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Effect of organic treatments and spacing on growth parameters of kalmegh (*Andrographis paniculata*) var. Cim-Megha

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Abstract
A field experiment conducted on the effect of organic treatments and spacing on growth parameters of kalmegh under *Rabi* season 2017-18 at college of Horticulture, Rajendranagar. The treatment M_3S_3 recorded maximum number of primary branches per plant (17.23), number of secondary branches per plant (5.78), number of leaves per plant (281.81), followed by M_1S_3 –FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm). Minimum was recorded in M_5S_1. The treatment M_1S_3 –FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded maximum leaf area (890.60 cm^2), LAI (1.75), leaf stem ratio (0.94), fresh weight of leaves per plant (60.63 g), dry weight of leaves per plant (30.26 g), crop growth rate (7.14 g/day/m^2), relative growth rate (17.32 mg/g/day) at harvest, followed by the treatment M_3S_3 whereas minimum was recorded in the treatment M_5S_1. Among all the interactions maximum growth parameters were recorded in the treatment M_1S_3 – FYM (30 t/ha) + Arka microbial consortium with spacing S_3 (30 x 45 cm).

Keywords: Kalmegh, FYM, neem cake, vermicompost, AMC, growth parameters

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 was recommended in "Charaka Samhita" in 175 BC for treatments of jaundice along with other plants in multi plant preparation. Kalmegh is widely used in Indian traditional system of medicine against different ailments. Kalmegh is one of the important ingredients in various ayurvedic preparations used for fever and liver disease, which are commonly used by ayurvedic physicians.

Organic farming provides several benefits to the growers. It reduces production cost and it is an environmentally friendly method of cultivation. Addition of organic manures, bio fertilizers improved soil structure and enhances activities of useful soil organism, to maintain flora and fauna and also known to improve the biodiversity (Enwall *et al*., 2005; Birkhofer *et al*., 2008) [5, 2] and may prove a large depository for excess carbon dioxide (Lal, 2004) [15].

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 CO_2. Maximum exploitation of these factors is achieved when the plant population puts forth maximum pressure on all the factors of production.

Resources and Research Methods
The field experiment was conducted at College of Horticulture, Rajendranagar during *Rabi* 2017-18. The soil type was loamy sand having pH 6, EC 0.06 dSm^{-1}, low in available N (175.61 kg ha^{-1}), low in available P (7.77 kg ha^{-1}) and medium in available potash (182.56 kg ha^{-1}). The experiment was laid out in Factorial randomized block design (FRBD) in three replications with 15 treatment combinations comprised of five levels of organic treatments *viz*., M_1 – FYM (30t/ha) + AMC (7.5 l/ha), M_2 – Vermicompost (6t/ha) + AMC (7.5 l/ha), M_3 – Neem cake (7.5t/ha) + AMC (7.5 l/ha), M_4 – Sheep manure (10t/ha) + AMC (7.5 l/ha), M_5 - Control and three levels of spacing *viz*., S_1 – 15x15 cm, S_2 – 30x30 cm, S_3 – 30x45 cm. The treatment combinations include M_1S_1: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm), M_1S_2: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm), M_1S_3: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm), M_2S_1: Vermicompost (6 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm), M_2S_2: Vermicompost (6 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm), M_2S_3: Vermicompost (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 (30 x 45 cm), M_3S_1: Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm), M_3S_2: Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm), M_3S_3: Neem cake

(7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm), M_4S_1: Sheep manure (10 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm), M_4S_2: Sheep manure (10 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm), M_4S_3: Sheep manure (10 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm), M_5S_1: Control (without organic treatments) with spacing S_1 (15 x 15 cm), M_5S_2: Control (without organic treatments) with spacing S_2 (30 x 30 cm), M_5S_3: Control (without organic treatments) with spacing S_3 (30 x 45 cm)

Research Findings and Discussion

1. Number of primary branches

Interaction between organic treatments and spacing had significant effect on number of primary branches at harvest. Among all the interactions, M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm recorded maximum number of primary branches (17.23) followed by M_1S_3 (16.63). M_2S_3 Vermicompost (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 30 x 45 cm (16.16), M_4S_3 Sheep manure (10 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (13.60) which were remained at par. Minimum number of primary branches was recorded in M_5S_1 Control with spacing S_1 -15 x 15 cm (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 [10]. Enchanced branching with wider spacing has also been reported by Rao *et al.* 2003 [21] in henna. This indicates that wider interspacing might have provide more congenial environment for branching owing to improved sunlight interception by the plants. Hangovan *et al.* (1990) [7] reported that wider spacing exhibited intense branching.

