Studies on impact of organic manures and spacing on growth and yield parameters of Kalmegh (Andrographis paniculata) var. CIM-Megha

M Chandana, Veena Joshi, D Lakshminarayana and D Vijaya

DOI: https://doi.org/10.22271/chemi.2021.v9.i1ac.11527

Abstract

A field experiment conducted on the effect of organic treatments and spacing on growth and yield parameters of kalmegh under rabi season 2017-18 at college of Horticulture, Rajendranagar revealed that organic treatments and spacing individually and combinedly has significant effect on growth and yield parameters. Application of FYM (30 t/ha) + AMC (7.5 l/ha) recorded maximum growth and yield parameters. Spacing of 15 x 15 cm gave higher herb yield and spacing of 30 x 45 cm recorded maximum growth parameters. Application of FYM (30 t/ha) + AMC (7.5 l/ha) with spacing 15 x 15 cm have shown maximum herb yield.

Keywords: Kalmegh, organic treatments, spacing, growth, yield

Introduction

Kalmegh (Andrographis paniculata) belonging to family Acanthaceae is one of the nineteen species of the genus Andrographis which is indigenous to India and has been in Indian systems of medicine since time immemorial. Kalmegh is well known under different vernacular names viz., Kirta, Kiryata, Kaplnath, Create, Green chirata (Anil kumar et al., 2008) [2]. The plant is also known as Mahatikta in Sanskrit (Ashok et al., 2002) [3], “Rice bitters” in West Indies and “King of bitters” in England (Farooqui and Sreeramu, 2004) [4]. Kalmegh is a bitter annual herb (perennial, if maintained), erect, 50 cm to 1m. In height, stem quadrangular, much branched; leaves opposite, short petioled, flowers in racemes, fruit capsule, linear, oblong or elliptic; seeds about 12 in number, subquadrate, brownish or creamy yellow.

Kalmegh was recommended in “Charaka Samhita” in 175 BC for treatments of jaundice along with other plants in multi plant preparation. The herb is having a preventive effect from many diseases, due to its powerful immune strengthening benefits. The entire plant is used to treat snake bite. The hot water extract of the whole plant is used for acute jaundice. The decoction of the dried leaf is used against high blood pressure. Plant nutrient status or plant nutrition is one of the important factors which controls growth and development of the various characters and determines final yield potentiality.

In the present content of rapid civilization, global warming, climate change, indiscriminate use of synthetic fertilizers and pesticides, sustainable production of agricultural crops is the prime objectives of agricultural researchers and policy makers. Organic production and integrated use of benefits are the key issues of today crop production. Continuous use of inorganic fertilizers, pesticides and fungicides without any organic manure cause environmental pollution especially, in soil thereby affecting its fertility on long term basis (Subramaniyan et al., 2001) [21]. Hence, organic manures can serve as alternative to mineral fertilizers for improving soil structure (Dauda et al., 2008) [4] and microbial biomass.

Scientific evidence clearly showed that combined application of biofertilizers like Nitrogen fixing, Phosphate solubilizing and mobilizing microbes had positive effect on crop growth and yield. The application of combined form of N fixing, P solubilizing and mobilizing, growth promoting microbes are difficult for farmers due to lack of unavailability in one place. To overcome these problems Arka Microbial consortium (AMC) Biofertilizer has been developed and released from IIHR, Bengaluru is recommended for media preparation, seed treatment
and soil application. AMC contains N fixing, P and Zn solubilizing and plant growth promoting microbes as a single formulation.

Spacing is an important factor for better growth and yield of the plant. Optimum number of plants is required per unit area to utilize efficiently the available production factors such as water, nutrient, light and CO₂. Maximum exploitation of these factors is achieved when the plant population puts forth maximum pressure on all the factors of production.

Materials and Methods
A field experiment entitled “Effect of organic treatments on growth and herb yield of kalmegh (Andrographis paniculata) var. CIM-Megha” was conducted during the Rabi season of 2017-18 at College of Horticulture, Rajendranagar. The details of materials used, methods followed and the techniques adopted during the period of experimentation are described below.

Experimental details
The experiment was laid out in a randomized block design with factorial concept (FRBD) and replicated thrice.

Factor I: Organic Manures and Biofertilizers
1. FYM (30 t/ha) + Arka Microbial Consortium (7.5 l/ha)
2. V.C (6 t/ha) + Arka Microbial Consortium (7.5 l/ha)
3. N.C (7.5 t/ha) + Arka Microbial Consortium (7.5 l/ha)
4. S.M (10 t/ha) + Arka Microbial Consortium (7.5 l/ha)
5. Control

Factor II: Spacing
1. 15 X 15 cm
2. 30 X 30 cm
3. 30 X 45 cm

Treatment details
T₁: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S₁ (15 x 15 cm)
T₂: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S₂ (30 x 30 cm)
T₃: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S₃ (30 x 45 cm)
T₄: V.C (6 t/ha) + AMC (7.5 l/ha) with spacing S₂ (30 x 30 cm)
T₅: V.C (6 t/ha) + AMC (7.5 l/ha) with spacing S₃ (30 x 45 cm)
T₆: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S₁ (15 x 15 cm)
T₇: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S₂ (30 x 30 cm)
T₈: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S₃ (30 x 45 cm)
T₉: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S₁ (15 x 15 cm)
T₁₀: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S₂ (30 x 30 cm)
T₁₁: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S₃ (30 x 45 cm)
T₁₂: Control (with out organic treatments) + spacing S₁ (15 x 15 cm)
T₁₃: Control (with out organic treatments) + spacing S₂ (30 x 30 cm)
T₁₄: Control (with out organic treatments) + spacing S₃ (30 x 45 cm)

Note: All organic manures and AMC (Arka microbial consortium) were incorporated into the soil before transplanting of the seedlings into the main field (as per treatments). AMC contains N fixing, P and Zn solubilizing and plant growth promoting microbes as a single formulation.

