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Studies on impact of organic manures and spacing on growth and yield 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 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) [6].
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 CO_2. 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

T_1: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm)
T_2: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm)
T_3: FYM (30 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm)
T_4: V.C (6 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm)
T_5: V.C (6 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm)
T_6: V.C (6 t/ha) + AMC (7.5 l/ha) with Spacing S_3 (30 x 45 cm)
T_7: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm)
T_8: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm)
T_9: N.C (7.5 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm)
T_{10}: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S_1 (15 x 15 cm)
T_{11}: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S_2 (30 x 30 cm)
T_{12}: S.M (10 t/ha) + AMC (7.5 l/ha) with spacing S_3 (30 x 45 cm)
T_{13}: Control (with out organic treatments) + spacing S_1 (15 x 15 cm)
T_{14}: Control (with out organic treatments) + spacing S_2 (30 x 30 cm)
T_{15}: Control (with out organic treatments) + spacing S_3 (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).

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

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 ^{0} 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 M_1 recorded maximum plant height (38.70cm), followed by organic treatment M_3 (32.8cm), M_2 (34.2cm) and M_4 (32.8cm) and were found to be at par. Whereas treatment M_5 recorded minimum plant height (30.5cm). At harvest, plant height differed significantly due to different spacing. The spacing S_1 (15 x 15 cm) recorded maximum plant height (40.77cm), whereas the spacing S_3 (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 M_1 at spacing S_1 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) [1] 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) [13] in ajwain and Sharma *et al*. (2016) [19] in coriander.

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

Treatments	Plant height (cm)							
	Spacing							
Organic Treatments	30 dap				60 dap			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	24.06	23.03	22.68	23.25	32.30	29.93	27.65	29.96
M_2	23.07	19.86	16.41	19.77	31.36	27.70	23.81	27.62
M_3	24.05	20.06	16.81	20.30	31.89	27.76	24.57	28.07
M_4	22.84	19.35	16.75	19.64	28.74	26.76	25.65	27.05
M_5	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		S	M x S	M		S	M x S
S.Em±	0.48		0.37	0.83	0.46		0.36	0.79
C.D	1.38		1.07	NS	1.34		1.04	NS

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

Treatments	Plant height (cm)							
	Spacing							
Organic treatments	90 dap				At harvest			
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
M_1	41.30	33.60	24.94	33.28	45.64	36.77	33.56	38.7
M_2	37.60	32.66	24.33	31.53	40.73	34.66	27.33	34.2
M_3	39.50	32.55	24.37	32.14	40.95	36.57	32.75	36.8
M_4	33.65	31.61	23.94	29.74	38.95	33.74	25.84	32.8
M_5	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	

	M	S	M x S	M	S	M x S
S.Em±	0.62	0.48	1.07	0.93	0.72	1.60
C.D	1.79	1.38	NS	2.68	2.07	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 M_3 recorded maximum number of primary branches (12.78) followed by M_1 (12.42). Whereas the treatment M_5 recorded minimum number of primary branches (8.75). At Harvest, number of primary branches differed significantly due to different spacing. The spacing S_3 recorded maximum number of primary branches (15.42), whereas the spacing S_1 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, M_3S_3 recorded maximum number of primary branches (17.23) followed by M_1S_3 (16.63). M_2S_3 (16.16), M_4S_3 (13.60) which were remained at par. Minimum number of primary branches was recorded in M_5S_1 (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 [8]. Kumar *et al*. (2010) [9] 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 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							
	Spacing							
Organic Treatments	30 Dap				60 Dap			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	0.40	1.06	2.00	1.16	3.20	4.42	6.82	4.82
M_2	0.21	1.00	1.80	1.00	2.43	3.78	6.60	4.27
M_3	0.46	1.13	3.21	1.60	2.79	4.82	7.42	5.01
M_4	0	0	1.46	0.48	2.42	3.42	6.01	3.95
M_5	0	0	1.40	0.46	1.01	3.02	6.01	3.35
MEAN	0.22	0.64	1.97		2.37	3.89	6.57	
	M	S		M x S	M		S	M x S
S.Em±	0.03	0.03		0.05	0.08		0.07	0.15
C.D	0.09	0.07		0.16	0.25		0.19	0.44

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							
	Spacing							
Organic Treatments	90 DAP				AT Harvest			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	5.62	9.44	14.86	9.98	8.01	12.60	16.63	12.42
M_2	5.46	6.71	14.36	8.85	7.86	12.01	16.16	12.01
M_3	7.02	10.42	15.15	10.87	8.3	12.79	17.23	12.78
M_4	5.36	6.03	14.02	8.47	6.84	7.02	13.60	9.15
M_5	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
S.Em±	0.28		0.21	0.48	0.21		0.16	0.36
C.D	0.82		0.63	1.41	0.61		0.47	1.06

