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# Influence of organics on various growth parameters and yield of cluster bean genotypes

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**Abstract**
There is a need of hour to study the effect of organics on physiology and yield components of various crops to boost up the productivity. Therefore, this investigation was undertaken to find out the suitable organics for increasing the production potential in cluster bean. A field experiment was conducted at the Main Research Station, College of Agriculture, University of Agricultural Sciences, Dharwad during *kharif* 2009-10 to study the influence of organics on growth, development and various growth parameters of cluster bean genotypes. The investigation was carried out in three genotypes namely Local, an improved variety (Pusa Navbahar) and an hybrid (SARPAN-101). The result revealed that genotype SARPAN-101 (hybrid) with the treatment of organic poultry manure recorded significantly higher growth and yield parameters *viz*., total dry weight (135.27 g plant$^{-1}$), number of pods per plant (109.38) and pod yield (85.86 q ha$^{-1}$). Absolute growth rate (0.71 g plant$^{-1}$ day$^{-1}$), crop growth rate (6.33 g m$^{-2}$ day$^{-1}$) and net assimilation rate (111.86 mg dm$^{-2}$ day$^{-1}$) was higher in local genotype with the combination of FYM treatment which may be due to the inconsistent difference in overall growth of the crop in a month. This reflects the variable growth of the crop before pod formation stages which negatively affects the yield. Whereas biomass duration (3983.66 g days) was found higher in SARPAN-101 (hybrid) with the poultry manure treatment, it indicates the maximum biomass accumulation at harvest. Local genotype with FYM recorded the lowest biomass duration (3006.10 g days).

**Keywords:** Cluster bean, organic, neem seed cake, poultry manure, vermicompost

## Introduction
Clusterbean (*Cyamopsis tetragonoloba* L. Taub) locally known as guar, guarphalli, chavali etc. belongs to the family Leguminaceae. It is an important legume crop mainly grown under rainfed condition in arid and semiarid regions of tropical India. It is a hardy and drought tolerant crop. Its deep penetrating root system enables the plant to utilize available moisture at different soil strata more efficiently and thus offers better scope for rainfed cropping. The crop survives best even at moderate salinity and alkalinity. There is no other legume crop so hardy and drought tolerant as cluster bean. It is good sources of carbohydrate, protein, fibre and minerals and contains an appreciable amount of vitamin C. India occupies the top position in world trade of guar gum.

Organic farming is a production system which largely excludes the use of synthetic compounded fertilizers, pesticides and livestock additives to the maximum extent (Ramesh and Manjunath, 2004) [5]. The basic reason that demands organic agriculture is to culminate the pollution of air, water and soil in varying degrees in different parts of the world which affects the environment and ultimately human welfare.

Use of organics may prove to be helpful in sustaining productivity in the situation stated above. FYM, vermicompost, poultry manure and neem seed cake have been used in improving the physio-chemical environment of soils and thus they have become the backbone of organic farming. In rainfed conditions, organics help in 1) enhancing moisture retention capacity of the soil, 2) improving aggregation, which further improves aeration and infiltration, and 3) supporting microbial masses in the soil which are responsible for on-farm nutrient-cycling and utilization, especially by legumes.

Sharma (2003) [8] reported that crop yield during the initial phase of transition from conventional to organic agriculture generally declines. However, yields recover in 2-3 years, which substantially improve the economic status eventually and bring in health and quality consciousness. Hence, there is a need to study the effect of organics on physiological and biochemical parameters and yield components in cluster bean to boost up productivity.

The phenology, growth and development characters of crop change considerably under organic nutrition supply which may be attributed to controlled and holistic nutritional benefits accrued through organics (FYM/compost) in timely manure especially during a critical stage.

The inherent nature of organics to slowly provide fulfil crop nutritional need along with modifying soil physical conditions, microclimate and biological consortia of soil result in positive changes in the physiology of crops which will result in producing the quality of the harvest. It is thus beneficial for both health point of view and quality point of view. In regard to this an experiment designed to plausible study beneficial effects of organic nutrition using cluster bean varieties (*viz.* Local, Pusa Navbahar and SARPAN-101).

**Material and Methods**

Study site of the experiment was Main Agricultural Research Station, University of Agricultural Sciences, Dharwad and time was *kharif*, 2010. The experimental site consisted of vertisol having 6.30 % coarse sand, 11.05 % fine sand, 36.87 % silt and 45.78 % clay. It contained 240.8, 29.7 and 320 kg N, P and K $ha^{-1}$ respectively with pH (7.56) and OC of 0.47 % at the beginning of the experiment.

