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Effect of planting density and integrated nutrient management on flowering, growth and yield of vegetable cowpea [*Vigna unguiculata* (L) Walp]

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ABSTRACT : A field experiment was conducted during the *Kharif* seasons of 2010, 2011 and 2012 to study the effect of planting density and integrated nutrients on flowering, growth and yield of vegetable cowpea cv. AVCP-1 at Horticultural Research Farm, AAU, Anand.The experiment was laid out in split plot design with three replications. From the three year data, it was found that plating density 60 x 30 cm recorded the highest plant height however, it was comparable with 45 x 45 cm. Planting density 45 x 45 cm recorded maximum pod weight and green pod yield which remained at par with planting density 60 x 30 cm. Whereas, planting density did not show any significant effect on days to flower initiation, days to 50 per cent flowering, number of branches per plant, pod length and number of seeds per pod. Application of nutrients 30 + 60 + 0 kg NPK / ha recorded significantly the earliest flowering. Application of fertilizer resulted in significant decreased in nodule production. However,any nutrients treatment did not observe the significant difference for days to 50 per cent flowering, plant height, number of branches per plant, yield attributing characters and green pod yield.

KEY WORDS : Cowpea, Nutrient management, Spacing, Split plot design

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Cowpea [*Vigna unguiculata* (L.) walp] is also known as black eye pea, southern pea and crowder pea. It is an important legume vegetable crop. The crop is used for variety of ways, as vegetable it is grown for its long tender green pods which are used as a vegetable. Mature but green seeds are also used as a vegetable purpose. Commonly it is used for soil fertility improvement through biological nitrogen fixation, green manuring, forage yield, production of high quality hay and silage, synthesis of nutritional products, suppression of weeds, food, and a source of protein and income generation (Tarawali *et al.*, 1997; Muli and Saha, 2002 and Kimiti, 2011). Due to high protein and carbohydrate content, it has immense importance in nutritional products (Imungi and Porter, 1983). Being a legume crop, cowpea fits well in inter-cropping system.The yield of cowpea is generally low due to the lack of knowledge of cultural practices, use of local varieties which are generally low yielding coupled with low soil fertility and infestation of disease and pest.

Nutrients are directly related with the growth and yield of cowpea. Application of nutrients through integrated approach reduce the cost of cultivation and also maintain as well as improve soil health by increasing the fertility, whereas, non-monetary inputs like spacing also play an important role for boosting the yield by increasing the plant population per unit area (Biswan *et al.*, 2002; Yadav, 2003 and Adigun *et al.*,2014). The

decline in food production due to reduced length of fallow on land prompted growers to improve soil with different materials (organic and inorganic) in order to enhance plant growth and yield improvement (Adepetu, 1997). It has been suggested that to use organic manure in place of chemical fertilizer to avoid long-term negative effects of chemical fertilizer on the soil (Parr *et al.*, 1990). Though, organics is needed in large quantity to retain crop production and may not be available to the small scale farmers (Nyathi and Campbell, 1995). The positive effect of the application of inorganic fertilizers on crop yields and yield improvement have been reported (Carsky and Iwuafor, 1999). Cowpea canfix more than 50 per cent of its nitrogen from N_2-fixation (Khan *et al.*, 2002). Crop productivity on more than 40 per cent of earth's arable land is limited by poor plant availability of phosphorus (Vance, 2001). The basic source of phosphorus is mineral apatite found in primary rocks. Conversely, organic matter, inorganic fertilizers and secondary and complex compounds in the soil are other sources of phosphorus. Hence, soil phosphorus can be replaced by addition of inorganic fertilizers, organic matter in form of plant and animal deposits or phosphate rocks (Chien and Menon, 1995).

There are many varieties of cowpea for vegetable purpose. A variety "Anand Vegetable Cowpea-1(AVCP-1)"released by Anand Agricultural University, Anand is semi spreading, high yielding and has long duration. There is no scientific information is available about spacing and nutrient requirement for such type of semi spreading and high yielding variety. Therefore, the study was conducted to select suitable dose of fertilizer and proper spacing to get maximum green pod yield.

