

Original Research Article

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Crop Geometry and Fertility Levels Effect on Growth and Productivity of Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub]

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ABSTRACT

A field experiment was conducted during *Kharif season* of 2016 at College of Agriculture, Gwalior with a view to assess the effect of crop geometry and fertility levels on growth and productivity of Clusterbean. Experiment was laid out as randomized block design(RBD) replicated thrice with 10 treatments. The study revealed that among different crop geometry treatments, reducing 25% plant population (by increased plant intra-row spacing) gave significantly higher values of all growth attributes viz., plant height and number of branches/plant; yield attributes viz., number of pods/plant, number of seeds/pod and seed index and yield viz.; seed and stover (kg/ha) over normal plant population 45cmx10cm and increasing 25% plant population, respectively. Similarly, among different fertility levels, application of Zn and B as a basal dose @ 5kg Zn/ha and @ 1 kg B/ha produced higher values of all growth attributes and yield attributes over rest of the treatments.

Keywords

Clusterbean, Crop geometry, Fertility levels, Productivity

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Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] is an annual legume crop mostly grown under resource constrained conditions in arid and semi-arid regions (Kumar, 2005). Cluster bean is a deep rooted plant of *Leguminosae* (*Fabaceae*) family known for drought and high temperature tolerance (Kumar and Rodge, 2012). It is used as vegetable, forage, green manure and also for the water soluble

gum. It is a rich source of protein, fats, carotenes, Phosphorus, Calcium and mineral salt needed in the foods for human beings, feeds and fodder for animals. It contains 42% crude protein as well as 29 to 31.4 per cent gum (Kumar and Rodge, 2012). India is one of the main producers of clusterbean accounting 82% of the total production of the world, and the same is grown in the north-western states of India, namely Rajasthan, Gujarat, Haryana, Punjab and some parts of

Uttar Pradesh and Madhya Pradesh. In India clusterbean is being grown in the area of 4.25 million hectares with a production of 2.42 million tonnes of clusterbean seed with an average productivity of 567 kg/ha. In M.P., Clusterbean is cultivated as pure crop in 75280 ha (Anonymous, 2015).

The yield of clusterbean can be increased through improved agronomic manipulations such as proper crop geometry and judicious use of fertilizer. The optimum planting geometry ensures the plant to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients (Miah *et al.*, 1990). Closer planting geometry hampers intercultural operations, more competition arises among the plant for nutrient, air and light as a result plant become weaker and thinner and consequently, yield is reduced. So it is most important to determine optimum crop geometry for maximizing the yield of clusterbean.

Clusterbean responds well to phosphorus (P) rather than nitrogen(N). Since, N fixing legumes usually require more phosphorus than nitrogen because phosphorus plays a very vital role in the nodule development and their activity (Serraj *et al.*, 2004). In recent years, the continuous application of only nitrogen and phosphorus led to the deficiency of micronutrients in arid soil. Deficiency of Zinc(Zn) in soil causes deficiency in crops and altogether this has become a problem all over the world with acute zinc deficiency ranges in arid and semi-arid regions of the world (Rashid and Ryan, 2004). Deficiency of micro nutrients has more detrimental effects on metabolic pathways, enzyme activities, performance of crops and uptake of micronutrients. Zinc application significantly increased the nitrogen activity, carbohydrate and protein content in clusterbean (Nandwal *et al.*, 1990). Poor management of fertilizer is the main culprit of low productivity.

Therefore, to achieve optimum crop productivity, it is crucial to have better management of nutrients through judicious application. Considering the facts and views highlighted above, the present study was planned to study the effect of crop geometry and fertility levels on growth and yield of *Kharif* Clusterbean.

Materials and Methods

The field experiment was conducted during *Kharif* 2016 at the College of Agriculture, Gwalior (M.P.). Gwalior is located at 26^o13' North latitude and 78^o14' East longitude and 208 meters above mean sea level. It lies in the North tract of Madhya Pradesh, enjoying subtropical climate, with extreme hot about 48^oC in summer and minimum temperature 4.0^oC in the winter season. The annual rainfall ranges between 750 to 800 mm, most of which received from end of June to end of September, with few showers in winter months. The soil of the experimental field was sandy clay loam. Soil of the experimental field was rich in potash content (240.50 kg/ha), but low in organic carbon (0.40%), available nitrogen (210.50 kg/ha) and medium in available phosphorus contents(14.50 kg/ha). It is slightly alkaline in reaction (pH 8.0) and had moderate cation exchange capacity. The experiment was conducted in RBD with three replications. The experiment consist of 10 treatments viz., Normal plant population 45 cm x 10 cm (as per state recommended row and plant spacing), 25 % Reduction in Plant population (by increased plant intra-row spacing), 25 %increase in plant population (by reduced plant intra-row spacing), Foliar spray of urea @ 1% at vegetative stage along with PP chemicals, Seed treatment with *Rhizobium* + PSB, Foliar spray of micronutrients @ 1 % (Zinc and Boron) at vegetative stage, Foliar spray of water soluble fertilizer 19:19:19 @ 1% at vegetative stage, Application of FYM @ 2.5

t/ha, Crop residue retention @ 3 t/ha, Application of Zn and Boron as a basal dose @ 5kg Zn/ha and @ 1kg B/ha.. Clusterbean variety 'HG- 563' was sown on 21st July 2016 at a row spacing of 45 x 10 cm using seed rate of 20 kg/ha and fertilized with 20 : 40 : 20 NPK kg/ha. All the growth and yield attributes were recorded using standard procedure. The crop growth rate(CGR), relative growth rate(RGR) and absolute growth rate(AGR) was calculated using the standard procedure and formula.