- S.M: Sheep manure, V.C: Vemicompost, N.C: Neem cake

Observations Recorded
1. Plant height (cm)
The plant height from ground level to the growing tip of the plants was measured at 30, 60, 90 days after transplanting and at harvest. The mean height of the five plants was taken and expressed in centimetre.

2. Number of primary branches
The number of primary branches per plant was counted in five tagged plants at 30, 60, 90 days after transplanting and at harvest. The mean value per plant was recorded.

3. Number of secondary branches
The number of secondary branches per plant was counted in five tagged plants at 30, 60, 90 days after transplanting and at harvest. The mean value per plant was recorded.

4. Number of leaves per plant
The total number of leaves was counted on the five tagged plants at 30, 60, 90 days after transplanting and at harvest. The mean value per plant was recorded.

5. Leaf area index
Leaf area index was calculated using the formula given by Williams (1946).

\[ \text{LAI} = \frac{\text{Leaf area per plant (cm)}}{\text{Land area occupied by the plant (cm)}} \]

6. Leaf stem ratio
Plant samples each weighing a kilogram weight at harvest was collected from the net plot area of each individual treatment and the leaves were stripped off the shoots and weight of leaves was recorded. Leaf to stem ratio was arrived by dividing the leaf weight by stem weight. Leaf stem ratio: Plant samples each weighing a kilogram weight at harvest was collected from the net plot area of each individual treatment and the leaves were stripped off the shoots and weight of leaves was recorded. Leaf to stem ratio was arrived by dividing the leaf weight by stem weight.

7. Fresh herb yield per plot (kg)
Fresh weight of all the plants was taken from each plot as a whole and was expressed in kilograms (kg).

8. Dry herb yield per plot (kg)
The fresh herb at harvest from the net plot was cut close to ground and dried in shade and then in hot air oven at 50°C till they attained constant weight and dry herbage weight recorded and was expressed in kg per plot.

9. Seed yield per plot (g)
Ten plants were selected randomly in each plot and the seeds from the capsules were separated and then threshed, cleaned. The seed yield obtained was expressed as grams per plot.

Result and Discussion
1. Plant height (cm)
At harvest, organic treatments had significant effect on plant height. The organic treatment M₁ recorded maximum plant height (38.70cm), followed by organic treatment M₃ (32.8cm), M₂ (34.2cm) and M₄ (32.8cm) and were found to be at par. Whereas treatment M₅ recorded minimum plant height (30.5cm). At harvest, plant height differed significantly due to different spacing. The spacing S₁ (15 x 15 cm) recorded maximum plant height (40.77cm), whereas the spacing S₃ (30 x 45 cm) recorded minimum plant height (29.06cm). Interaction between organic treatments and spacing found to be non significant effect on plant height at 30, 60, 90 DAP.
and at harvest. Plant height was significantly affected by organic treatments. The treatment with M₁ at spacing S₁ recorded significantly maximum plant height at 30, 60, 90 DAP and at harvest. The increase in plant height as response to application of organic manures and biofertilizers is probably due to enhancing the availability of nutrients which emphasized by (Al-Fraihat et al. 2011) on marjoram plants. Maximum plant height was obtained in closer spacing 20 cm ×15 cm. Increase in plant height in narrow spacing might be due to less plant canopy which facilitated vertical growth by producing weak, lanky and taller plants due to stiff competition for space, light, nutrients and moisture. Similar results were also reported by Muvel et al. (2015) in ajwain and Sharma et al. (2016) in coriander.

Table 1: Effect of organic treatments and spacing on plant height (cm) in kalmegh at 30 DAP and 60 DAP

| Treatments | 30 dap | Plant height (cm) | 60 dap |
|------------|-------|------------------|-------|
| Organic Treatments | Spacing | | |
| M₁ | S₁ | S₂ | S₃ | MEAN | S₁ | S₂ | S₃ | MEAN |
| 24.06 | 23.03 | 22.68 | 23.25 | 32.30 | 29.93 | 27.65 | 29.96 |
| M₂ | 23.07 | 19.86 | 16.41 | 19.77 | 31.36 | 27.70 | 23.81 | 27.62 |
| M₃ | 24.05 | 20.06 | 16.81 | 20.30 | 31.89 | 27.76 | 24.57 | 28.07 |
| M₄ | 22.84 | 19.35 | 16.75 | 19.64 | 28.74 | 26.76 | 25.65 | 27.05 |
| M₅ | 21.75 | 17.33 | 15.21 | 18.09 | 27.15 | 25.64 | 21.76 | 24.85 |
| MEAN | 23.15 | 19.93 | 17.57 | | 30.29 | 27.56 | 24.69 | |

| M x S | M x S | M x S |
|-------|-------|-------|
| 0.48 | 0.37 | 0.83 |
| 0.46 | 0.36 | 0.79 |
| 1.38 | 1.07 | NS |
| 1.34 | 1.04 | NS |

