	48.5	914.33	12.97
SEm±	0.24	9.70	0.05
CD (P=0.05)	0.72	28.47	0.14
Phosphate levels (kg/ha)			
0	53.7	734.22	10.52
20	53.1	838.33	10.98
40	55.2	959.00	11.10
60	52.7	1036.66	11.70
SEm±	0.32	12.94	0.06
CD (P=0.05)	0.96	37.96	0.18
Interaction of genotype x phosphorus level			
SEm±	0.98	38.83	0.19
CD (P=0.05)	2.88	113.88	0.56
CV (%)	5.5	13	3.54

Pod yield (kg/plot)

Pod yield was differed significantly among cowpea genotypes. The genotype Baramasi produced significantly higher pod yield/plot (5.22 kg) and in terms of pod yield/ha was (4355 kg/ha) than other genotypes and the highest pod yield (5.12 kg/plot) was recorded with the application of 60 kg P_2O_5/ha and it was significantly superior to other phosphorus levels. Interaction effects on Pod yield between the genotypes and phosphorus levels were also significant. Satodiya *et al.* (2015) [11] observed the significant effect of yield and yield attributes.

Seed yield (kg/plot)

The cowpea genotypes expressed variation in exhibiting the seed yield of cowpea. The maximum seed yield/plot was recorded with the genotype Baramasi (1.15 kg) and the Baramasi genotype produced higher seed yield than the genotypes SB-2 and Rawati. Further, application of 60 kg P_2O_5/ha registered the maximum seed yield/plot (1.37 kg) and in terms of seed yield/ha was (964.81 kg/ha) the treatment was significantly superior to other phosphorus levels. Interaction effects on seed yield between the genotypes and phosphorus levels were also significant. The results are in conformity with the findings of earlier researchers like Pardhi (2016) [12].

Table 3: Response of cowpea genotypes to phosphorus levels on pod and seed yield (kg/plot).

Treatments	Pod yield (kg/plot)	Seed yield (kg/plot)
Genotype		
SB-2	4.92	1.07
Rawati	4.46	0.97
Baramasi	5.22	1.15
SEm ±	**0.03**	**0.01**
CD (P=0.05)	**0.10**	**0.02**
Phosphate levels (kg/ha)		
0	4.27	0.75
20	4.97	0.93
40	5.10	1.22
60	5.12	1.37
SEm±	**0.04**	**0.01**
CD (P=0.05)	**0.13**	**0.02**
Interaction of genotype x phosphorus level		
SEm±	**0.13**	**0.02**
CD (P=0.05)	**0.40**	**0.07**
CV (%)	**8.5**	**6.7**

Conclusion

From the present study, it has been clearly observed that the genotype Baramasi performed better than SB-2 and Rawati. However, the best results in terms of yield attributes and yield were registered with 60 kg P_2O_5/ha.

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