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RESEARCH ARTICLE :

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

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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 experiment 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 growth phase *viz.*, plant height (cm), number of branches per plant, number of leaves per plant, leaf area, days to first flower flush (50%) plant, number of root nodules per plant at 60 DAS and dry weight of stem, root, nodules and leaves.

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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).

In India, cowpea is grown in an area of 3.9 million hectares with a production of 2.21 million tones (C.L.R.S., 2010). In Madhya Pradesh, the crop is grown in an area of 0.75 million hectares with a production of 0.24 million tones. The productivity of cowpea in Madhya Pradesh is low (418 kg/ha) as compared to the national productivity of 567 kg per ha. This clearly indicates the necessity to identify the reasons for such low productivity in India in general and Madhya Pradesh in particular.

The vegetable seed production is a very important and profitable enterprise but to obtain the optimum production of quality seeds, the knowledge of various cultural practices required to raise the crop is very essential but meagre. Hence, need to obtain the adequate information on cultural practices *viz.*, spacing and fertilizer doses were felt. The establishment of an optimum plant population per unit land area is one of the most important contributory factors determining the growth and seed yield of cowpea the spacing between plants has a direct bearing on the growth, development, seed yield and quality. However, the response of different varieties to spacing may vary depending on their growth pattern and fertilizer uptake efficiency. Therefore, appropriate spacing should be determined for maximum production.

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 growth phase *viz.*, plant height (cm), number of branches per plant, number of leaves per plant, leaf area, days to first flower flush (50%) plant, number of root nodules per plant at 60 DAS and dry weight of stem, root, nodules and leaves are important growth characters.

OBSERVATIONS AND ANALYSIS

The influence of N, P and plant density levels were significant in the all growth stages. The plant height were recorded maximum (85.30 cm) in $D_1N_1P_2$ treatment combination 60x10 cm plant density with N 20 kg/ha + 80 kg/ha. Further, it was also noted that the impact of N and P levels found significant linearly as per increasing levels. But the effect of plant density were reverse here, maximum plant height was noted in dose on D_1 (60x10 cm) than wider plant density D_2 (60x15 cm), D_3 (60x20 cm). Pawar *et al.* (2007), Ahlawat (1996) found similar result. Baboo and Mishra (2001), Paliwa *et al.* (1999), Ayub *et al.* (2002) reported increased in plant height with the application of N. Yadav (2003) found significant effect of spacing.

Number of branches per plant were recorded and found linear increasing with the increase in plant density, nitrogen and phosphorus levels as a individual factor but statistically the effect was non-significant on number of branches per plant the highest number of branches (4.66) were noted in N_2 (40 kg/ha) followed by D_3 (60x20 cm) and P_2 (80 kg/ha) (4.76) and (4.66), respectively. Paliwal *et al.* (1999) were observed significant increased in number of branches per plant (20.00) with the application of 120 kg /ha. Ahmed and Tanki (1997) reported similar result.

The leaves per plant were affecting by the levels of N and P significantly but plant density had non- significant impact. In N_2 (40 kg /ha) maximum number of leaves per plant were (53.17) noted as compared to N_0 (0 kg / ha) (45.72). Similarly P_2 (80 kg /ha) shown highest number of leaves per plant (54.79) than P_0 (0 kg /ha).

The treatment combination $D_2N_2P_2$ (80 kg P/ha, 40 kg N/ha and 60x15 cm) were observed highest number of leaves (67.97). Fegeria *et al.* (1992) shows significant impact of nitrogen over number of leaves per plant similar result reported by Paliwal *et al.* (1999). Baboo and Mishra (2001) reported positive impact of N and P on number of leaves per plant. Similarly Rajput (1994), Naim

Table 1 : Effect of different levels of plant density, nitrogen and phosphorus on plant height, number of branches per plant at successive crop growth stages