2. Number of primary branches

With respect to organic treatments there was significant effect on number of primary branches at harvest. The organic treatment M₅ recorded maximum number of primary branches (12.78) followed by M₁ (12.42). Whereas the treatment M₅ recorded minimum number of primary branches (8.75). At Harvest, number of primary branches differed significantly due to different spacing. The spacing S₁ recorded maximum number of primary branches (15.42), whereas the spacing S₁ recorded minimum number of primary branches (7.41). Interaction between organic treatments and spacing had significant effect on number of primary branches at harvest. Among all the interactions, M₅S₁ recorded maximum number of primary branches (17.23) followed by M₁S₃ (16.63). M₂S₁ (16.16), M₅S₃ (13.60) which were remained at par. Minimum number of primary branches was recorded in M₂S₁ (6.01). The increase in number of primary branches treated with organic manures resulted in more production of branches which might be attributed to sufficient quantity of nutrient flow in the plants as reported by Kale et al. 1987. Kumar et al. (2010) reported that maximum number of primary branches from wider spacing crop in kalmegh. The closer spacing (15 x 15 cm) recorded the minimum number of primary branches per plant might be due to overcrowding and competition for sunlight, nutrients and air.

Table 2: Effect of organic treatments and spacing on plant height (cm) in kalmegh at 90 DAP and at harvest

| Treatments | Plant height (cm) |
|------------|------------------|
| Organic treatments | 90 dap | At harvest |
| | Spacing | | |
| M₁ | S₁ | S₂ | S₃ | MEAN | S₁ | S₂ | S₃ | MEAN |
| 41.30 | 33.60 | 24.94 | 33.28 | 45.64 | 36.77 | 33.56 | 38.7 |
| M₂ | 37.60 | 32.66 | 24.33 | 31.53 | 40.73 | 34.66 | 27.33 | 34.2 |
| M₃ | 39.50 | 32.55 | 24.37 | 32.14 | 40.95 | 36.57 | 32.75 | 36.8 |
| M₄ | 33.65 | 31.61 | 23.94 | 29.74 | 38.95 | 33.74 | 25.84 | 32.8 |
| M₅ | 34.72 | 28.65 | 23.12 | 28.83 | 37.57 | 28.23 | 25.83 | 30.5 |
| MEAN | 37.35 | 31.81 | 24.14 | | 40.77 | 33.99 | 29.06 | |

| S.Em± | M | S | M × S | M | S | M × S |
|-------|---|---|-------|---|---|-------|
| 0.62 | 0.48 | 1.07 | 0.93 | 0.72 | 1.60 |
| 1.79 | 1.38 | NS | 2.68 | 2.07 | NS |

Table 3: Effect of organic treatments and spacing on number of primary branches in kalmegh at 30 DAP and 60 DAP

| Treatments | Number of Primary Branches |
|------------|---------------------------|
| Organic Treatments | 30 Dap | 60 Dap |
| | Spacing | | |
| M₁ | S₁ | S₂ | S₃ | MEAN | S₁ | S₂ | S₃ | MEAN |
| 0.40 | 1.06 | 2.00 | 1.16 | 3.20 | 4.42 | 6.82 | 4.82 |
| M₂ | 0.21 | 1.00 | 1.80 | 1.00 | 2.43 | 3.78 | 6.60 | 4.27 |
| M₃ | 0.46 | 1.13 | 3.21 | 1.60 | 2.79 | 4.82 | 7.42 | 5.01 |
| M₄ | 0.46 | 0.00 | 1.46 | 0.48 | 2.42 | 3.42 | 6.01 | 3.95 |
| M₅ | 0.00 | 1.40 | 0.46 | 0.46 | 1.01 | 3.02 | 6.01 | 3.35 |
| MEAN | 0.22 | 0.64 | 1.97 | | 2.37 | 3.89 | 6.57 | |

| S.Em± | M | S | M × S | M | S | M × S |
|-------|---|---|-------|---|---|-------|
| 0.03 | 0.03 | 0.05 | 0.08 | 0.07 | 0.15 |
| 0.09 | 0.07 | 0.16 | 0.25 | 0.19 | 0.44 |

- "2063"
Table 4: Effect of organic treatments and spacing on number of primary branches in kalmegh at 90 DAP and at harvest

| Treatments | Number of Primary Branches | 90 DAP | AT Harvest |
|------------|----------------------------|--------|------------|
|            | Spacing | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| Organic Treatments |         | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| M1         | 5.62    | 9.44 | 14.86 | 9.98 | 8.01 | 12.60 | 16.63 | 12.42 |
| M2         | 5.46    | 6.71 | 14.36 | 8.85 | 7.86 | 12.01 | 16.16 | 12.01 |
| M3         | 7.02    | 10.42 | 15.15 | 10.87 | 8.3 | 12.79 | 17.23 | 12.78 |
| M4         | 5.36    | 6.03 | 14.02 | 8.47 | 6.84 | 7.02 | 13.60 | 9.15 |
| M5         | 3.01    | 6.02 | 12.01 | 7.02 | 6.01 | 6.78 | 13.46 | 8.75 |
| MEAN       | 5.29    | 7.72 | 14.08 | 7.41 | 10.24 | 15.42 |
|            | M       | S   | M x S | M   | S   | M x S |
|            | C.D     | 0.28 | 0.21 | 0.48 | 0.21 | 0.16 | 0.36 |