Crop Growth Rate (g/m²/day)

Crop growth rate (CGR) is the rate of dry matter production per unit ground area per unit time. CGR was calculated by adopting the formula as suggested by Watson (1952) and expressed as g/m²/ day.

CGR (g/m²/day) =

$$\frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where,

W₁ = Dry weight of the plant (g) at time t₁

W₂ = Dry weight of the plant (g) at time t₂

t₂ - t₁ = Time interval in days

A = Unit land area occupied by the plant (1m²)

Relative Growth Rate (g/g/day)

It is the rate of increase in the dry weight per unit dry weight already present and is expressed as g/g/day (Blackman, 1919).

Relative growth rate at various stages was calculated as follows:-

Relative Growth Rate (RGR) =

$$\frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}$$

Where,

W₁ = Dry weight of plant (g) at time t₁

W₂ = Dry weight of plant (g) at time t₂

t₂ - t₁ = Time interval in days

Absolute Growth Rate (g/day)

Absolute growth rate (AGR) is the dry matter production per unit time (g/day), which was calculated by using the formula as given by Radford (1967).

$$\text{Absolute Growth Rate (g/day)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

W₁ = Dry weight of the plant (g) at time t₁

W₂ = Dry weight of the plant (g) at time t₂

The plant sample were collected at 30,60,90 and at harvest days after sowing. The samples were dried in the oven at 65 °C for 3 days or until the dry weight was stabilized. The samples were weighed using an electronic balance.

Results and Discussion

Growth parameters

The effect of crop Geometry treatments on various growth indices is shown in Table 1. The result revealed that treatment of reducing 25% plant population produced significantly higher values of all growth attributes *viz.*, the plant height (104.81cm), number of branches per plant(8.54), Dry weight per plant(49.61), crop growth rate(10.60g), relative growth rate(10.72) and absolute growth rate(0.0471)over treatment of Increasing 25% plant population and Normal plant population 45cmx10cm, respectively. It may be due to wider row to row spacing allows the plant to attain their normal growth to express their full potential.

Table.1 Effect of crop geometry and fertility levels on growth of Clusterbean

Treatment	Plant height at harvest (cm)	No. of branches per plant at harvest	Dry Weight(g/plant) at				CGR(g/m ² /day) at				RGR(g/g/day) at				AGR(g/day) at			
			30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity	30 DAS	60 DAS	90 DAS	Maturity
Normal plant population 45cm x 10cm (as per state recommended row and plant spacing)	88.75	7.01	2.01	9.57	21.15	27.28	1.49	5.61	8.58	4.54	23.53	50.04	25.38	8.14	0.067	0.252	0.386	0.204
25% reduction in plant population	104.81	8.54	2.52	13.62	35.49	49.61	1.88	8.78	15.97	10.60	31.18	55.46	28.88	10.72	0.085	0.396	0.706	0.471
25% increase in plant population	84.60	6.36	1.76	7.75	16.69	21.15	1.31	4.44	6.77	3.16	19.38	47.41	24.96	7.20	0.059	0.203	0.304	0.146
Foliar spray of urea @ 1% + PP chemicals	97.16	7.52	2.50	13.60	33.24	46.35	1.85	8.06	14.53	9.72	30.61	54.10	28.58	10.62	0.083	0.372	0.654	0.437
Seed treatment with Rhizobium + PSB	88.68	6.65	2.02	9.72	21.77	28.35	1.50	5.70	8.94	4.88	23.78	50.28	25.87	8.45	0.067	0.256	0.402	0.219
Foliar spray of (Zinc and Boron) @ 1% vegetative stage	92.33	7.39	2.14	10.37	23.41	30.77	1.58	6.09	10.27	5.54	25.38	50.43	25.82	8.74	0.072	0.274	0.435	0.245
Foliar spray of water soluble fertilizer 19: 19: 19 @ 1 % at vegetative stage	90.55	7.10	2.10	10.13	22.72	29.62	1.56	5.94	9.33	5.11	25.08	50.31	25.82	8.48	0.070	0.268	0.420	0.230
Application of FYM @ 2.5 t/ha	97.54	8.13	2.32	12.15	29.01	38.88	1.72	7.29	12.48	7.32	28.22	53.00	27.84	9.38	0.077	0.328	0.562	0.329
Crop residue retention @ 3 t/ha	96.52	8.06	2.29	11.99	28.33	37.61	1.70	7.18	12.11	6.88	27.92	52.88	26.88	9.07	0.077	0.323	0.545	0.214
Application of Zn and B as a basal dose @ 5 kg Zn/ha and @ 1 kg B/ha	102.51	8.16	2.36	12.40	29.73	40.16	1.75	7.44	12.86	7.73	28.79	53.08	27.98	9.63	0.079	0.334	0.578	0.348
S.E.(m)±	4.033	0.295	0.10	0.50	0.89	1.61	0.065	0.283	0.540	0.274	1.086	2.328	1.140	0.305	0.003	0.012	0.020	0.013
C.D. (at 5%)	11.98	0.876	0.29	1.50	2.66	4.79	0.194	0.840	1.604	0.815	3.226	6.917	3.388	0.905	0.009	0.036	0.062	0.040

DAS= Days after Sowing; *MAT= Maturity.

