

Effect of organic manures and biofertilizers on herb yield and economics of kalmegh (*Andrographis paniculata* Wall. Ex. Nees.) var. CIM Megha

ABSTRACT

Aim: To study the effect of organic manures and biofertilizers on growth, herb yield and economics of kalmegh.

Study Design: The experiment was carried out with 13 treatments in Randomized Block Design (RBD) with three replications.

Place and Duration of Study: The research trial was carried out at P.G students research block, College of Horticulture, Rajendranagar, SKLTSU, Hyderabad during Kharif, 2021.

Results: Among the organic and biofertilizer treatments at combinations the results reported that the (T₆): 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC recorded the highest herb yield and Benefit cost ratio compared to other treatments.

Conclusion: Organic produce fetches higher price in market compared to inorganic produce, which helped in increasing the gross returns, net returns and highest B:C ratio compared to other treatments.

Key words: Organic manures, biofertilizers, herb yield and economics

1. INTRODUCTION

Kalmegh (*Andrographis paniculata* Wall. Ex. Nees.) an acanthaceae member is indigenous to India and has been used in Indian systems of medicine since time immemorial. The plant is known as "Mahatita" which literally means 'King of bitters'. In Sanskrit, it is called Bhuinimb and in telugu, NelaVemu. It is one of the bitterest erect or recumbent, annual herbaceous plant (perennial if maintained). The major bitter constituent in kalmegh is due to the presence of diterpene lactone called as "andrographolide" which is 3 % in leaves and 2 % in stems. Other important constituent is a non-bitter compound, neo-andrographolide. The branches are quadrangular, leaves simple, petiolate, lanceolate with acute base and apex. Flowers are small, solitary and panicles with externally hairy, rose or purple coloured corolla, calyx-lobes glandular, pubescent, anther bearded at the base, fruits 20 mm long, linear-oblong capsules acute at both ends. Seeds are numerous (i.e. 8-12 seeds/capsule) and yellowish brown in colour.

Ayoola and Makinde (2008) reported that organic manures like Farm yard manure, vermicompost, neem cake, poultry manure etc., resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity and exchangeable Ca, Mg and K which invariably enhance crop yield and productivity. The role of organic manures in improving soil structure, better water holding capacity and drainage which in turn help for better growth, yield and drying percentage in kalmegh.

The role of biofertilizers is perceived as growth regulators besides biological nitrogen fixation collectively leading to much higher response on various growth and yield attributing characters (Avitoli et al., 2012). The extensive use of biofertilizers in crop production is the major breakthrough as pollution free low-cost input technology during recent years. Scientific evidence clearly showed that combined application of biofertilizers like N₂ fixing, P solubilizing and mobilizing microbes had positive effect on crop growth and yield. The application of combined form of N fixing, P solubilizing and Zn mobilizing, growth promoting microbes is difficult for farmers due to lack of availability in one place.

To overcome these problems, Arka Microbial Consortium (AMC) biofertilizer has been developed and released from IIHR, Bengaluru which is recommended for media preparation, seed treatment and soil application either by fertigation or drenching. AMC contains N fixing, P and Zn solubilizing and plant growth promoting microbes as a single formulation. Organically grown products fetch higher price and also there is a great demand for organically grown plant produce in the Western countries. Hence, the present experiment has been carried out to study the effect of organic manures and biofertilizers on herb yield and economics of kalmegh.

Comment [THS1]: Why? Kalmegh is selected....Objective and hypothesis?

2. MATERIALS AND METHODS

2.1 The Experimental Site

The experiment was carried out at PG Students Research Block, College of Horticulture, SKLTSHU, India, during *kharif* 2021. The experimental site is situated at a latitude of 17°32' north, longitude of 78°40' East and altitude of 542.3 m above mean sea level.

Comment [THS2]: Journal style and points

2.2 The Experimental Variants and the Experimental Design

The experiment was laid out in a complete RBD with thirteen treatments replicated thrice. The thirteen treatments viz., T₁: 100 % N through FYM + AMC, T₂: 100 % N through VC + AMC, T₃: 100 % N through NC + AMC, T₄: 100 % N through PM + AMC, T₅: 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC + AMC, T₆: 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC, T₇: 75 % N through NC + 12.5 % N through PM + 12.5 % N through FYM + AMC, T₈: 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC, T₉: 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC, T₁₀: 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC, T₁₁: 50 % N through NC + 25 % N through PM + 25 % N through FYM + AMC, T₁₂: 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC, T₁₃: Control (100 % RDF:87:75:50 kg NPK/ha) were imposed.

The experimental field was prepared well by repeated ploughing, harrowing and brought to a fine tilth. Weeds and stubbles were removed and plots were laid out along with drip laterals as per the layout plan. According to the treatments, FYM, vermicompost, neem cake and poultry manure are mixed with different combinations based on their N: P: K levels and incorporated into the soil 15 days before planting the seedlings into the main field. Soil drenching of Arka Microbial Consortium (AMC) @10 ml/L of water 20 days after transplanting near root zone for all the treatments. Whereas for Control, 100 % RDF: 87:75:50 kg NPK/ha was applied in the form of straight fertilizer.

