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RESEARCH ARTICLE :

Effect of plant density, nitrogen and phosphorus level on yield attributing charecters of cowpea (*Vigna unguiculata* (L.) Walp)

MANISHA SHIVADE, M.S. PARIHAR, A. HALDAR, P. BARDE AND R. THAKUR

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SUMMARY : Cowpea is a popular grain legume which is grown as vegetable and fodder. It can be grown successfully during monsoon and summer. Being rich sources of proteins, vitamins and minerals for the predominantly vegetarian population and are popularly known as “Poor man’s meat” and “rich man’s vegetable” (Singh and Singh, 1992). This investigation was conducted at the Vegetable Research Farm Department of Horticulture, R.A.K. College of Agriculture, Sehore, under Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during the *kharif* season of 2011-2012. The experiment was aimed to find out specific plant density, nitrogen and phosphorus level. The experiment consisted of three plant densities *viz.* D_1 (60 x 10 cm), D_2 (60 x 15 cm) and D_3 (60 x 20 cm), three nitrogen levels *viz.* N_0 (0 kg/ha), N_1 (20 kg/ha) and N_2 (40 kg/ha) and three phosphorus levels *viz.* P_0 (0 kg/ha), P_1 (40 kg/ha) and P_2 (80 kg/ha) with three replication and Randomized Block Design (RBD). The significant findings of the investigations are highlighted as under plant density, nitrogen and phosphorus level on different yield charecters *viz.* first flower flush (50%), number of cluster per plant, flowers per plant, pod per plant, pod per plant, seed per pod, seed index, pod length, seed yield per ha, protein content and net profit.

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Author for correspondence :
MANISHA SHIVADE
R.V.S. Agriculture University, Gwalior, R.A.K. College of Agriculture, SEHORE (M.P.) INDIA
Email : ajayhldr@gmail.com
See end of the article for authors’ affiliations

BACKGROUND AND OBJECTIVES

The important grain legumes grown in India are bengalgram, lentil, greengram, blackgram, cowpea, redgram, peas etc. Among grain legumes cowpea (*Vigna unguiculata* (L.) Walp.) Is of immense importance. It is an important multipurpose grain legume extensively cultivated in arid and semiarid tropics. The green pod of cowpea is used as vegetables. In addition to grain, it is also grown for its nutritious fodder. Cowpea is grown as catch crop, mulch crop, intercrop, mixed crop and green crop. It has ability to fix atmospheric nitrogen in soil at the rate of 56 kg per ha in association with symbiotic bacteria under favourable conditions (Yadav,

1986).

Cowpea can be used at all stages of growth as a vegetable crop. The tender green leaves are an important food source in Africa and are prepared as a pot herb, like spinach. Immature snapped pods are used in the same way as snap beans, often being mixed with other foods. Green cowpea seeds are boiled as a fresh vegetable, or may be canned or frozen. Dry mature seeds are also suitable for boiling and canning.

In many areas of the world, the cowpea is the only available high quality legume hay for livestock feed. Digestibility and yield of certain cultivars have been shown to be comparable to alfalfa. Cowpea may be used green or sas dry fodder. It also is used as a green manure crop, a nitrogen fixing crop, or for erosion control. Similar to other grain legumes, cowpea contains trypsin inhibitors which limit protein utilization.

Application of fertilizers and optimum plant density type within the genetic limit is determined by its environment. The releases of high yielding varieties have contributed a great deal towards the improvement of cowpea yields. The yield potential of these high yielding varieties can be further exploited through better agronomic practices including balanced fertilizer application.