3. Number of secondary branches

At Harvest, organic treatments had significant effect on number of secondary branches. The organic treatment M_3 recorded maximum number of secondary branches (3.96) followed by M_1 (3.77), M_2 (3.58) were at par. Whereas the treatment M_5 (Control) recorded minimum number of secondary branches (2.97) and it remained on par with M_4. There were significant differences on number of secondary branches among different spacings at harvest. The spacing S_3 (30 x 45 cm) recorded maximum number of secondary branches (4.80), whereas the spacing S_1 (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. M_3S_3 recorded maximum number of secondary branches (5.78) followed by M_1S_3 (5.57), M_2S_3 (5.01) and were at par. Minimum number of secondary branches was recorded in M_5S_1 (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			
	Spacing			
Organic Treatments	60 DAP			
	S_1	S_2	S_3	MEAN
M_1	0.53	0.77	2.33	1.21
M_2	0.42	0.67	1.81	0.97
M_3	0.64	0.80	2.38	1.27
M_4	0.24	0.64	1.79	0.88
M_5	0.23	0.64	0.83	0.57
MEAN	0.41	0.70	1.83	
	M		S	M x S
S.Em±	0.03		0.02	0.05
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							
	Spacing							
Organic Treatments	90 DAP				AT Harvest			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	1.47	2.45	3.57	2.50	2.41	3.33	5.57	3.77
M_2	1.45	2.41	3.21	2.36	2.39	3.34	5.01	3.58
M_3	2.02	2.62	4.82	3.15	2.61	3.48	5.78	3.96
M_4	1.44	2.22	3.19	2.28	2.53	3.03	4.02	3.11
M_5	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	M		S	M x S
S.Em±	0.09		0.07	0.15	0.12		0.09	0.20
C.D	0.25		0.19	0.43	0.33		0.26	0.58

4. Number of leaves

At Harvest, organic treatments had significant effect on number of leaves. The organic treatment M_3 recorded maximum number of leaves (234.5) followed by M_1 (218.3), M_2 (214.6) and M_4 (213.4) were remained at par. Whereas the treatment M_5 recorded minimum number of leaves (212.4). At Harvest, number of leaves differed significantly due to different spacing. The spacing S_3 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. M_3S_3 recorded maximum number of leaves (281.81) followed by M_1S_3 (240.21), M_2S_3 (233.23) and M_4S_3 (231.42) were at par. Among all the interactions M_5S_1 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) [7, 22].

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

Treatments	Number of Leaves							
	Spacing							
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	68.0
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	
	M	S	M x S		M	S	M x S	
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	NS	

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

Treatments	Number of Leaves							
	Spacing							
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	
	M	S	M x S		M	S	M x S	
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	

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_3 (1.37). Whereas the treatment M_5 recorded minimum leaf area index (0.60). At Harvest, leaf area index differed significantly due to different spacing. The spacing S_3 recorded maximum leaf area index (2.60), whereas the spacing S_1 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_3 recorded maximum leaf area index (3.94) followed by M_3S_3 (2.83) and M_2S_3 (2.83) and were at par. Minimum leaf area index was recorded in M_5S_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 9: Effect of organic treatments and spacing on Leaf area index in kalmegh at 30 DAP and 60 DAP

Treatments	Leaf Area Index							
	Spacing							
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	
	M	S	M x S		M	S	M x S	
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							
	Spacing							
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

MEAN	0.26	0.33	1.33		0.51	0.71	2.60	
	M	S	M x S		M	S	M x S	
S.Em±	0.031	0.024	0.054		0.047	0.036	0.081	
C.D	0.090	0.070	NS		0.136	0.105	0.236	

6. Leaf stem ratio

At Harvest, organic treatments had significant effect on leaf stem ratio. The organic treatment M_1 recorded maximum leaf stem ratio (0.71) followed by M_3 (0.70) and M_2 (0.68) and were at par. Whereas the treatment M_5 recorded minimum leaf stem ratio (0.55) which was at par with M_4 (0.62). At Harvest, leaf stem ratio differed significantly due to different spacing. The spacing S_3 recorded maximum leaf stem ratio (0.85), whereas the spacing S_1 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 M_1- 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) [18], and also due to more availability of macro and micronutrients to the plants (Graddi, 1993 and Thanunathan *et al*. 1997) [22].