Table.2 Effect of crop geometry and fertility levels on yield attributes and yield of Clusterbean

Treatment	No. of pods/plant	No. of seeds/pod	Seed index (g)	Seed yield (kg/ha)	Strover yield (kg/ha)
Normal plant population 45cm x 10cm (as per state recommended row and plant spacing)	65.62	7.22	3.21	1453.70	2527.78
25% reduction in plant population	72.96	7.32	3.30	1583.33	2861.11
25% increase in plant population	61.05	6.75	3.15	1324.07	2287.37
Foliar spray of urea @ 1% + PP chemicals	71.47	7.13	3.15	1527.78	2331.48
Seed treatment with Rhizobium + PSB	67.30	6.79	3.18	1324.07	2101.85
Foliar spray of (Zinc and Boron) @ 1% vegetative stage	71.16	7.19	3.21	1365.74	2308.33
Foliar spray of water soluble fertilizer 19: 19: 19 @ 1 % at vegetative stage	68.23	6.87	3.18	1365.74	2393.52
Application of FYM @ 2.5 t/ha	78.24	7.68	3.26	1777.78	2337.03
Crop residue retention @ 3 t/ha	74.25	7.22	3.23	1564.81	2135.19
Application of Zn and B as a basal dose @ 5 kg Zn/ha and @ 1 kg B/ha	80.62	7.70	3.38	1859.26	2418.52
S.E.(m)±	2.40	0.30	0.13	76.34	202.19
C.D. (at 5%)	7.15	0.90	0.41	228.58	605.42

Similarly, all the observed growth parameters were significantly influenced under different fertility treatments. Application of Zn and B as a basal dose @ 5kg Zn/ha and @ 1 kg B/ha produced significantly higher growth attributing characters, i.e. plant height (102.51), number of branches/plant (8.16) dry weight per plant (40.16), crop growth rate (7.73), relative growth rate (9.63) and absolute growth rate (0.348) at harvest followed by Application of FYM @ 2.5 t/ha and crop residue retention @ 3t/ha, respectively. The increase may be expected as zinc plays an important role in the production of indole acetic acid, a growth hormone and tryptophan, a precursor of auxin. Further increase in zinc levels i.e. above 5 kg/ha caused deleterious effect. The similar result was also reported by Sharma *et al.*, (2004) in Clusterbean. It is a well-known fact that boron is essential in enhancing carbohydrate metabolism, sugar transport, cell wall structure, protein metabolism, root growth and stimulating other physiological process of plant (Ashour and Reda, 1972). The earlier findings of Rawat *et al.*, (2008 and 2010), Rajput *et al.*, (2015), Reddy *et al.*, (2011) also corroborate the present results.

Yield and Yield attributes

Among different crop geometry treatments, Reducing of 25% plant population resulted in significantly highest number of pods per plant (72.96), number of seeds per pod (7.22) and seed index (3.30g) over treatment of Increasing 25% plant population and Normal plant population 45cmx10cm, respectively. It may be due widening of space might have provided more nutrients thus resulted in higher production of pods. The seed and strover yield (1583.33 and 2861.11 kg/ha) were recorded highest in the treatment of reducing 25% plant population over the treatment of increasing 25 % plant population and normal plant population 45cmx10 cm

which might be due to fact that wider planting geometry provide efficient use of nutrient and available resources with less competition .

Similarly among the different fertility treatments, application of Zn and B as a basal dose @ 5kg Zn/ha and 1-kg B/ha produced significantly highest number of pods per plant (80.62), number of seeds per pod (7.70) and seed index (3.38g) over treatment of application of FYM @ 2.5 t/ha and crop residue retention @ 3t/ha, respectively. The seed and strover yield (1859.26 and 2418.52 kg/ha) were recorded highest in the Application of Zn and B as a basal dose @ 5kg Zn/ha and @ 1 kg B/ha followed by Application of FYM @ 2.5 t/ha and crop residue retention @ 3t/ha, respectively. The higher yield with zinc application could be ascribed to accelerated nutrient uptake helped the plant to put optimum growth. As these growth and yield attributes showed significant increase seed yield, evidently resulted in higher yields with zinc fertilization. Strover yield was also found significant resulted due to significant response of plant growth parameters viz., plant height, number of branches per plant (Singh and Tiwari 1992). The present findings are in close agreement with the results obtained by Rajput *et al.*, (2015), Salih (2013), Yadav *et al.*, (1991).

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