RESOURCES AND METHODS

This investigation was conducted at the Vegetable Research Farm Department of Horticulture, R.A.K. College of Agriculture, Sehore, under Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during the *kharif* season of 2011-2012. The experiment was aimed to find out specific plant density, nitrogen and phosphorus level. The experiment consisted of three plant densities *viz.* D_1 (60 x 10 cm), D_2 (60 x 15 cm) and D_3 (60 x 20 cm), three nitrogen levels *viz.* N_0 (0 kg/ha), N_1 (20 kg/ha) and N_2 (40 kg/ha) and three phosphorus levels *viz.* P_0 (0 kg/ha), P_1 (40 kg/ha) and P_2 (80 kg/ha) with three replication and Randomized Block Design (RBD). Observations recorded during the yield charecters *viz.* first flower flush (50%), number of cluster per plant, flowers per plant, pod per plant, pod per plant, seed per pod, seed index, pod length, seed yield per ha, protein content and net profit.

OBSERVATIONS AND ANALYSIS

Days to first flower flush (50%) plant were affect by the levels of plant density had significant impact. In D_1 (60 x 10cm) found early flowering were (43.04) as compared to D_3 (60 x 20 cm) (44.83). The treatment

Table 1: Effect of different levels of plant density, nitrogen and phosphorus on yield charecters

Treatments	Days to first flower flush (50%) plant	Cluster per plant		Flowers per plant	Percentage of pod set	Pods per plant	Seed per pod	Seeds index (g)	Pod length (cm)	Seed yield (q/ha)	Protein content in seed
		45 DAS	60 DAS								
Plant density											
D_1 (60 x 10 cm)	43.04	4.30	5.94	18.60	42.78	13.48	12.63	11.74	15.47	6.30	23.59
D_2 (60 x 15 cm)	44.40	4.06	5.89	19.31	40.48	12.01	13.41	11.98	14.83	5.69	23.14
D_3 (60 x 20 cm)	44.83	4.57	5.20	19.04	40.94	12.72	12.03	12.47	14.13	5.86	23.36
S.E.±	0.40	0.14	0.12	0.10	0.90	0.16	0.17	0.11	0.21	0.08	0.11
C.D. (P=0.05)	1.16	NS	0.36	0.29	NS	0.46	0.49	0.33	0.34	0.25	0.33
Nitrogen level											
N_0 (0 kg/ha)	44.74	3.64	5.40	18.99	42.78	10.57	12.48	12.05	14.56	5.39	23.32
N_1 (20 kg/ha)	43.76	4.45	5.64	18.95	40.90	13.02	13.51	11.88	15.50	5.75	23.46
N_2 (40 kg/ha)	43.77	4.84	5.99	19.01	40.51	14.63	12.09	12.26	14.39	6.71	23.32
S.E.±	0.40	0.14	0.12	0.10	0.90	0.16	0.17	0.11	0.21	0.08	0.11
C.D. (P=0.05)	NS	0.40	0.36	NS	NS	0.46	0.49	0.33	0.34	0.25	NS
Phosphorus level											
P_0 (0 kg/ha)	44.17	4.00	5.27	17.13	41.07	11.42	12.17	11.65	14.13	4.83	22.55
P_1 (40 kg/ha)	44.52	4.34	5.82	18.53	40.93	12.33	12.93	12.28	14.74	6.04	23.63
P_2 (80 kg/ha)	43.58	4.58	5.94	21.30	42.19	14.63	12.97	12.26	15.57	6.99	23.92
S.E.±	0.40	0.14	0.12	0.10	0.90	0.16	0.17	0.11	0.21	0.08	0.11
C.D. (P=0.05)	NS	0.40	0.36	0.29	NS	0.46	0.49	0.33	0.34	0.25	0.33

NS=Non-significant

combination was shown significant impact over this factor. The lowest days to first flower were noted in $D_3N_2P_2$ (38 days). Prasad *et al*. (2008) reported that the affect the P level.

The numbers of cluster per plant were affected significantly by the levels of found plant density, N and P levels. In D_1 (60 x 10cm) found maximum cluster per plant were (5.94) noted as compared to D_3 (60 x 20 cm) (5.20). The level of N found maximum number of cluster per plant, at N_2 (40kg/ha), where noted (5.99) as compared to N_0 (0kg/ha) (5.40). Similarly P_2 (80kg/ha) were shown highest number of cluster per plant (5.94) then P_0 (0 kg/ha) (5.27). The treatment combination $D_1N_2P_2$ (60x 10cm- , 40kg/ha and 80 kg/ha) were noted the highest number of cluster (7.87).