3. Number of secondary branches
At Harvest, organic treatments had significant effect on number of secondary branches. The organic treatment M1 recorded maximum number of secondary branches (3.96) followed by M2 (3.77), M3 (3.58) were at par. Whereas the treatment M3 (Control) recorded minimum number of secondary branches (2.97) and it remained on par with M1. There were significant differences on number of secondary branches among different spacings at harvest. The spacing S1 (30 x 45 cm) recorded maximum number of secondary branches (4.80), whereas the spacing S1 (15 x 15 cm) recorded minimum number of secondary branches (2.38). There were significant differences on number of secondary branches among different spacings at harvest. Interaction between organic treatments and spacing had significant effect on number of secondary branches at harvest. M1S3 recorded maximum number of secondary branches (5.78) followed by M1S1 (5.57), M1S3 (5.01) and were at par. Minimum number of secondary branches was recorded in M1S1 (2.25).

Table 5: Effect of organic treatments and spacing on number of secondary branches in kalmegh at 60 DAP

| Treatments | Number of Secondary Branches | 60 DAP | 90 DAP |
|------------|----------------------------|--------|--------|
|            | Spacing | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| Organic Treatments |         | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| M1         | 0.53    | 0.77 | 2.33 | 1.21 |
| M2         | 0.42    | 0.67 | 1.81 | 0.97 |
| M3         | 0.64    | 0.80 | 2.38 | 1.27 |
| M4         | 0.24    | 0.64 | 1.79 | 0.88 |
| M5         | 0.23    | 0.64 | 0.83 | 0.57 |
| MEAN       | 0.41    | 0.70 | 1.83 |
|            | M       | S   | M x S |
|            | C.D     | 0.09 | 0.07 | 0.15 |

Table 6: Effect of organic treatments and spacing on number of secondary branches in kalmegh at 90 DAP and at harvest

| Treatments | Number of Secondary Branches | 90 DAP | 120 DAP |
|------------|----------------------------|--------|---------|
|            | Spacing | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| Organic Treatments |         | S1 | S2 | S3 | MEAN | S1 | S2 | S3 | MEAN |
| M1         | 1.47    | 2.45 | 3.57 | 2.50 | 2.41 | 3.33 | 5.57 | 3.77 |
| M2         | 1.45    | 2.41 | 3.21 | 2.36 | 2.39 | 3.34 | 5.01 | 3.58 |
| M3         | 2.02    | 2.62 | 4.82 | 3.15 | 2.61 | 3.64 | 5.48 | 3.96 |
| M4         | 1.44    | 2.22 | 3.19 | 2.28 | 2.53 | 3.03 | 4.02 | 3.11 |
| M5         | 1.42    | 2.01 | 2.79 | 2.07 | 2.25 | 3.02 | 3.62 | 2.97 |
| MEAN       | 1.56    | 2.34 | 3.52 | 2.38 | 3.24 | 4.80 |
|            | M       | S   | M x S |
|            | C.D     | 0.09 | 0.07 | 0.15 |

4. Number of leaves
At Harvest, organic treatments had significant effect on number of leaves. The organic treatment M3 recorded maximum number of leaves (234.5) followed by M1 (218.3), M2 (214.6) and M4 (213.4) were at par. Whereas the treatment M3 recorded minimum number of leaves (212.4). At Harvest, number of leaves differed significantly due to different spacing. The spacing S1 recorded maximum number of leaves (243.46), whereas the spacing recorded minimum number of leaves (202.17). Interaction between organic treatments and spacing had significant effect on number of leaves at Harvest. M1S3 recorded maximum number of leaves (281.81) followed by M1S5 (240.21), M2S3 (233.23) and M1S3 (231.42) were at par. Among all the interactions M1S3 recorded minimum number of leaves (198.02).

Planting at wider spacing, resulted in increased photosynthetic activity due to more penetration of sunlight on the plants, ending up in more vigorous growth of foliage (Ram et al. 2008). The increased number of leaves might be due to the presence of vital macro and micronutrients availability with FYM (Giraddi, 1993 and Thanunathan et al. 1997)[17, 22].
5. Leaf area index (LAI)

At Harvest, organic treatments had significant effect on leaf area index. The organic treatment M_1 recorded maximum leaf area index (1.75) followed by M_2 (1.37). Whereas the treatment M_3 recorded minimum leaf area index (0.60). At Harvest, leaf area index differed significantly due to different spacing. The spacing S_1 recorded maximum leaf area index (2.60), whereas the spacing S_3 recorded minimum leaf area index (0.51). Interaction between organic treatments and spacing had significant effect on leaf area index at Harvest.

Among all the interactions M_1S_1 recorded maximum leaf area index (3.94) followed by M_2S_2 (2.83) and M_3S_3 (2.83) and were at par. Minimum leaf area index was recorded in M_3S_1 (0.46).

Leaf area index (LAI) is a crucial growth in determining the capacity of plant to trap solar energy for photosynthesis and has marked effect on growth and yield of plant. The influence on leaf area index remained significant under different types of organic manure and spacing levels. (Detpiratmongkol, 2014)\[5]..