RESEARCH METHODS

The field experiment was carried out at Horticultural Research Farm of the Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand during the *Kharif* seasons of 2010, 2011 and 2012. The treatments comprised of 3 planting density (S_1: 60x45, S_2: 60x30 and S_3: 45x45 cm) as main plots and 6 nutrients levels F_1: 20+40+0 kg NPK/ha, F_2:30+60+0 kg NPK/ha, F_3:10+20+0 kg/ha + seed treatment with *Rhizobium* + PSB, F_4:15+60+0 kg NPK/ ha + seed treatment with *Rhizobium*, F_5:30+30+0 kg NPK/ ha + Seed treatment with PSB and F_6:15+30+0+ seed treatments with *Rhizobium* + PSB. The treatments were replicated thrice in a Split Plot Design. The observations were recorded from randomly selected five plants from each plot for flowering, growth and yield contributing traits. Soil samples were taken at a depth of 0-15 cm in each year from different plots and number of nodules at 50 per cent flowering and *Rhizobium* counts were reckoned.

RESEARCH FINDINGS AND DISCUSSION

The planting density had significant effect on the plant height (Table 1). Maximum plant height was recorded in 60 x 30 cm planting density (48.76 cm) followed by 45 x 45 cm (48.57 cm), it might be due to increase in internodes length in close space as compared to wide spaced plants. These results are in close conformity with findings of Daljit *et al.* (1992);Yadav (2003) and Adigun *et al.* (2014). While, days to flower initiation, days to 50 per cent flowering and number of branches per plant did not differ significantly with planting density. Days to flower initiation were significantly influenced by different nutrients treatments. Application of nutrient 30 + 60 + 0 kg NPK/ ha (F_2) recorded significantly the earliest flower initiation (35.52 days) as compared to other nutrient treatments. It might be due to more availability of nutrients which enhance the early flowering. However, days to 50 per cent flowering, plant height and number of branches per plant did not record any significant difference between nutrient treatments. The results of present study are contradictory to the results reported by Dart *et al.* (1977) who recognized and demonstrated that application of a small quantity of nitrogen fertilizer enhances early vegetative growth.Also the results showed that plant height, was highest with the highest level of fertilizer applied. This is in line with the observation of Minchin *et al.* (1981) who found that plants given inorganic nitrogen during vegetative period were much larger by the onset of flowering than those dependent on symbiotic N fixation.

The data presented in Table 2 showed the significant effect of yield and yield attributes. The planting density, 45 x 45 cm recorded maximum pod weight and green pod yield (3.49 g and 65.73 q/ ha, respectively) but, it was at par with 60 x 30 cm (3.46 g and 62.80 q/ ha, respectively). This indicates the positive correlation between pod weight and green pod yield and at these planting densities individual plants might have enjoyed a more suitable environment to fully utilized available space, light and nutrients. Whereas, planting density did not affect the average pod length and number of seeds per

Table 1 : Effect of planting geometry and nutrients on flowering and growth of cowpea (Three years pooled data)

Treatments	Days to flower initiation	Days to 50 % flowering	Plant height (cm)	Number of branches/ plant
Spacing (S) (Main plot treatment)				
S_1 : 60 x 45 cm	37.68	43.85	45.90	13.78
S_2 : 60 x 30 cm	36.80	43.22	48.76	13.65
S_3 : 45 x 45 cm	36.72	43.65	48.57	14.07
S. E.±	0.75	0.50	0.79	0.22
C.D. (P = 0.05)	NS	NS	2.43	NS
C.V. %	5.13	3.16	12.15	11.71
Nutrients (F) (Sub plot treatment)				
F_1 : 20+40+0 kg NPK/ha	37.63	43.82	47.83	13.84
F_2 : 30+60+0 kg NPK/ha	35.52	43.07	47.82	14.14
F_3 : 10+20+0 kg NPK/ha + Seed treatment with *Rhizobium* + PSB	37.33	43.78	47.27	13.57
F_4 : 15+60+0 kg NPK/ha + Seed treatment with *Rhizobium*	37.33	44.07	47.61	14.02
F_5 : 30+30+0 kg NPK/ha + Seed treatment with PSB	37.15	43.33	47.75	13.52
F_6 : 15+30+0 kg NPK/ha + Seed treatment with *Rhizobium* + PSB	37.44	43.37	48.19	13.89
S. E.±	0.36	0.34	0.73	0.22
C.D. (P = 0.05)	1.01	NS	NS	NS
Interaction				
S x F	NS	NS	NS	NS
C.V. %	5.03	4.05	7.93	8.20