Flower per plant observed the levels of P and plant density significant but N had non-significant impact. In D-$_2$ (60 x15cm) (18.60). The level of P found maximum flower per plant N_2 (80kg/ha) were (21.30) as compared to P_0 (17.13). The treatment combination D_2N-$_1P_2$ (60x15 cm, 20 kg N/ha and 80 kg P/ha) were observed highest number of flower (22.37). Jain *et al*. (1993) reported increasing effect of N.

Pod per plant were affect by the levels of N, P and plant density found significant. In D_1 (60x 10 cm) found maximum pods per plant were (13.48) as compared to D_2 (60 x 15cm) (12.01). The levels of N_2 (40kg/ha) maximum pods per plant were (14.63) noted than N_1 (13.02). Similarly P_2 (80kg/ha) shown highest pods per plant $D_1N_2P_2$ (60 x 10cm, 40kg/ha and 80 kg P_2O_5/ha)

Table 2: Combined effect of plant density, nitrogen and phosphorus on different yield charecters

Treatments	Days to first flower flush (50%) plant	Cluster per plant at 60 DAS	Flowers per plant	Pods per plant	Seed per pod	Seed index (g)	Pod length (cm)	Seed yield (q/ha)	Protein content in seed
$D_1N_0P_0$	40.34	5.40	17.20	9.20	12.07	10.57	14.93	5.24	22.60
$D_1N_1P_0$	43.23	5.50	17.20	11.07	13.93	10.63	15.90	4.32	22.18
$D_1N_2P_0$	42.31	5.83	16.57	12.83	10.80	12.53	13.40	5.40	24.23
$D_2N_0P_0$	44.86	3.97	17.97	9.53	14.03	10.73	13.40	5.30	22.13
$D_2N_1P_0$	43.07	5.50	16.70	12.63	13.10	10.63	15.13	4.27	22.69
$D_2N_2P_0$	49.08	6.20	17.47	11.80	12.87	11.77	13.53	4.17	21.73
$D_3N_0P_0$	47.67	4.97	17.60	9.51	10.00	12.27	13.47	4.03	22.38
$D_3N_1P_0$	44.58	5.40	16.50	13.40	12.80	13.50	13.97	5.33	22.52
$D_3N_2P_0$	45.41	4.63	16.95	12.7	9.96	12.20	13.40	5.36	22.44
$D_1N_0P_1$	43.11	5.77	17.90	10.40	10.93	13.20	15.73	5.57	23.29
$D_1N_1P_1$	43.47	5.63	18.67	13.93	14.03	11.13	16.43	6.08	24.88
$D_1N_2P_1$	42.09	5.20	18.10	14.07	14.07	12.77	14.07	7.67	23.56
$D_2N_0P_1$	44.73	7.53	18.20	10.67	13.03	13.37	14.70	4.67	23.43
$D_2N_1P_1$	45.57	5.77	19.13	11.30	14.23	12.30	13.77	5.83	23.96
$D_2N_2P_1$	46.10	7.40	19.00	12.93	12.83	10.93	13.63	6.33	23.41
$D_3N_0P_1$	46.78	4.40	19.47	10.57	12.60	12.20	13.67	5.17	23.90
$D_3N_1P_1$	46.04	5.97	18.07	12.83	12.97	12.03	15.67	6.43	23.65
$D_3N_2P_1$	42.07	4.73	18.20	14.3	11.63	12.60	14.96	6.5	22.60
$D_1N_0P_2$	44.97	5.73	18.80	11.30	12.53	12.33	15.50	6.32	24.89
$D_1N_1P_2$	42.73	6.53	21.10	17.10	13.80	11.00	16.83	6.83	23.01
$D_1N_2P_2$	45.10	7.87	21.90	21.43	11.50	11.47	16.43	9.26	23.70
$D_2N_0P_2$	42.03	4.87	21.70	11.83	14.03	12.37	15.97	6.67	23.31
$D_2N_1P_2$	41.11	6.07	22.37	13.10	13.97	13.10	16.97	5.67	24.12
$D_2N_2P_2$	46.06	5.73	21.27	14.30	12.60	12.63	16.40	8.27	23.51
$D_3N_0P_2$	48.20	5.97	22.07	12.03	13.07	11.43	13.63	5.53	23.98
$D_3N_1P_2$	44.03	4.40	20.86	11.83	12.73	12.60	14.80	7.00	24.10
$D_3N_2P_2$	38.00	6.30	21.66	17.20	12.5	13.40	13.60	7.33	24.69
S.E. ±	1.22	0.38	0.31	0.49	0.52	0.35	0.36	0.26	0.35
C.D. (P=0.05)	3.48	1.10	0.88	1.39	1.48	1.004	1.03	0.75	0.99