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

Treatments	**Leaf Stem Ratio**							
	Spacing							
Organic Treatments	**30 DAP**				**60 DAP**			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	2.85	4.51	7.55	4.97	1.44	2.22	4.43	2.70
M_2	2.51	3.31	5.11	3.65	1.42	1.83	3.25	2.17
M_3	2.76	3.55	5.42	3.91	1.43	2.05	3.35	2.28
M_4	2.14	3.16	5.01	3.44	1.36	1.59	2.65	1.87
M_5	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	
	M		S	M x S	M		S	M x S
S.Em±	0.08		0.06	0.14	0.09		0.07	0.16
C.D	0.24		0.19	0.42	0.27		0.21	0.47

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

Treatments	**Leaf Stem Ratio**							
	Spacing							
Organic Treatments	**90 DAP**				**AT Harvest**			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
M_1	1.05	1.35	1.96	1.45	0.54	0.67	0.94	0.71
M_2	1.03	1.25	1.85	1.37	0.53	0.64	0.88	0.68
M_3	1.04	1.26	1.94	1.41	0.54	0.66	0.92	0.70
M_4	0.95	1.22	1.46	1.21	0.48	0.62	0.76	0.62
M_5	0.66	1.15	1.37	1.06	0.35	0.55	0.75	0.55
MEAN	0.94	1.24	1.71		0.48	0.63	0.85	
	M	S		M x S	M	S		M x S
S.Em±	0.03	0.02		0.06	0.03	0.02		0.05
C.D	0.10	0.08		0.18	0.09	0.06		NS

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 M_1 - FYM 30t/ha + AMC 7.5 l/ha recorded maximum fresh herb yield per plot (2.15) followed by M_3 - Neem cake 7.5 t/ha + AMC 7.5 l/ha (2.04). Minimum fresh herb yield per plot was observed in M_5 –Control (1.44). Among different spacing fresh herb yield per plot was significantly affected at harvest. The spacing S_1 (15 x 15 cm) recorded maximum fresh herb yield per plot (2.41) whereas spacing S_3 (30 x45 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 M_1S_1 - FYM (30t/ha) + AMC 7.5 l/ha with spacing S_1 - 15 x 15 cm recorded the maximum (3.12) followed by M_3S_1 - Neem cake 7.5 t/ha + AMC 7.5 l/ha with spacing S_1 - 15 x 15 cm (2.96). Minimum fresh herb yield per plot was observed in M_5S_3 - Control with spacing S_3 - 30 x 45 cm (1.22).

Sindhu *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 confirmity 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**			
	S_1	S_2	S_3	MEAN

M_1	3.12	1.86	1.46	2.15
M_2	2.43	1.75	1.34	1.84
M_3	2.96	1.79	1.38	2.04
M_4	1.91	1.63	1.28	1.61
M_5	1.64	1.45	1.22	1.44
MEAN	2.41	1.70	1.34	
	M		S	M x S
S.Em±	0.01		0.01	0.02
C.D	0.04		0.31	0.70

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 M_1 - FYM 30t/ha + AMC 7.5 l/ha recorded maximum dry herb yield per plot (1.07) followed by M_3 - Neem cake 7.5 t/ha + AMC 7.5 l/ha (1.03). Minimum fresh herb yield per plot was observed in M_5 –Control (0.70). At harvest, dry herb yield per plot was significantly affected by spacing. The spacing S_1 (15 x 15 cm) recorded maximum dry herb yield per plot (1.21) whereas spacing S_3 (30 x45 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 M_1S_1 - FYM 30t/ha + AMC 7.5 l/ha with spacing S_1 - 15 x 15 cm recorded the maximum (1.56) followed by M_3S_1 - Neem cake 7.5 t/ha + AMC 7.5 l/ha with spacing S_1- 15 x 15 cm (1.48). Minimum dry herb yield per plot was observed in M_5S_3 Control with spacing S_3 - 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			
Organic Treatments	**At Harvest**			
	S_1	S_2	S_3	MEAN
M_1	1.56	0.93	0.73	1.07
M_2	1.21	0.88	0.71	0.93
M_3	1.48	0.90	0.73	1.03
M_4	0.95	0.82	0.64	0.80
M_5	0.82	0.68	0.61	0.70
MEAN	1.21	0.84	0.68	
	M		S	M x S
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 M_1 - FYM 30t/ha + AMC 7.5 l/ha (4.91) recorded maximum seed yield per plot followed by M_3 - Neem cake 7.5 t/ha + AMC 7.5 l/ha (4.51). Minimum seed yield per plot was observed in M_5 – Control (3.78). At harvest, seed yield per plot was significantly affected by spacing. The spacing S_1 (15 x 15 cm) recorded maximum, seed yield per plot (5.83) whereas spacing S_3 (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	**AT Harvest**			
	S_1	S_2	S_3	MEAN
M_1	6.80	4.53	3.40	4.91
M_2	5.90	3.76	3.30	4.32
M_3	6.36	3.76	3.40	4.51
M_4	5.20	3.70	3.00	3.97
M_5	4.90	3.50	2.93	3.78
MEAN	5.83	3.85	3.20	
	M		S	M x S
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.

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