### Table 7: Effect of organic treatments and spacing on number of leaves in kalmegh at 30 DAP and 60 DAP

| Treatments | Number of Leaves |
|------------|-----------------|
| **Organic Treatments** | **30 DAP** | **60 DAP** |
| | S_1 | S_2 | S_3 | MEAN | S_1 | S_2 | S_3 | MEAN |
| M_1 | 10.61 | 17.40 | 23.01 | 17.01 | 64.42 | 68.62 | 70.82 | 70.82 |
| M_2 | 10.40 | 17.40 | 21.60 | 16.47 | 58.02 | 68.42 | 70.82 | 65.8 |
| M_3 | 12.19 | 18.39 | 23.02 | 17.87 | 67.02 | 69.61 | 72.02 | 69.5 |
| M_4 | 9.81 | 16.79 | 21.40 | 16.00 | 55.41 | 67.82 | 70.80 | 64.7 |
| M_5 | 7.20 | 16.20 | 21.02 | 14.81 | 51.82 | 67.81 | 69.62 | 63.1 |
| **MEAN** | 10.04 | 17.23 | 22.01 | | 59.34 | 68.46 | 70.82 | |
| **S.Em±** | 0.23 | 0.18 | 0.39 | 1.24 | 0.96 | 2.15 |
| **C.D** | 0.65 | 0.50 | 1.13 | 3.58 | 2.77 | 11.0 |

### Table 8: Effect of organic treatments and spacing on number of leaves in kalmegh at 90 DAP and at harvest

| Treatments | Number of Leaves |
|------------|-----------------|
| **Organic Treatments** | **90 DAP** | **AT Harvest** |
| | S_1 | S_2 | S_3 | MEAN | S_1 | S_2 | S_3 | MEAN |
| M_1 | 161.81 | 170.02 | 177.21 | 169.7 | 204.80 | 210.02 | 240.21 | 218.3 |
| M_2 | 156.83 | 169.41 | 177.01 | 167.8 | 201.21 | 209.29 | 233.23 | 214.6 |
| M_3 | 164.32 | 172.61 | 179.61 | 172.2 | 207.02 | 214.63 | 281.81 | 234.5 |
| M_4 | 153.21 | 167.81 | 174.82 | 165.3 | 199.80 | 209.01 | 231.42 | 213.4 |
| M_5 | 149.07 | 167.04 | 174.68 | 163.6 | 198.02 | 208.61 | 230.62 | 212.4 |
| **MEAN** | 157.05 | 169.38 | 176.66 | | 202.17 | 210.31 | 243.46 | |
| **S.Em±** | 1.92 | 1.49 | 3.34 | 2.16 | 1.67 | 3.75 |
| **C.D** | 5.58 | 4.32 | NS | 6.27 | 4.86 | 10.87 |

### Table 9: Effect of organic treatments and spacing on Leaf area index in kalmegh at 30 DAP and 60 DAP

| Treatments | Leaf Area Index |
|------------|-----------------|
| **Organic Treatments** | **30 DAP** | **60 DAP** |
| | S_1 | S_2 | S_3 | MEAN | S_1 | S_2 | S_3 | MEAN |
| M_1 | 0.01 | 0.02 | 0.12 | 0.05 | 0.07 | 0.12 | 0.55 | 0.25 |
| M_2 | 0.01 | 0.013 | 0.10 | 0.04 | 0.07 | 0.11 | 0.42 | 0.20 |
| M_3 | 0.01 | 0.02 | 0.12 | 0.05 | 0.06 | 0.11 | 0.48 | 0.22 |
| M_4 | 0.01 | 0.01 | 0.08 | 0.03 | 0.05 | 0.10 | 0.40 | 0.18 |
| M_5 | 0.01 | 0.01 | 0.07 | 0.03 | 0.05 | 0.07 | 0.38 | 0.16 |
| **MEAN** | 0.01 | 0.01 | 0.10 | | 0.06 | 0.10 | 0.44 | |
| **S.Em±** | 0.002 | 0.002 | 0.004 | 0.005 | 0.004 | 0.008 |
| **C.D** | 0.006 | 0.005 | 0.011 | 0.015 | 0.011 | 0.025 |

### Table 10: Effect of organic treatments and spacing on Leaf area index in kalmegh at 90 DAP and at harvest

| Treatments | Leaf Area Index |
|------------|-----------------|
| **Organic Treatments** | **90 DAP** | **AT Harvest** |
| | S_1 | S_2 | S_3 | MEAN | S_1 | S_2 | S_3 | MEAN |
| M_1 | 0.28 | 0.43 | 1.49 | 0.73 | 0.54 | 0.77 | 3.94 | 1.75 |
| M_2 | 0.25 | 0.32 | 1.35 | 0.64 | 0.52 | 0.74 | 2.83 | 1.36 |
| M_3 | 0.27 | 0.35 | 1.49 | 0.70 | 0.53 | 0.74 | 2.83 | 1.37 |
| M_4 | 0.26 | 0.28 | 1.18 | 0.57 | 0.52 | 0.73 | 2.66 | 1.30 |
| M_5 | 0.24 | 0.28 | 1.16 | 0.56 | 0.46 | 0.56 | 0.77 | 0.601 |
6. Leaf stem ratio

At Harvest, organic treatments had significant effect on leaf stem ratio. The organic treatment M₁ recorded maximum leaf stem ratio (0.71) followed by M₁ (0.70) and M₂ (0.68) and were at par. Whereas the treatment M₃ recorded minimum leaf stem ratio (0.55) which was at par with M₄ (0.62). At Harvest, leaf stem ratio differed significantly due to different spacing. The spacing S₁ recorded maximum leaf stem ratio (0.85), whereas the spacing S₂ recorded minimum leaf stem ratio (0.48). Interaction between organic treatments and spacing did not exhibit any significant effect on leaf stem ratio at Harvest.