were observed highest pods per plant (17.20). Jain *et al.* (1993), Sharma *et al.* (1996), Ahmad and Tanki (1997) and Shank *et al.* (2003) reported that nitrogen application significantly increase pods per plant. Rajput (1994), Singh *et al.* (2005), Maharudrappa and Sharanappa (1990), Baboo and Mishra (2001), Parmar *et al.* (1999) found similar result to application of Phosphorus. Yadav (2003) reported that significant effect of spacing.

The seed per pod was influenced significantly affected by the level of plant density, N and P. In plant density D_2 (60 x 15cm) maximum seed found in pod were (13.41) as compared to D_3 (60 x 20cm) (12.03). The level of N_1 maximum seed per pod (13.51) noted as compared to N_2 (40kg/ha) (12.09). In P_2 (80kg/ha) were found maximum seed per pod (12.97) than P_0 (0kg/ha) (12.17). The treatment combination $D_2N_1P_2$ found maximum sees per pod (14.23). Rajput (1994), Ahlawat (1996) and Parmar *et al.* (1999) reported increasing effect of P_2O_5 and N.

The seed index was affect by the levels of plant density and P levels significant but N had non-significant impact. In D_3 (60 x 20cm) maximum seed index (12.47) were noted as compared to D_1 (60 x 10cm) (11.74). The level of P_1 (40kg/ha) was found maximum seed index (12.28) than P_0 (0kg P/ha) (11.65). The treatment combination $D_3N_1P_0$ (60x20 cm, 20 kg N/ha and 0 kg P/h) found maximum seed index (13.50). Baboo and Sharma (1995) and Naim and Jabereldu (2010) found significant impact of plant density and P_2O_5.

The pod length was recorded significant levels of N, P and plant density. In D_2 (60 x 15cm) maximum pod length were (14.83) noted as compared to D_3 (60 x 20cm) (14.13). The levels of N found maximum pod length at N_1 (20kg/ha) in (15.50) as compared to N_2 (40kg/ha) (14.39). In P_2 (80kg/ha) maximum pod length were (15.57) noted as compared to P_0 (0kg/ha) (14.13). The