SARPAN-101 is an hybrid released by Sarpan Hybrid Seed Co. Pvt. Ltd., Dharwad. SARPAN-101 (Hybrid) is a compact, erect and non-branching plant. Fruits are broad, long, tender, glossy, light green with low fibre, low bitter and gum content. Clusters of 8-10 fruits appear on every node. Pusa Naubahar is a variety released from IARI, which has got 65-80 days duration and is suited for *kharif* and summer seasons. It has got traits of both Pusa Sadabahar and Pusa Mausami. Local is erect and branched plant. Fruits are narrow, small, rough and dark green. Fruits appear in a discrete pattern on the stem.

The experiment was laid out in a split plot design with 3 replications. Main plot treatments consisted of three genotypes *viz.*, Local, Pusa Navbahar (Improved variety) and SARPAN-101 (Hybrid). Sub-plot treatments include different organic sources of nutrients i.e. neem seed cake ($T_1$), poultry manure ($T_2$), vermicompost ($T_3$) and FYM ($T_4$). All four manures were analysed for their N content. Neem seed cake, poultry manure, vermicompost and FYM were applied on N equivalent basis *i.e* (3.13, 1.32, 2.27 and 10 t $ha^{-1}$ respectively) at the time of planting.

Leaf area was determined by using the leaf disc method at 90 DAS. Twenty leaf discs having a known diameter were collected randomly from top 4-6 fully expanded leaves of the plant. The samples (disc and remaining leaves) were dried separately in a hot air oven at 80 °C for 72 hours. The dry weight of leaf discs and the rest of the leaves were recorded and the leaf area was calculated by using the following formula given by Vivekanandan *et al.* (1972) [9].

$$\text{Leaf area} = \frac{a \times w}{b} \times \frac{1}{100} \text{ dm}^2 \text{ plant}^{-1}$$

where,
a = Leaf area ($cm^2$) of 20 circular discs
b = Dry weight (g) of 20 circular discs
w = Dry weight (g) of rest of the leaves

Absolute growth rate (AGR) is the dry matter production per unit time (g $day^{-1}$) and it was calculated by using the Radfords formula (1967) [4].

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

where,
$W_1$ = Dry weight of the plant at time $t_1$
$W_2$ = Dry weight of the plant at time $t_2$

Crop growth rate (CGR) is the rate of dry matter production per unit ground area per unit time (g $m^{-2}$ $day^{-1}$) measured using Watson method (1952) [10].

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{A}$$

where,
$W_1$ = Dry weight of the plant (g) at time $t_1$
$W_2$ = Dry weight of the plant (g) at time $t_2$
$t_2 - t_1$ = Time interval in days
A = Land area ($m^2$)

Net assimilation rate (NAR) is the rate of dry weight increase per unit leaf area per unit time. It was calculated by following the formula of Gregory (1926) [2] and expressed as mg $dm^{-2}$ $day^{-1}$.

$$NAR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{(\log_e A_2 - \log_e A_1)}{(A_2 - A_1)}$$

where,
$A_1$, $W_1$ = Leaf area ($dm^2$) and dry weight of the plant (mg), respectively at time $t_1$
$A_2$, $W_2$ = Leaf area ($dm^2$) and dry weight of the plant (mg), respectively at time $t_2$
$t_2 - t_1$ = Time interval in days

The biomass duration was calculated by using the following formula and expressed in g day as given by Sestak *et al*. (1971).

$$BMD = \frac{TDM_{(i)} + TDM_{(i+1)}}{2} \times (t_2 - t_1)$$

where,
$TDM_{(i)}$ = Total dry matter at $i^{th}$ stage
$TDM_{(i+1)}$ = Total dry matter $(i+1)^{th}$ stage
$t_2 - t_1$ = Time interval (days) between $i^{th}$ stage and $(i+1)^{th}$ stage.

The specific leaf weight (SLW) which indicates the leaf thickness was determined by the method of Radford (1967) [4] and expressed as g $dm^{-2}$ using the formula:

$$SLW = \frac{\text{Leaf dry weight (g)}}{\text{Leaf area (dm}^2\text{)}}$$

The specific leaf area (SLA) is just the reverse of the specific leaf weight and was worked out by using the following formula and expressed as $dm^2$ $g^{-1}$ leaf weight.

$$SLA = \frac{\text{Leaf area (dm}^2\text{)}}{\text{Leaf weight (g)}}$$

## Results and discussion

The hybrid SARPAN-101 was found to have significantly higher number of pods per plant and pod yield over Local genotype and was at par with Pusa Navbahar. Among the treatments, poultry manure recorded significantly higher number of pods per plant (88.03) which was significantly superior over the rest of the treatments. The increased yield may be attributed to higher dry matter production and its accumulation in reproductive parts, enhanced chlorophyll and photosynthetic rate. Given the fact that poultry manure is rich in phosphorous along with N and K it can be effect of fulfillment of major nutrition *viz* N, P, K in a balanced ratio. Similar result was obtained by Roy and Hore (2007) [6] in ginger.