2. Number of secondary branches

Interaction between organic treatments and spacing had significant effect on number of secondary branches at harvest. M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm recorded maximum number of secondary branches (5.78) followed by M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (5.57), M_2S_3 Vermicompost (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 30 x 45 cm (5.01) and were at par. Minimum number of secondary branches was recorded in M_5S_1 Control with spacing S_1 -15 x 15 cm (2.25).

Wider spacing promotes branching in mint, because of exposure of the plant to light, which affected the plants to promote maximum number of secondary branches. (Salim *et al.* 2014) [25]. The positive response with the application of Neem cake due to increased plant growth through improvement in soil conditions and increased availability of nutrients favoured maximum production of secondary branches in kalmegh. These results are in confirmity with the findings of Rizvi *et al*., (2013) [23], Kavitha and Vadivel (2006) [11] and Ravi Kumar *et al*., (2013) [22].

3. Number of leaves

Interaction between organic treatments and spacing had significant effect on number of leaves at Harvest. M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm recorded maximum number of leaves (281.81) followed by M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (240.21), M_2S_3 Vermicompost (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 30 x 45 cm (233.23) and M_4S_3 Sheep manure (10 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (231.42) are at par. Among all the interactions M_5S_1 Control with spacing S_1 -15 x 15 cm recorded minimum number of leaves (198.02).

The better performance of plants with neem cake was probably because it acted as natural fertilizer with pesticidal properties and performs as a nitrification inhibitor and prolongs the availability of nitrogen to short duration as well as long duration crops. Beside these, it improves the soil condition considerably and protects the soil during the droughts. The manure provided nutrients to the plants and may improved edaphic factors, which resulted in maximum number of leaves. These results are in good agreement with the findings of several researchers which revealed that organic manuring increased the number of leaves (Roy *et al*., 2010; Dinesh *et al*., 2010; Mohapatra & Das, 2009; Manikerri, 2006) [24, 5, 17]. 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) [20].

4. Leaf area

Interaction between organic treatments and spacing had significant effect on leaf area at Harvest. Among all the interactions M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded maximum leaf area (890.60) followed by M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (788.10). Minimum leaf area was recorded in M_5S_1 Control with spacing S_1 -15 x 15 cm (586.70).

The increment of leaf area may be caused by the increasing of cell enlargement, cell number, number of leaves or all of them. These results may be attributed to the effect of organic manures and AMC in increasing levels of endogenous hormones in treated plants which could be interpreted by cell division and cell elongation (Khedr and Farid, 2000) [13]. Further, this may be due to the physiological roles of vitamins and amino acids in the effect of organic treatments and AMC which increased the metabolic processes role and levels of indogenous hormones, i.e., IAA and GA_3 (Chaliakhyan, 1957) [3]. The present investigated results were in accordance to those found by Jacoub (1999) [8] on *Ocimum basilicum* and *Thymus vulgaris*, Abd Ellatif (2006) on *Salvia officinalis*. Light is important source of photosynthesis for plant growth, wider spaced plant get proper light intensity and nutrient as compare to the closely spaced plant So, maximum leaf area recorded under wider spacing. Similar results have been reported by Kahsay *et al*., (2014) [9] who found that wider spaced plant get more leaf area.

5. Leaf area index

Interaction between organic treatments and spacing had significant effect on leaf area index at Harvest. Among all the interactions M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded maximum leaf area index (3.94) followed by M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (2.83) and M_2S_3 Vermicompost (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 30 x 45 cm (2.83) and were on par. Minimum leaf area index was recorded in M_5S_1 Control with spacing S_1 -15 x 15 cm (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) [14].

6. Leaf stem ratio
Interaction between organic treatments and spacing did not exhibit any significant effect on leaf stem ratio at Harvest.