2.3 The Determined parameters.

2.3.1 Yield parameters:

The recorded data on yield parameters like fresh herb yield per plot (kg), dry herb yield per plot (kg), Fresh herb yield per hectare (q), Fresh herb yield per hectare (q), number of capsules per plant, seed yield per plot (g) were analyzed.

2.3.2 Economics:

The recorded data on various growth and yield components of plant were subjected to Fisher's method of "Analysis of variance" (ANOVA) as outlined by Gomez and Gomez (1984). All the data were analysed and the results are presented and discussed at a probability level of 0.05 percent.

3. RESULTS AND DISCUSSIONS

3.1 Yield parameters

3.1.1 Fresh herb yield per plot (kg)

The data from table 1 revealed that, significantly maximum fresh herb yield per plot (3.29 kg) was observed with T₁₃: Control (100 % RDF-87:75:50 kg NPK/ha) followed by T₆: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (2.52 kg), T₁₀: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (2.46 kg), T₅: (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC + AMC) (2.33 kg). The minimum fresh herb yield per plot (1.78 kg) was recorded with T₄: 100 % N through PM + AMC.

3.1.2 Dry herb yield per plot (kg)

The data from table 1 revealed that, significantly maximum dry herb yield per plot (1.226 kg) was observed with T₁₃: Control (100 % RDF- 87:75:50 kg NPK/ha) followed by T₆: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (0.981 kg), T₁₀: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (0.958 kg), T₅: (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) (0.927 kg). The minimum dry herb yield per plot (0.665 kg) was recorded with T₄: 100 % N through PM + AMC.

The increase in fresh and dry herb yield was observed in T₁₃: Control (100 % RDF- 87:75:50 kg NPK/ha) might be attributed to the increased growth of plants in respect of height of plant and number of leaves. The healthy top growth might be responsible for the higher rate of photosynthesis, which might have accumulated carbohydrates resulting in increased number of primary and secondary branches per plant, number of leaves etc. ultimately increasing the overall herbage yield. The results are in conformity with the findings of Ahmad *et al.* (2016) in Aloe.

The higher biomass with application of organic manures and biofertilizers (AMC) might have helped the plant metabolic activity through the supply of important micronutrient such as zinc, iron, copper, manganese, etc. These are involved in biochemical synthesis of many phytohormones. Besides, organic manures and AMC have a role in nitrogen fixation and are also involved in the production of phytohormones like IAA, GA and cytokinin like substances, phosphorous solubilizing bacteria and Arbuscularmycorrhizal fungi helping in solubilization and mobilization of phosphorous in soil which ultimately resulted in higher herbage yield. These results are in line with Mohanchandra (2003) in makoi and Chandana *et al.* (2018) in kalmegh.

Comment [THS3]: Make it one para

3.1.3 Fresh herb yield per hectare (q)

At harvest significantly maximum fresh herb yield per hectare (64.21 q) was observed with T₁₃: Control (100 % RDF- 87:75:50 kg NPK/ha) followed by T₆: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (49.45 q), T₁₀: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (48.89 q), T₅: (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) (46.28 q). The minimum fresh herb yield per hectare (35.31 q) was recorded with T₄: 100 % N through PM + AMC.

3.1.4 Dry herb yield per hectare (q)

The data from table 1 revealed that, significantly maximum dry herb yield per hectare (24.27 q) was observed with T₁₃: Control (100 % RDF- 87:75:50 kg NPK/ha) followed by T₆: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (19.28 q), T₁₀: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (18.77 q), T₅: (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) (18.19 q). The minimum dry herb yield per hectare (13.07 q) was recorded with T₄: 100 % N through PM + AMC.

Maximum fresh and dry herbage yield per hectare (q) was recorded in T₁₃: Control (100 % RDF- 87:75:50 kg NPK/ha). Increase in per plant, per plot yields could be automatically leads to increase in per hectare yields. The results confirm with the findings of Panchabhai *et al.* (2005) and Yadav *et al.* (2013) in ashwagandha and Chandana *et al.* (2018) in kalmegh.

Comment [THS4]: Single para

3.1.5 Number of capsules per plant

At harvest, the data from table 1 revealed that, significantly maximum number of capsules per plant (400.02) was observed with T₁₃: Control (100% RDF- 87:75:50 kg NPK/ha) followed by T₆: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (334.23), T₁₀: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (317.13) and T₅: (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) (309.54). The minimum number of capsules per plant (254.01) was recorded with T₄: 100 % N through PM + AMC.

Maximum number of capsules per plant was recorded in Control (100% RDF- 87:75:50 kg NPK/ha) may be due to better uptake of nutrients and effective utilization of RDF through chemical fertilizers as reported by Anwar *et al.* (2005) in french basil.

Application of organic manures like Vermicompost and FYM was found to increase available NPK and micronutrients resulting in increased pod yield (Sadanathan *et al.*, 1998) in Black pepper.