Treatments	Plant height					Number of branches per plant				
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS
Plant density										
D_1 (60 x 10 cm)	9.57	21.17	35.36	44.18	63.37	1.99	2.91	3.28	3.46	4.21
D_2 (60 x 15 cm)	9.49	21.10	30.66	39.13	51.54	2.03	2.81	3.36	3.87	4.59
D_3 (60 x 20 cm)	9.53	21.49	29.09	42.16	51.99	2.21	2.87	3.37	4.02	4.76
S.E. ±	0.24	0.70	1.25	1.16	0.08	0.07	0.07	0.08	0.11	0.14
C.D. (P=0.05)	NS	NS	3.57	3.30	3.07	NS	NS	NS	0.32	0.41
Nitrogen level										
N_0 (0 kg/ha)	8.53	18.76	26.69	37.51	50.54	1.89	2.68	3.13	3.55	4.19
N_1 (20 kg/ha)	10.10	22.89	33.67	42.83	57.83	2.16	2.92	3.36	3.89	4.51
N_2 (40 kg/ha)	10.01	22.22	34.74	45.13	58.52	2.18	2.99	3.54	3.91	4.86
S.E. ±	0.24	0.70	1.25	1.16	0.08	0.07	0.07	0.08	0.11	0.14
C.D. (P=0.05)	0.69	1.99	3.57	3.30	3.07	0.22	0.22	0.22	NS	0.41
Phosphorus level										
P_0 (0 kg/ha)	8.61	18.82	32.21	40.79	50.57	1.97	2.84	3.25	3.57	4.27
P_1 (40 kg/ha)	9.18	21.96	29.99	40.52	54.64	2.15	2.95	3.42	3.90	4.63
P_2 (80 kg/ha)	10.86	23.09	32.91	44.16	61.68	2.11	2.80	3.34	3.87	4.66
S.E. ±	0.24	0.70	1.25	1.16	0.08	0.7	0.7	0.8	0.11	0.14
C.D. (P=0.05)	0.69	1.99	NS	NS	3.07	NS	NS	NS	NS	NS

NS=Non-significant

Table 2 : Effect of different levels of plant density, nitrogen and phosphorus on number of leaves per plant and leaf area cm^2 at successive crop growth stages

Treatments	Number of leaves per plant					Leaf area cm^2				
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS
Plant density										
D_1 (60 x 10 cm)	12.74	28.97	38.93	44.42	51.63	10.22	17.50	38.03	46.73	53.39
D_2 (60 x 15 cm)	12.19	31.19	36.74	42.43	46.72	10.18	17.20	38.60	46.49	50.19
D_3 (60 x 20 cm)	12.51	27.70	37.82	42.58	49.94	10.25	19.75	38.35	46.70	55.36
S.E. ±	0.37	1.36	1.06	1.31	1.42	0.18	0.33	0.21	0.10	1.21
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	0.95	NS	NS	3.45
Nitrogen level										
N_0 (0 kg/ha)	11.30	26.36	34.81	40.15	45.72	9.95	17.18	37.63	46.33	50.48
N_1 (20 kg/ha)	13.15	32.56	37.53	44.76	49.60	10.48	17.69	38.66	46.97	54.53
N_2 (40 kg/ha)	12.99	28.94	41.14	44.53	53.17	10.22	19.59	38.68	46.62	53.93
S.E. ±	0.37	1.36	1.06	1.31	1.42	0.18	0.33	0.21	0.10	1.21
C.D. (P=0.05)	1.07	3.88	3.02	3.74	4.05	NS	0.95	0.60	0.31	3.45
Phosphorus level										
P_0 (0 kg/ha)	11.47	28.94	35.93	39.07	45.00	8.65	15.21	32.20	44.77	52.98
P_1 (40 kg/ha)	12.54	31.00	36.00	42.03	48.70	10.16	17.98	38.76	46.78	57.59
P_2 (80 kg/ha)	13.43	27.91	41.56	48.33	54.79	11.84	21.26	44.02	48.40	54.37
S.E. ±	0.37	1.36	1.06	1.31	1.42	0.18	0.33	1.21	0.10	1.21
C.D. (P=0.05)	1.07	NS	3.02	3.74	4.05	0.53	0.95	0.60	0.31	3.45

NS=Non-significant

and Jabrelder (2010) had similar result as found in the study. The increase in plant density had decrease in number of leaves per plant.

The leaf area per plant was affected by the levels of plant density and N was found significant with the increasing levels. But P had non-significant impact. In plant density D_3 (60x20 cm) maximum leaf area was (55.36) noted as compared to D_2 (60x15 cm) (50.19). Similarly N_1 (20 kg/ha) maximum leaf area were (54.53) found as compared to N_0 (0 kg/ha) (50.48). The treatment combination $D_3N_2P_2$ (60x20 cm, 40 kg N/ha and 80 kg P/ha) were noted maximum leaf area (66.50). Singh *et al.* (1995) reported increasing effect of P. Naim and Jabrelder (2010) had similar result found in the study.