7. Fresh weight of leaves per plant
Interaction between organic treatments and spacing did not exhibit any significant effect on fresh weight of leaves at Harvest.

8. Dry weight of leaves per plant
Interaction between organic treatments and spacing had significant effect on dry weight of leaves at Harvest. Among all the interactions M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded the maximum dry weight of leaves (30.26) followed by M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (29.04). Minimum dry weight of leaves was observed in M_5S_1 Control with spacing S_1 -15 x 15 cm (13.53).
Higher production of dry matter by the plant with application of organic manures and biofertilizers might be due to the fact that organic manures have high amounts of humus, which facilitate N-fixation by microbes, regulate the nitrogen supply to the plants and also helps in the production of plant growth promoters (Krishnamoorthy and Ravikumar, 1973) [14] in mint. The increasing dried leaf yield may be due to the compensation with growth of number of plants per unit area by efficient utilization of available resources viz., nutrients, water, light and space and having comparatively less competition between intra and inter row spacing under wider spacing. The same results have been supported by various workers (Khanda and Mishra, 1999, Santhi and Vijayakumar, 1997, and Pareek *et al*., 1991) [12, 26, 18].

9. Crop growth rate
Interaction between organic treatments and spacing had significant effect on crop growth rate at Harvest. Among all the interactions M_1S_3 - FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded the maximum crop growth rate (7.14) followed by M_3S_3 - Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (6.31). Minimum crop growth rate was observed in M_5S_1 Control with spacing S_1 -15 x 15 cm (0.97).

10. Relative growth rate
Interaction between organic treatments and spacing had significant effect on relative growth rate at Harvest. Among all the interactions M_1S_3 FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm) recorded the maximum relative growth rate (17.32) followed by M_3S_3 Neem cake (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 30 x 45 cm (16.82). Minimum relative growth rate was observed in M_5S_1 Control with spacing S_1 -15 x 15 cm (5.62).
The increasing crop growth rate and relative growth rate due to application of FYM and biofertilizers may be due to the compensation with growth of number of plants per unit area by efficient utilization of available resources *viz*., nutrients, water, light and space and having comparatively less competition between intra and inter row spacing resulting optimum crop growth rate under wider spacing. The same results have been supported by various workers (Khanda and Mishra, 1999; Santhi and Vijayakumar, 1997, and Pareek *et al*., 1991) [12, 26, 18].

Conclusion
Interaction between organic treatments and spacing significantly influenced growth parameters. Among all the interactions maximum growth parameters were recorded in the treatment M_1S_3 – FYM (30 t/ha) + Arka microbial consortium with spacing S_3 (30 x 45 cm), followed by M_3S_3 – Neem cake (7.5 t/ha) + Arka microbial consortium (7.5 l/ha) with spacing S_3 (30 x 45 cm). Minimum was recorded in the treatment M_5S_1 Control with spacing S_1 -15 x 15 cm.

Table 1: Effect of organic treatments and spacing on growth parameters of kalmegh at harvest