The increase in leaf stem ratio under the treatment M₁- FYM (30 t/ha) + AMC (7.5 l/ha) might be due to improvement of soil physical properties such as reduction in bulk density and increase in water holding capacity with the application of FYM (Sanjutha et al. 2008) [10], and also due to more availability of macro and micronutrients to the plants (Graddi, 1993 and Thanunathan et al. 1997) [23].

Table 11: Effect of organic treatments and spacing on leaf stem ratio in kalmegh at 30 DAP and 60 DAP

| Treatments | Spacing | Leaf Stem Ratio |
|------------|---------|----------------|
|            | 30 DAP  | 60 DAP         |
|            | S₁      | S₂      | S₁      | MEAN | S₁      | S₂      | S₁      | MEAN | S₁      | S₂      | MEAN |
| M₁         | 2.85    | 4.51    | 7.55    | 4.97  | 1.44    | 2.22    | 4.43    | 2.70 |
| M₂         | 2.51    | 3.31    | 5.11    | 3.65  | 1.42    | 1.83    | 3.25    | 2.17 |
| M₃         | 2.76    | 3.55    | 5.42    | 3.91  | 1.43    | 2.05    | 3.35    | 2.28 |
| M₄         | 2.14    | 3.16    | 5.01    | 3.44  | 1.36    | 1.59    | 2.65    | 1.87 |
| M₅         | 1.08    | 2.93    | 4.90    | 2.97  | 0.96    | 1.54    | 2.34    | 1.61 |
| MEAN       | 2.27    | 3.49    | 5.60    | 1.32  | 1.84    | 3.20    |         |      |

Table 12: Effect of organic treatments and spacing on leaf stem ratio in kalmegh at 90 DAP and at harvest

| Treatments | Spacing | Leaf Stem Ratio |
|------------|---------|----------------|
|            | 90 DAP  | AT Harvest     |
|            | S₁      | S₂      | S₁      | MEAN | S₁      | S₂      | S₁      | MEAN | S₁      | S₂      | S₁      | MEAN |
| M₁         | 1.05    | 1.35    | 1.96    | 1.45  | 0.54    | 0.67    | 0.94    | 0.71 |
| M₂         | 1.03    | 1.25    | 1.85    | 1.37  | 0.53    | 0.64    | 0.88    | 0.68 |
| M₃         | 1.04    | 1.26    | 1.94    | 1.41  | 0.54    | 0.66    | 0.92    | 0.70 |
| M₄         | 0.95    | 1.22    | 1.46    | 1.21  | 0.48    | 0.62    | 0.76    | 0.62 |
| M₅         | 0.66    | 1.15    | 1.37    | 1.06  | 0.35    | 0.55    | 0.75    | 0.55 |
| MEAN       | 0.94    | 1.24    | 1.71    | 1.06  | 0.48    | 0.63    | 0.85    |      |

7. Fresh herb yield per plot (Kg)

At Harvest, fresh herb yield per plot was significantly affected by organic treatments. Among all the organic treatments M₁ - FYM 30 t/ha + AMC 7.5 l/ha recorded maximum fresh herb yield per plot (2.15) followed by M₁ - Neem cake 7.5 t/ha + AMC 7.5 l/ha (2.04). Minimum fresh herb yield per plot was observed in M₅ - Control (1.44). Among different spacing fresh herb yield per plot was significantly affected at harvest. The spacing S₁ (15 x 15 cm) recorded maximum fresh herb yield per plot (2.41) whereas spacing S₂ (30 x 45 cm) recorded minimum fresh herb yield per plot (1.34). Interaction between organic treatments and spacing had significant effect on fresh herb yield per plot at Harvest. Among all the interactions M₁S₁ - FYM (30 t/ha) + AMC 7.5 l/ha with spacing S₁ - 15 x 15 cm recorded the maximum (3.12) followed by M₂S₁ - Neem cake 7.5 t/ha + AMC 7.5 l/ha with spacing S₁ - 15 x 15 cm (2.96). Minimum fresh herb yield per plot was observed in M₃S₂ - Control with spacing S₁ - 30 x 45 cm (1.22). Sindhul et al., 2016 [20] reported that combined application of farm yard manure 10 Mg ha⁻¹ and azospirillum 2 kg ha⁻¹ gave the highest herbage yield in *Indigofera tinctoria*. As per reports of Mekki and Ahmmed (2005) [12], pod yield of soyabean was increased by the combined application of organic manures and biofertilisers. The increase in fresh yield in wider spacing might be due to optimum plant population, better nourishment and less competition for nutrients, (30 cm x 45 cm). The results are in conformity with those reported by Ramchandran and Subbian (1981) [15].