Number of nodules per plant was reported significant impact on the levels of plant density, N and P. In N_2 (40 kg/ha) maximum number of nodules were (21.90) noted as compared to N_0 (0 kg/ha) (14.56). Similarly impact of P level were noted (18.75) noted in P_2 (80 kg/ha) as compared to P_0 (0 kg/ha) (17.39). In plant density levels were found statistically significant at the level of D_3 (60x20 cm) (19.92) as compared to (16.74) in D_1 (60x10 cm). The treatment combination $D_2N_2P_2$ (60x15 cm, 40 kg N/ha and 80 kg P/ha) were observed highest number of nodules per plant (23.43). Singh and Nair (1995) were observed significant impact in number of nodules per plant. The result agreed with the finding of Norman *et al.* (1998) and Ankomah *et al.* (1995). Okleya and Okelana (1997) reported similar result. Rajput (1994) observed increasing effect of P_2O_5.

Dry weight of nodules was recorded significantly impact the level of N,P and plant density. In D_1 (60x10 cm) maximum dry weight of nodules were (0.39) noted as compared to D_3 (60x20 cm) (0.34). In N_2 (20 kg/ha) shown maximum dry weight of nodules (0.44) than N_0 (0.29) in P level found statistically significant in P2 (80 kg/ha) maximum dry weight of nodules (0.38) as compared to P_0 (0 kg/ha) (0.35). The treatment combination $D_1N_2P_2$ (60x10 cm, 40 kg/ha and 80 kg/ha) were observed maximum dry eight of nodules (0.52).

Dry weight of stem was recorded significant impact on N, P and plant density levels. In D_3 (60x20 cm) maximum dry weight of stem were (1.46) noted as compared to D_2 (60x15 cm) (1.38). In N_0 (0 kg/ha) maximum dry weight of stem (1.46) noted as compared to N_2 (1.40). The P levels maximum dry weight of stem noted (1.46) in P_2 (80 kg/ha) as compared to P_0 (0kg/ha) (1.35). The treatment combination $D_1N_0P_2$ (60x10cm, 0 kg/ha and 80 kg/ha) were observed maximum dry weight of stem (1.63).

Table 3 : Effect of different levels of plant density, nitrogen and phosphorus on Number of nodules per plant, dry weight of nodules, dry weight of stem (g), dry weight of root (g), dry weight of leaves (g) and leaf area cm^2 at successive crop growth stages

Treatments	Number of nodules per plant	Dry weight of nodules	Dry weight of stem (g)	Dry weight of root (g)	Dry weight of leaves (g)
Plant density					
D_1 (60 x 10 cm)	16.74	0.39	1.42	1.01	3.24
D_2 (60 x 15 cm)	17.73	0.36	1.38	1.02	3.01
D_3 (60 x 20 cm)	19.92	0.34	1.46	1.01	3.20
S.E. ±	0.22	0.009	0.01	0.004	0.33
C.D. (P=0.05)	0.64	0.02	0.04	NS	NS
Nitrogen level					
N_0 (0 kg/ha)	14.56	0.29	1.46	1.03	2.64
N_1 (20 kg/ha)	17.93	0.37	1.41	1.02	3.37
N_2 (40 kg/ha)	21.90	0.44	1.40	0.99	3.44
S.E. ±	0.22	0.009	0.01	0.004	0.33
C.D. (P=0.05)	0.64	0.02	0.04	NS	NS
Phosphorus level					
P_0 (0 kg/ha)	17.39	0.35	1.35	0.96	2.93
P_1 (40 kg/ha)	18.25	0.36	1.45	1.03	3.14
P_2 (80 kg/ha)	18.75	0.38	1.46	1.05	3.39
S.E. ±	0.22	0.009	0.01	0.004	0.33
C.D. (P=0.05)	0.64	0.02	0.04	0.012	NS

NS=Non-significant

Table 4 : Combined effect of plant density, nitrogen and phosphorus on different growth stages of plant