**Table 1:** Effect of organics on yield and yield component in cluster bean genotypes

| Treatments | No. of pods/plant | | | | Pod yield (q/ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | $G_1$ | $G_2$ | $G_3$ | Mean | $G_1$ | $G_2$ | $G_3$ | Mean |
| T1-Neem seed cake | 49.55 | 80.93 | 88.24 | 72.91 | 56.63 | 65.18 | 74.14 | 65.32 |
| T2-Poultry manure | 59.09 | 95.61 | 109.38 | 88.03 | 68.79 | 79.46 | 85.86 | 78.04 |
| T3-Vermicompost | 54.50 | 86.19 | 94.95 | 78.55 | 63.70 | 74.74 | 81.50 | 73.31 |
| T4-FYM | 45.22 | 70.05 | 79.28 | 64.85 | 52.92 | 59.76 | 65.30 | 59.33 |
| Mean | 52.09 | 83.20 | 92.96 | | 60.51 | 69.79 | 76.70 | |
| For comparing | S.Em ± | | CD (5%) | | S.Em ± | | CD (5%) | |
| Genotypes (G) | 4.41 | | 17.26 | | 2.75 | | 10.79 | |
| Treatments (T) | 3.47 | | 10.32 | | 2.43 | | 7.21 | |

$G_1$- Local, $G_2$- Pusa Navbahar, $G_3$- SARPAN-101

The genotype Local with poultry manure produced significantly higher leaf area per plant (11.55 $dm^2$ $plant^{-1}$) than SARPAN-101 and Pusa Navbahar at 90 DAS. Poultry manure has a low and stable C: N ratio (10-15:1). When added to soil, poultry manure maintains low bulk density and high moisture holding capacity for a longer time as it is stable as compared to another organic under study which is having relatively higher and less stable C: N. Thus poultry manure helps improving moisture holding capacity of soil which maintains water balance in leaf, hence keeps leaves fully fledged. Madhavi *et al.* (2009) [3] confirmed that poultry manure was responsible for the increase in leaf area in Indian spinach **(***Beta vulgaris* var. *Benghalensis).*

Among the genotypes and organics, SARPAN-101 with poultry manure (135.27 g $plant^{-1}$) recorded significantly higher total dry matter production at 90 DAS. The amount of total dry matter (TDM) produced is an indication of the overall efficiency of the utilization of the resources and better light interception. The data pertaining to total dry weight per plant indicated that it increased continuously from 30 DAS to 90 DAS. Such result was also obtained by Kavitha *et al.* (2008) in *Mucuna pruriens.*

**Table 2:** Effect of organics on growth parameters in cluster bean genotypes

| Treatment | Growth parameters at 90 DAS | | | | Growth parameters at 60-90 DAS | | | |
|---|---|---|---|---|---|---|---|---|
| | Leaf area (dm $plant^{-1}$) | Total dry weight (g $plant^{-1}$) | SLW (g $dm^{-2}$) | SLA ($dm^2$ $g^{-1}$) | AGR (g $plant^{-1}$ $day^{-1}$) | CGR (g $m^{-2}$ $day^{-1}$) | NAR (mg $dm^{-2}$ $day^{-1}$) | BMD (g days) |
| Local + Neem seed cake | 9.07 | 107.74 | 1.10 | 0.94 | 0.39 | 3.45 | 49.21 | 3087.59 |
| Local + Poultry manure | 11.55 | 108.67 | 0.94 | 1.09 | 0.29 | 2.56 | 26.37 | 3176.24 |
| Local + Vermicompost | 10.28 | 106.38 | 1.01 | 1.02 | 0.40 | 3.57 | 43.26 | 3101.90 |
| Local + FYM | 7.43 | 105.82 | 1.30 | 0.78 | 0.71 | 6.33 | 111.86 | 3006.10 |
| Pusa Navbahar + Neem seed cake | 3.46 | 123.06 | 2.41 | 0.42 | 0.26 | 2.34 | 72.05 | 3573.24 |
| Pusa Navbahar + Poultry manure | 6.83 | 127.94 | 1.39 | 0.73 | 0.21 | 1.88 | 29.73 | 3748.46 |
| Pusa Navbahar + Vermicompost | 4.31 | 124.83 | 2.04 | 0.49 | 0.21 | 1.83 | 41.62 | 3652.12 |
| Pusa Navbahar + FYM | 2.42 | 119.11 | 3.75 | 0.32 | 0.24 | 2.11 | 87.12 | 3466.25 |
| SARPAN-101 + Neem seed cake | 3.44 | 132.65 | 2.35 | 0.45 | 0.32 | 2.86 | 93.52 | 3834.70 |
| SARPAN-101 + Poultry manure | 6.66 | 135.27 | 1.42 | 0.71 | 0.17 | 1.47 | 23.55 | 3983.66 |
| SARPAN-101 + Vermicompost | 4.11 | 133.91 | 2.45 | 0.49 | 0.23 | 2.07 | 53.97 | 3912.24 |
| SARPAN-101 + FYM | 2.29 | 128.18 | 3.60 | 0.32 | 0.24 | 2.16 | 88.06 | 3735.77 |