Treatments	Number of primary branches	Number of secondary branches	Number of leaves	Leaf area (cm^2)	Leaf area index	Leaf stem ratio	Fresh weight of leaves per plant (g)	Dry weight of leaves per plant (g)	Crop growth rate g/day/m^2	Relative growth rate mg/g/day
M_1S_1	8.01	2.41	204.80	653.90	0.54	0.54	32.39	18.16	1.87	8.56
M_1S_2	12.60	3.33	210.02	683.60	0.77	0.67	38.08	19.36	2.53	14.04
M_1S_3	16.63	5.57	240.21	890.60	3.94	0.94	60.63	30.26	7.14	17.32
M_2S_1	7.86	2.39	201.21	635.40	0.52	0.53	31.57	16.07	1.26	8.34
M_2S_2	12.01	3.34	209.29	669.40	0.74	0.64	36.70	18.62	2.16	10.07
M_2S_3	16.16	5.01	233.23	714.00	2.83	0.88	58.14	27.72	5.09	16.13
M_3S_1	8.30	2.61	207.02	645.30	0.53	0.54	31.95	17.16	1.36	8.54
M_3S_2	12.79	3.48	214.63	670.20	0.74	0.66	37.34	19.21	2.36	13.29
M_3S_3	17.23	5.78	281.81	788.10	2.83	0.92	59.43	29.04	6.31	16.82
M_4S_1	6.84	2.53	199.80	629.10	0.52	0.48	31.51	14.93	1.26	7.56
M_4S_2	7.02	3.03	209.01	668.90	0.73	0.62	36.55	15.63	1.96	8.78
M_4S_3	13.60	4.02	231.42	701.40	2.66	0.76	56.12	26.44	2.93	15.77
M_5S_1	6.01	2.25	198.02	586.70	0.46	0.35	30.70	13.53	0.97	5.62
M_5S_2	6.78	3.02	208.61	667.20	0.56	0.55	35.34	14.82	1.93	8.56
M_5S_3	13.46	3.62	230.62	684.20	0.77	0.85	54.74	24.54	2.52	14.55
S.Em±	0.36	0.20	3.75	7.38	0.081	0.05	1.55	0.18	0.20	0.34
C.D	1.06	0.58	10.87	21.39	0.236	N.S	N.S	N.S	0.59	0.99

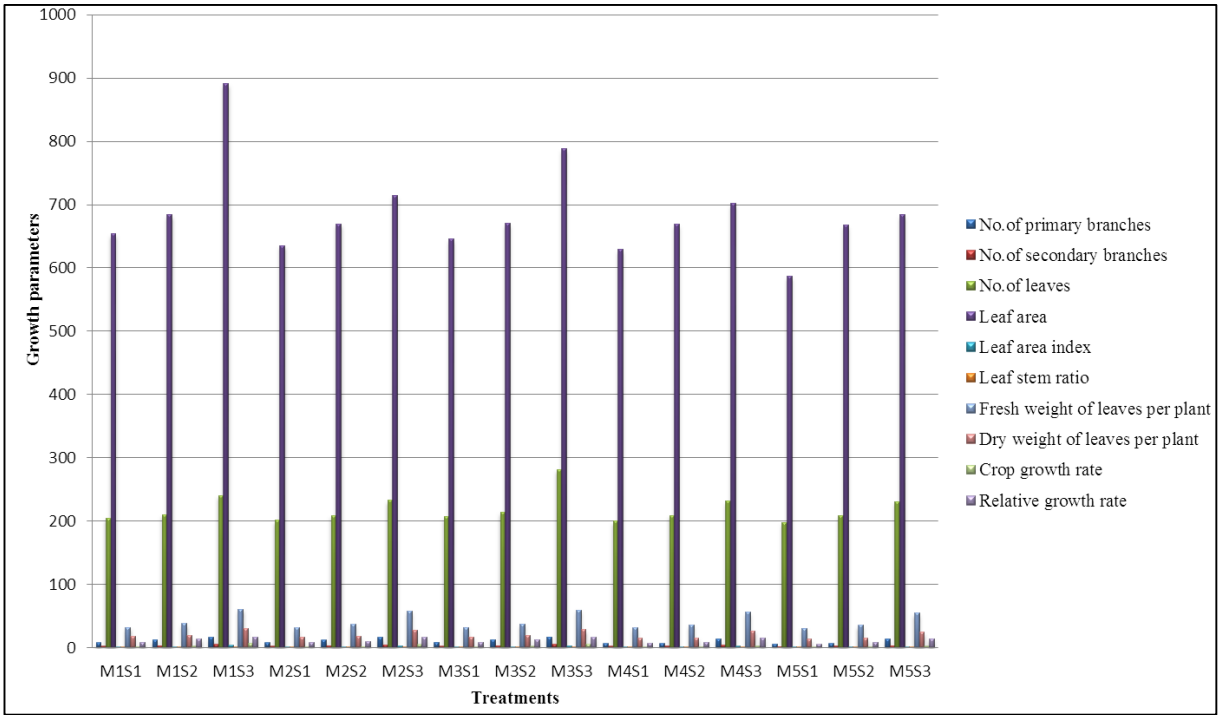

Fig1: Effect of organic treatments and spacing on growth parameters of kalmegh at harvest

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