Table 13: Effect of organic treatments and spacing on fresh herb yield per plot in kalmegh at harvest

| Treatments | Fresh Herb Yield Per Plot (kg) |
|------------|--------------------------------|
|            | Spacing                        |
| Organic Treatments | AT Harvest | S₁ | S₂ | S₁ | MEAN |
| M₁         | 15 x 15 cm                     | 0.54 | 0.67 | 0.94 | 0.71 |
| M₂         | 15 x 15 cm                     | 0.53 | 0.64 | 0.88 | 0.68 |
| M₃         | 30 x 45 cm                     | 0.48 | 0.63 | 0.85 |      |
| M₄         | 30 x 45 cm                     | 0.35 | 0.55 | 0.75 | 0.55 |
| M₅         | 15 x 15 cm                     | 0.09 | 0.06 |      |      |
| MEAN       |                                | 0.23 | 0.27 | 0.30 | 0.25 |

International Journal of Chemical Studies

http://www.chemijournal.com
8. Dry herb yield per plot (Kg)

At harvest, dry herb yield per plot was significantly affected by organic treatments. Among all the organic treatments, M1 - FYM 30t/ha + AMC 7.5 l/ha recorded maximum dry herb yield per plot (3.78) followed by M2 - Neem cake 7.5 l/ha + AMC 7.5 l/ha + AM 7.5 l/ha (4.91). Minimum dry herb yield per plot was observed in M4 - Control (0.70). At harvest, dry herb yield per plot was significantly affected by spacing. The spacing S1 (15 x 15 cm) recorded maximum dry herb yield per plot (1.21) whereas spacing S3 (30 x 45 cm) recorded minimum dry herb yield per plot (0.68). Interaction between organic treatments and spacing had significant effect on dry herb yield per plot at harvest. Among all the interactions, M1S1 - FYM 30t/ha + AMC 7.5 l/ha with spacing S1 - 15 x 15 cm recorded the maximum (1.56) followed by M2S1 - Neem cake 7.5 l/ha + AMC 7.5 l/ha with spacing S1 - 15 x 15 cm (1.48). Minimum dry herb yield per plot was observed in M4S3 Control with spacing S3 - 30 x 45 cm (0.61).

Increase in dry herb yield over control could be attributed to the effective functioning of AZT, PSB and VAM, which produced bio-active substances showing similar effect as that of growth regulators, which helped in better uptake and utilisation of nutrients for promoting plant growth. The results are in conformity with the findings of Ravi (2004) [17] in coleus, Rameshbabu (1996) [16] in Ashwagandha and Velmurugan et al. (2008) [23] in turmeric.

Table 14: Effect of organic treatments and spacing on dry herb yield per plot (kg) in kalmegh at harvest

| Treatments | Dry Herb Yield Per Plot (Kg) | Spacing | At Harvest |
|------------|-----------------------------|---------|------------|
| Organic Treatments | S1 | S2 | S3 | MEAN |
| M1 | 1.56 | 0.93 | 0.73 | 1.07 |
| M2 | 1.21 | 0.88 | 0.71 | 0.93 |
| M3 | 1.48 | 0.90 | 0.73 | 1.03 |
| M4 | 0.95 | 0.82 | 0.64 | 0.80 |
| M5 | 0.82 | 0.68 | 0.61 | 0.70 |
| MEAN | 1.21 | 0.84 | 0.68 |  |  |
| S.Em± | 0.02 | 0.02 | 0.04 |  |
| C.D | 0.05 | 0.05 | 0.10 |  |

9. Seed yield per plot (g)

At harvest, seed yield per plot was significantly affected by organic treatments. Among all the organic treatments, M1 - FYM 30t/ha + AMC 7.5 l/ha (4.91) recorded maximum seed yield per plot followed by M2 - Neem cake 7.5 l/ha + AMC 7.5 l/ha (4.51). Minimum seed yield per plot was observed in M4 - Control (3.78). At harvest, seed yield per plot was significantly affected by spacing. The spacing S1 (15 x 15 cm) recorded maximum seed yield per plot (5.83) whereas spacing S3 (30 x 45 cm) recorded minimum seed yield per plot (3.20). Interaction between organic treatments and spacing found non-significant on seed yield per plot at harvest. The combined application of organic manures and biofertilizers (AMC) might have supplied adequate amounts of nutrients, which favoured higher metabolic rate and auxin activities in the plant, resulting in better yield attributes and higher seed yield. This is in accordance with the findings of Manohar et al. (2012) [11] in ashwagandha. Plant geometry 10 cm x 15 cm recorded maximum seed yield, it may be due to accommodation of more plant population per unit area. Similar results were also reported by Kumar et al. (2015) [10] in fenugreek.

Table 15: Effect of organic treatments and spacing on seed yield per plot (g) in kalmegh at harvest

| Treatments | Seed Yield Per Plot (g) | Spacing |
|------------|-------------------------|---------|
| Organic Treatments | S1 | S2 | S3 | MEAN |
| M1 | 6.80 | 4.53 | 3.40 | 4.91 |
| M2 | 5.90 | 3.76 | 3.30 | 4.32 |
| M3 | 6.36 | 3.76 | 3.40 | 4.51 |
| M4 | 5.20 | 3.70 | 3.00 | 3.97 |
| M5 | 4.90 | 3.50 | 2.93 | 3.78 |
| MEAN | 5.83 | 3.85 | 3.20 |  |  |
| S.Em± | 0.13 | 0.10 | 0.22 |  |
| C.D | 0.38 | 0.29 | NS |  |
Conclusion
It can be concluded that growing of kalmegh with the combined use of organic manures and biofertilizers was found effective in promoting growth, and herb yield. Application of FYM (30 t/ha) + AMC (7.5 l/ha) recorded maximum growth and yield parameters. Spacing of 15 x 15 cm have shown higher herb yield and spacing of 30 x 45 cm recorded maximum growth parameters.