Table 3: Economics of various treatments for cowpea

Treatments	Seed yield (q/ha)	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net profit (Rs./ha)	B:C ratio
$D_1N_0P_0$	5.24	20960	8481.4	12478.6	2.47
$D_1N_1P_0$	4.23	16920	8728.34	8181.66	1.93
$D_1N_2P_0$	5.40	21600	8777.03	12822.97	2.46
$D_1N_0P_1$	5.57	22280	9331.4	12948.6	2.38
$D_1N_1P_1$	6.08	24320	9578.34	14741.66	2.53
$D_1N_2P_1$	7.67	30680	9627.03	21052.97	3.18
$D_1N_0P_2$	6.32	25280	10181.4	15098.6	2.48
$D_1N_1P_2$	6.83	27320	10428.34	16891.66	2.61
$D_1N_2P_2$	9.26	37040	10477.03	26562.97	3.53
$D_2N_0P_0$	5.30	21200	8481.4	12718.6	2.49
$D_2N_1P_0$	4.27	17080	8728.34	8351.66	1.95
$D_2N_2P_0$	4.17	16680	8777.03	7902.97	1.90
$D_2N_0P_1$	4.67	18680	9331.4	9348.6	2.00
$D_2N_1P_1$	5.83	23320	9578.34	13741.66	2.43
$D_2N_2P_1$	6.33	25320	9627.03	15692.97	2.63
$D_2N_0P_2$	6.67	26680	10181.4	16498.6	2.62
$D_2N_1P_2$	5.67	22680	10428.34	12251.66	3.17
$D_2N_2P_2$	8.27	33080	10477.03	22602.97	1.53
$D_3N_0P_0$	4.03	16120	8481.4	7638.6	2.51
$D_3N_1P_0$	5.33	21320	8728.34	12591.66	2.45
$D_3N_2P_0$	5.36	21440	8777.03	12662.97	2.44
$D_3N_0P_1$	5.17	20680	9331.4	11348.6	2.21
$D_3N_1P_1$	6.43	25720	9578.34	16141.66	2.68
$D_3N_2P_1$	6.50	26000	9627.03	16372.97	2.70
$D_3N_0P_2$	5.53	22120	10181.4	11938.6	2.17
$D_3N_1P_2$	7.00	28000	10428.34	17571.66	2.68
$D_3N_2P_2$	7.33	29320	10477.03	18842.97	2.79

treatment combination $D_2N_1P_2$ found maximum pod length (16.97). Ahmad and Tanki (1997) and Shanke *et al.* (2003) reported the significant effect of N fertilizer. Singh *et al.* (2005) found similar result.

The seed yield was recorded significantly increasing with the increase in plant density, N level and Phosphorus level as an individual factor. The level of plant density D_1 (60 x 10 cm) was recorded maximum seed yield (6.30 q/ha) as compared to D_2 (60 x 15cm) (5.69 q/ha). In N_2 (40kg/ha) maximum seed yield noted (6.71q/ha) to compared with N_0 (0kg/ha) (5.39 q/ha). Similarly, P_2 (80kg/ha) shown highest seed yield (6.99 q/ha) than P_0 (0kg/ha) (4.83 q/ha). The treatment combination $D_1N_2P_2$ found maximum seed yield (9.26 q/ha). Patil *et al.* (1991), Manjappa *et al.* (1994) and Abdilbagi *et al.* (2000) reported that significant effect on plant density levels. Jain *et al.* (1993) and Sharma *et al.* (1996) observed significant impact on N level. Singh and Verma (2002), Murthy *et al.* (1990), Ramamurthy *et al.* (1990), Gandhi *et al.* (1991), Singh (1991), Kher *et al.* (1994), Sharma (2001) found similar result in the study.

The protein content was affect by the level of plant density and P significantly but N found non- significant impact. The level of plant density D_1 (60 x 10cm) maximum protein content were (23.59) noted as compared to D_2 (60 x 15cm) (23.14). In P_2 (80kg/ha) maximum protein content in seed found (23.92) than P_0 (0kg/ha) (22.55). The treatment combination $D_1N_0P_2$ (60x10, 0 kg N/ha and 80 kg P/ha) were observed the highest protein content (24.89). Das *et al.* (1997) and Baboo and Mishra (2001), show positive response of P.

The plant density, nitrogen and phosphorus levels were observed highest net return (Rs. 26562.97/ha) and cost benefit ratio (3:53) was maximum with the treatment combination of $D_1N_2P_2$ (60x10 cm, 40 kg N /ha and 80 kg/ha). Singh and Tripathi (1994), Naidu *et al.* (2001) Swaroop *et al.* (2002) and Nandi (2008) reported the similar result in this study. Patil *et al.* (1995) also reported the maximum cost benefit ratio with the application of N and P.

Authors' affiliations :

M.S. PARIHAR, A. HALDAR, P. BARDE AND R. THAKUR, R.V.S. Agriculture University, Gwalior, R.A.K. College of Agriculture, SEHORE (M.P.) INDIA

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