Treatments	Plant height at 75 DAS	Number of leaves / plant at 75 DAS	Leaf area at 75 DAS	Number of nodules/ plant at 60 DAS	Dry weight of nodules at final harvest	Dry weight of stem (g)	Dry weight of root (g)	Dry weight of leaves (g)
$D_1N_0P_0$	46.73	44.23	50.50	12.67	0.28	1.41	1.01	2.10
$D_1N_1P_0$	57.77	44.90	53.63	15.37	0.43	1.23	0.92	3.59
$D_1N_2P_0$	54.50	50.83	52.03	18.80	0.39	1.22	0.98	3.57
$D_2N_0P_0$	55.20	40.87	48.13	14.47	0.29	1.24	0.97	2.18
$D_2N_1P_0$	44.77	41.60	57.07	14.87	0.38	1.36	0.93	2.65
$D_2N_2P_0$	57.30	41.30	47.43	20.70	0.40	1.26	0.94	3.20
$D_3N_0P_0$	56.07	55.40	60.23	15.04	0.31	1.36	0.92	2.43
$D_3N_1P_0$	38.97	41.70	54.30	21.23	0.24	1.47	0.96	3.23
$D_3N_2P_0$	43.86	44.20	53.47	22.3	0.44	1.57	0.73	3.44
$D_1N_0P_1$	75.40	50.97	51.63	13.30	0.28	1.51	1.04	2.94
$D_1N_1P_1$	61.93	45.23	49.43	14.87	0.47	1.42	1.02	3.43
$D_1N_2P_1$	55.63	62.07	53.23	22.50	0.41	1.53	1.01	3.27
$D_2N_0P_1$	42.87	33.67	46.27	15.07	0.35	1.34	1.03	2.48
$D_2N_1P_1$	46.40	42.63	53.43	17.37	0.34	1.48	1.06	3.21
$D_2N_2P_1$	55.17	53.90	49.83	21.53	0.41	1.33	1.05	3.32
$D_3N_0P_1$	34.40	42.57	51.57	15.73	0.23	1.55	1.03	2.48
$D_3N_1P_1$	69.53	63.40	59.47	21.37	0.33	1.51	1.03	3.72
$D_3N_2P_1$	50.46	43.86	49.4	22.5	0.38	1.42	1.04	3.37
$D_1N_0P_2$	66.63	48.57	44.10	14.57	0.29	1.65	1.05	3.26
$D_1N_1P_2$	85.30	59.30	60.60	15.87	0.45	1.44	1.04	3.51
$D_1N_2P_2$	66.47	58.53	65.37	22.73	0.52	1.36	1.05	3.46
$D_2N_0P_2$	36.30	44.17	52.33	14.23	0.30	1.45	1.06	3.36
$D_2N_1P_2$	61.87	56.20	49.23	17.87	0.31	1.46	1.08	3.57
$D_2N_2P_2$	63.97	67.97	48.00	23.43	0.47	1.53	1.06	3.17
$D_3N_0P_2$	41.30	51.07	49.53	16.00	0.25	1.63	1.04	2.51
$D_3N_1P_2$	53.97	57.43	53.63	21.53	0.37	1.29	1.05	3.47
$D_3N_2P_2$	79.30	55.86	66.50	22.50	0.49	1.35	1.05	4.17
S.E. ±	3.24	4.27	2.10	0.60	0.02	0.05	0.01	0.09
C.D. (P=0.05)	9.22	12.15	10.3	1.73	0.75	0.14	0.03	0.28

Dry weight of root was affect by the levels of P had significant but plant density and N had non-significant impact. In P_2 (80 kg/ha) maximum dry weight of root were noted (1.05) as compared to P_0 (kg/ha). The treatment combination $D_2N_1P_2$ (60x15 cm, N 20 kg/ha and P 80 kg/ha) were observed maximum dry weight of root (1.08).

The dry weight of leaves was affect the levels of plant density, N and P had significant impact. In D_1 (60x10 cm) maximum dry weight of leaves were (3.24) noted as compared to D_2 (60x15cm) (3.01). In the level of P found statistically significantly in N_2 (40 kg/ha) maximum dry weight of leaves were (3.44) as compared to N_0 (0 kg/ha) (2.64). Similarly P_2 (80 kg/ha) shown maximum dry weight of leaves (3.39) than P (0 kg/ha) (2.29). The treatment combination $D_3N_2P_2$ (60x20 cm, N 40 kg/ha and 80 kg/ha P) were observed maximum dry weight of leaves (4.17). Baboo and Mishra (2001), Bhilare and Patil (2002) found similar result.

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