References
1. Al-Fraihat A, Al-dalain SY, Al-Rawashdeh ZB, Abu-Darwish MS, Al-Tabtal JA. Effect of organic and biofertilizers on growth, herb yield and volatile oil of marjoram plant grown in Ajloun region, Jordan. Journal of Medicinal Plants Research 2011;5(13):2822-2833.
2. Anil Kumar, Sanjeev Kumar, Madan VK, Vinod Phogat. Potential of kalmegh (Andrographis paniculata Wall Ex. Nees) under north Indian conditions. Indian journal of arecanut, spices & medicinal plants 2008;10(3):134-137.
3. Ashok K, Amit A, Sujatha A, Murali B, Anand MS. Effect of aging on androgrophiode content in Andrographis paniculata. Journal of natural remedies 2002;2(2):179-181.
4. Dauda SN, Ajayi FA, Ndor E. Growth and yield of water melon (Citrullus lanatus) as affected by poultry manure application. Journal of Agriculture and Social Sciences 2008;4:121-124.
5. Detpiratmongkol S, Ubolkerd T, Yoosukyingstaporn. Effects of chicken, pig and cow manures on growth and yield of kalmegh (Andrographis paniculata Nees). Journal of Agricultural Technology 2014;10(2):475-482.
6. Faroqui AA, Sreeramu BS. Cultivation of medicinal and aromatic crops. Rev Edn University Press Hyderabad 2004.
7. Giraddi RA. Vermiculture and role in agriculture. In: proc., course on the officers of the state department of agriculture, Karnataka, 18-20 october by the department of agriculture microbiology University Agricultural sciences Dharwad (M.S) India 1993, 50-54.
8. Kale RD, Bano K, Sreenivas MN, Bagyayaraj DJ. Influence of worm cast (Vee Comp. EUAS 83) on the growth and mycorrhizea colonization of two ornamental plants. South Indian Hort 1987;35:433-437.
9. Kumar K, Choudhary HP, Awasthi UD, Sharma DC. Impact of plant density and sowing on growth, yield and Andrographole content of Kalmegh (Andrographis paniculata Nees).Society for Recent Development in Agriculture Prog. Agric 2010;10(1):56-59.
10. Kumar R, Meena SS, Kakani RK, Mehta RS, Meena NK. Response of fertilizer levels and genotypes on productivity of fenugreek. International Journal of Seed Spices 2015;5(1):63-67.
11. Manohar S, Choudhary MR, Yadav BL, Dadheech S, Singh SP. Analyzing the efficacy of organic and inorganic sources of nitrogen and phosphorus on growth of ashwaganda (Withania somnifera Dunal.). J Hort. Sci 2012;7(2):161-165.
12. Mekki BB, Ahmed AG. Growth, yield and seed quality of soybean (Glycine max L.) as affected by organic, biofertilizer and yeast application. Res. J Agric. Biol. Sci 2005;1(4):320-324.
13. Muvel R, Naruka IS, Chundawat RS, Shaktawat RPS, Rathore SS, Verma KS. Production, productivity and quality of ajwain (Trachyspermum ammi L. Sprague) as affected by plant geometry and fertilizer levels. International Journal of Seed Spices 2015;5(2):32-37.
14. Ram D, Chandra R, Kumar B. Effect of spacing and organics on growth and herbage yield of kalmegh (Andrographis paniculata Wall. Ex. Nees). Progressive Horticulture 2008;40(1):69-73.
15. Ramchandran S, Subbiah KK. Effect of plant density and graded level of nitrogen on yield and yield components of chilies (Capsicum annuum L.). South Indian J Hort 1981;29:178-181.
16. Ramesh Babu TI. Nutritional Studies on Ashwagandha. M.Sc. (Hort.) Thesis Submitted to Horticultural College and Research Institute, Periyakulam 1996.
17. Ravi P. Efficacy of integrated nutrient management for growth and yield of coleus (Coleus forskohlii Briq.). M.sc. (Agri.) Thesis, Tamilnadu Agricultural University 2004.
18. Sanjutha S, Subramanian S, Indu Rani C, Maheswari J. Integrated Nutrient Management in Andrographis paniculata. Research Journal of Agriculture and Biological Sciences 2008;4(2):141-145.
19. Sharma A, Naruka IS, Shaktawat RPS. Effect of row spacing and nitrogen on growth and yield of coriander (Coriandrum sativum L.). Journal of Krishi Vigyan 2016;5(1):49-53.
20. Sindhu PV, Kanakamany MT, Beena C. Effect of organic manures and biofertilisers on herbage yield, quality and soil nutrient balance in Indigofera tinctoria cultivation. Journal of Tropical Agriculture 2016;54(1):16-20.
21. Subramanian KS, Sivasamy N, Thangaraj T. Integrated nutrient management for turmeric. Spice India 2001;14(12):25-26.
22. Thanunathan K, Natarajan S, Senthil Kumar R, Arulmurugan K. Effect of different sources of organic amendments on growth and yield of onion in minespoil. Madra Agric. J 1997;84:382-384.
23. Velmurugan M, Chezhiany N, Jawaharlal M. Influence of organic manures and inorganic fertilizers on cured rhizome yield and quality of turmeric (Curtcuma longa L.). Int. J Agric. Sci 2008;4(1):142-145.
24. Williams RF. The physiology of plant growth with special reference to the concept of net assimilationrate. Annals of botany 1946;10:9-16.