NS=Non-significant

Table 2 : Effect of planting geometry and nutrients on green pod yield and its attributes, nodulation and *Rhizobium* count (Three years pooled data)

Treatments	Av. length of pod (cm)	Av. weight of pod (g)	No. of seeds/ pod	Green pod yield (q/ha)	No. of nodules/ plant at 50% flowering*	*Rhizobium* count* (cfu/ g soil)
Spacing (S) (Main plot treatment)						
S_1 : 60 x 45 cm	14.68	3.33	13.27	56.92	7.04 (52.85)	950.25 (1.00×10^6)
S_2 : 60 x 30 cm	14.83	3.46	13.38	62.80	7.49 (60.63)	996.39 (1.08×10^6)
S_3 : 45 x 45 cm	14.88	3.49	13.52	65.73	7.46 (49.20)	1003.54 (1.08×10^6)
S. E.±	0.16	0.04	0.12	1.95	0.24	28.92
C D (P = 0.05)	NS	0.13	NS	6.02	NS	NS
C V %	3.91	8.94	6.49	23.20	23.75	0.99
Nutrients (F) (Sub plot treatment)						
F_1 : 20+40+0 kg NPK/ha	14.89	3.41	13.47	59.75	6.00 (38.19)	1018.59 (1.13×10^6)
F_2 : 30+60+0 kg NPK/ha	14.73	3.50	13.37	59.25	6.00 (37.63)	919.05 (8.80×10^5)
F_3 : 10+20+0 kg NPK/ha + Seed treatment with *Rhizobium* + PSB	14.49	3.30	13.16	60.80	8.18 (71.22)	1001.44 (1.14×10^6)
F_4 : 15+60+0 kg NPK/ha + Seed treatment with *Rhizobium*	14.99	3.46	13.59	63.81	8.09 (67.85)	1093.36 (1.26×10^6)
F_5 : 30+30+0 kg NPK/ha + Seed treatment with PSB	14.89	3.44	13.39	63.69	7.47 (58.26)	755.99 (6.06×10^5)
F_6 : 15+30+0 kg NPK/ha + Seed treatment with *Rhizobium* + PSB	14.79	3.46	13.36	63.62	8.24 (72.22)	1111.95 (1.32×10^6)
S. E.±	0.16	0.07	0.15	1.59	0.68	92.83
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS
Interaction						
S x F	NS	NS	NS	NS	NS	NS
C.V. %	5.76	11.19	5.98	13.34	17.96	4.87

* Square root transformed value while, those in parenthesis are original values. NS=Non-significant

pod. These findings are in agreement with Daljit *et al.* (1992); Yadav (2003) and Patel *et al.* (2011) for green pod yield in cowpea and Biswan *et al.* (2002) in black gram. There was no any significant difference observed between different integrated nutrients levels for green pod yield and its attributes. Similar results were also reported by Subramanian *et al.* (1977) and Jain *et al.* (1993).

The results of number of nodules per plant at 50 per cent flowering and *Rhizobium* counts showed non-significant effects of planting density and nutrients applications. Nodulation was significantly reduced by successive application of NPK fertilizer from 15-30-0 to 30-30-0 kg N-P-K ha^{-1} (Table 2). These results are in line with the reports of the earlier workers who showed that application of N fertilizer depressed nodule numbers (Ofori, 1973; Rhodes, 1981; Olson *et al.*, 1981 and Chowdhury *et al.*, 2000). Similarly, Graham and Scott (1984) reported that nodulation in cowpea was inhibited by nitrogen fertilizer application at rates greater than 30 kg ha^{-1}. In the same vein, Eriksen and Whitney (1984) showed that even though the application of nitrogen fertilizer at flowering promoted vegetative dry weight, it decreased nodule dry weight.

On the basis of results it could be concluded that, vegetable cowpea cv. ANAND VEGETABLE COWPEA-1 produced the maximum green pod yield by sowing the seeds at 45 x 45 cm or 60 x 30 cm spacing along with seed treatment of *Rhizobium* + PSB culture each at 5 ml/ kg seed and the application of 10 + 20 + 0 kg NPK / ha in middle Gujarat agro-climatic conditions.

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