At 90 DAS, the FYM treatment with the Pusa Navbahar has higher SLW (3.75 g $dm^{-2}$) over all the treatments while the poultry manure treatment with the Local has lower SLW (0.94 g $dm^{-2}$). This finding was supported by Gaddagimath (2011) [1]. The specific leaf weight is the indicator of leaf thickness and it increased up to 90 DAS. The SLW was more with the treatment poultry manure and vermicompost which may due to the presence of growth promoting substances present in the poultry manure and vermicompost. These growth promoting substances found to have established a role in cell division and elongation which might have contributed for an increased number of cells and facilitated the better stacking of the mesophyll cells of the leaves.

The average daily increment of stand biomass is an important characteristic and is called either the rate of dry matter production or CGR (Watson, 1952) [10]. It is a widely used character for estimating production efficiency of the crop stand and enables to make comparisons between the aspects

of the study. Among the genotypes and organics studied, Local with FYM (6.33 g $m^{-2}$ $day^{-1}$) showed more CGR.

At 60 - 90 DAS among the genotypes and organics, Local with FYM recorded significantly higher NAR (111.86 mg $dm^{-2}$ $day^{-1}$) and which was followed by neem seed cake whereas significantly lower NAR (23.55 mg $dm^{-2}$ $day^{-1}$) was recorded in SARPAN-101 with poultry manure compared to other treatments. Net assimilation rate (NAR) is synonymously called 'unit leaf rate'. It expresses the rate of dry weight increase at any instant on a leaf area basis with leaf representing an estimate of the size of the assimilatory surface area. The maximum NAR value was recorded in the treatment FYM. Watson (1952) [10] suggested that NAR does not measure real photosynthesis but represents the net result of photosynthetic gain over the respiratory loss and it gives no direct indication of respiratory losses. Further, the NAR was maximum at early stages and decreased with advancement in crop growth and development. Since leaf area is taken into account while computing NAR, the leaf area steadily increased with crop growth and was the maximum in poultry manure treated plants thereby causing a mutual shading of leaves in the canopy leading to lower NAR values.

During 60- 90 DAS, SARPAN-101 with poultry manure treatment recorded significantly higher BMD (3983.66 g days) which was followed by the treatment vermicompost. Significantly lower BMD (3006.10 g days) was recorded in the Local with FYM treatment. The biomass duration (BMD) indicates the maintenance of dry matter over a period of time and is essential for the prolonged supply of photosynthates to the developing sinks. Among the genotypes, SARPAN-101 had a faster rate of biomass accumulation from 60-90 DAS. The biomass duration was significantly increased due to the application of organics, which could be attributed to the increased dry matter production and its maintenance.

## Conclusion

Among organics used poultry manure resulted in better performance in improving physiological parameters of cluster bean. However, its effect was much pronounced in case of SARPAN-101 hybrid as hybrids tend to have relatively high vigour and tend to response much to a ready supply of balanced nutrition. Consequently, local which is acclimatized to local soil and conditions responded well with FYM itself.

In order of better performance vermicompost followed poultry manure whereas neem cake and FYM supply had almost similar results. Result support the hypothesis that each genotype responds differently to different organic nutrition source and it generally recommended to include a different source of organics in nutrition package and improve overall yield along with other physiological traits of the crop.

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