Comment [THS5]: Results and discussion is primitive, try to improve

Comment [THS6]: Missing in ref

Biofertilizers (AMC) increases the production of growth hormones viz., IAA, GA and Dehydrozeatin which in turn resulted in maximum number of capsules (Govindan and Nair, 1986) in Pepper. Similar results have been reported by Ramesh Babu (1996) in aswagandha and Chandana *et al.* (2018) in kalmegh.

3.1.6 Seed yield per plot (g)

The data from table 1 also revealed that significantly maximum seed yield per plot (5.18 g) was observed with T₁₃ (100% RDF- 87:75:50 kg NPK/ha) followed by T₆ (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (3.91 g), T₁₀ (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (3.84 g), T₅ (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) (3.76 g). The minimum seed yield per plot (3.43 g) was recorded with T₄:100 % N through PM + AMC.

Maximum seed yield/plot was recorded in Control (100% RDF- 87:75:50 kg NPK/ha). More number of capsules also one of the reason for more seed yield. 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) and Ramesh babu (1996) in aswagandha and Chandana *et al.* (2019) in kalmegh.

Table: 1 Effect of organic manures and biofertilizers on yield parameters of kalmegh.

Treatments	Fresh herb yield/plot(kg)	Dry herb yield/plot(kg)	Fresh herb yield/ha (q)	Dry herb yield/ha (q)	Number of capsules/plant	Seed yield/plot (g)
T ₁	1.86	0.791	36.94	15.64	271.34	3.54
T ₂	2.15	0.878	42.91	17.29	280.19	3.60
T ₃	2.07	0.861	41.10	16.84	266.12	3.52
T ₄	1.78	0.665	35.31	13.07	254.01	3.43
T ₅	2.33	0.927	46.28	18.19	309.54	3.76
T ₆	2.52	0.981	49.45	19.28	334.23	3.91
T ₇	2.13	0.870	42.62	17.17	286.87	3.60
T ₈	1.81	0.740	35.93	14.60	281.09	3.48
T ₉	2.27	0.900	45.30	17.72	300.21	3.64
T ₁₀	2.46	0.958	48.89	18.77	317.13	3.84
T ₁₁	2.11	0.867	41.87	17.21	309.63	3.56
T ₁₂	1.98	0.818	39.45	16.42	297.17	3.69
T ₁₃	3.29	1.226	64.21	24.27	400.02	5.18
S.Em±	0.12	0.035	1.76	0.72	10.70	0.08
C.D.at 5%	0.36	0.102	5.14	1.47	31.22	0.25

Table:2 Effect of organic manures and biofertilizers on economics of kalmegh.

Treatments	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net returns (Rs/ha)	B:C ratio
T ₁	49222	78200	28978	0.59
T ₂	49022	86450	37428	0.76
T ₃	57722	84200	26478	0.46
T ₄	40622	65350	24728	0.61
T ₅	50252	90950	40698	0.81
T ₆	49052	96400	47348	0.97
T ₇	54442	85850	31408	0.58
T ₈	42762	73000	30238	0.71
T ₉	51197	88600	37403	0.73
T ₁₀	49097	93850	44753	0.91
T ₁₁	51322	86050	34728	0.68

Comment [THS7]: Provide the fixed and variable costs details, separate table

T ₁₂	45872	82100	36228	0.79
T ₁₃	37250	72810	35560	0.95

3.2 Economics

3.2.1 Benefit cost ratio

The economics as influenced by the effect of organic manures and biofertilizers has been calculated and presented in Table 2. Among the treatments, T₆ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC recorded the highest gross returns (Rs. 96,400/ha), net returns (Rs. 47,348/ha) with benefit cost ratio of 0.97, followed by T₁₃ : Control (100% RDF- 87:75:50 kg NPK/ ha) (0.95), T₁₀ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC (0.91) and T₅ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC (0.81).

The minimum benefit cost ratio (0.46) was recorded in T₃: 100 % N through NC + AMC. The increase in benefit cost ratio was mainly due to the increased dry herbage yield as the application of organic manures in combination with biofertilizers (AMC) and due to the organic produce fetches higher price in market compare to inorganic produce, which helped in increasing the gross returns, net returns and B:C ratio. Similar results were reported by Thakur *et al.* (2014) in sweet basil, Godara *et al.* (2014) in coriander, Ravikumar *et al.* (2013) in coleus and Amala *et al.* (2019) in turmeric.

CONCLUSION

The yield parameters indicated that, among all treatments, T₁₃: Control (100 % RDF- 87: 75: 50 kg NPK/ha) recorded significantly highest fresh herb yield/plot (3.29 kg), dry herb yield/plot (1.226 kg), fresh herb yield/ha (64.21 q), dry herb yield/ha (24.27 q), number of capsules per plant (400.02) and seed yield/plot (5.18 g). Among the organic manures with biofertilizers, highest yield parameters were recorded with T₆: 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC.

The data on economics revealed that T₆: 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC recorded the highest benefit cost ratio (0.97) over all the other treatments.

Comment [THS8]: Revise the conclusion

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