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# Effect of Organic Manures and Biofertilizers on Quality and Soil Analysis of Kalmegh (*Andrographis panniculata* Wall. Ex. Nees.) Var. CIM Megha

**D. Amala [a++*], M. Raj Kumar [b#], A. Kiran Kumar [c†], B. Naveen Kumar [d‡], P. Gouthami [e^] and G. Sathish [f^]**

[a] *Department of PSMA, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad-500030, Telangana, India.*
[b] *Fruit Research Station, SKLTSHU, Sangareddy, India.*
[c] *Director of Extension, SKLTSHU, Mulugu, India.*
[d] *Horticultural Polytechnic, Ramagirikhilla, Peddapalli, India.*
[e] *College of Horticulture, Mojerla, SKLTSHU, India.*
[f] *Administrative Office, PGIHS SKLTSHU, Mulugu, India.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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[++] *Ph.D Research Scholar;*
[#] *Principal Scientist (Horti.) & Head (Retd.);*
[†] *Dean of Horticulture Comptroller;*
[‡] *Vice-Principal;*
[^] *Assistant Professor;*
**Corresponding author: E-mail: daggulaamala@gmail.com;*

## ABSTRACT

**Aim:** To study the effect of organic manures and biofertilizers on quality and soil parameters 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, SKLTSHU, Hyderabad during Kharif, 2021.

**Results:** Among the organic and biofertilizer treatmental combinations the results reported that the ($T_6$): 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC, $T_{10}$: 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC recorded the highest quality and soil analysis compared to other treatments.

**Conclusion:** Treatmental combinations of vermicompost, Neem cake, Poultry manure and Arka Microbial Consortium recorded the highest quality and soil analysis compared to other treatments.

*Keywords: Farm yard manure; vermicompost; neem cake; arka microbial consortium.*

## 1. INTRODUCTION

Kalmegh (*Andrographis paniculata* Wall. Ex. Nees.) belonging to family Acanthaceae and genus *Andrographis* consists of 40 species out of which,19 species are reported to be available in India and have been effectively used in Indian systems of medicine for centuries.

The plant is found growing in plains throughout India and Srilanka. It is also reported from certain parts of China,Thailand and Bangladesh. In India, it is distributed in the states of undivided Andhra Pradesh, Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Chattisgarh, West Bengal and Himachal Pradesh [1]. The demand of Kalmegh is increasing day by day [2,3].

"Constant use of chemical fertilizers over a long period of time was found to impair the ecological balance and hitting the sustainability in soil and decreasing its potency. It reduces the crop quality attributes, which lead to poor market price to the farmers". [4] Organic manures have positive influence on soil texture and structure, better water holding capacity and drainage which in turn help for better growth, yield and drying percentage in kalmegh.

Farm yard manure, vermicompost, neem cake, poultry manure *etc*., are well recognized organic manures which supply necessary macro and micro plant nutrients and maintain soil fertility. Organically grown products fetch higher price and also there is a great demand for organically grown plant produce in the Western countries.

"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" [5]. "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 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 Zn mobilizing, growth promoting microbes is difficult for farmers due to lack of availability in one place". [6]

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. High demand for andrographolide in Indian as well as in international markets has encouraged Indian farmers to start commercial cultivation of this important medicinal plant. Among the various medicinal plants, *Andrographis paniculata* is in pressing demand because of its anti-HIV property. But the biological yield and production of secondary metabolites is very low in this plant.

## 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

17º.32’ North, longitude of 78º.40’ East and altitude of 542.3 m above mean sea level.

## 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.,*$T_1$:100 % N through FYM + AMC, $T_2$ : 100 % N through VC + AMC, $T_3$ : 100 % N through NC + AMC, $T_4$ : 100 % N through PM + AMC, $T_5$ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC + AMC, $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC, $T_7$ : 75 % N through NC + 12.5 % N through PM + 12.5 % N through FYM + AMC, $T_8$ : 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC, $T_9$ : 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC, $T_{10}$ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC , $T_{11}$ : 50 % N through NC + 25 % N through PM + 25 % N through FYM + AMC, $T_{12}$ : 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC, $T_{13}$ : Control (100 % RDF:87:75:50) were imposed.

## 2.3 The Determined Parameters

### 2.3.1 Andrographolide content (%)

Andrographolide content was analysed by using the procedure followed by parasher et al., [7].

*2.3.1.1 Sample preparation for estimation of Andrographolide percentage*

The powder (1g) of plant material was refluxed for 1 hour with methanol (50 ml) on a water bath. The mare was filtered and subjected for another two cycles of refluxes (1hr each) with methanol (50ml). The combined filtrates were evaporated under vacuum to dryness. The residue was dissolved in methanol (25ml) and filtered through a 0.45 µm (Nylon) filter into HPLC vials.

*2.3.1.2 Calibration*

“2mg of andrographolide standard was placed in a 5ml volumetric flask and dissolved in MeOH (stock solution). Standard solution 4ºc for further analysis and analysis and was stable for at least 30 days (confirmed by re-assaying the solution). Within the range of concentrations injected (40.0-2.0 µm/ml) the dectector response was linear. All date were recorded and processed by millennium 32 software from waters (Milford, MA, USA)”. [18]

*2.3.1.3 Analaytical method*

“HPLC analysis was performed on a Waters HPLC system, equipped with a 2996 photodiode array detector (Waters Pvt. Ltd). For all separation x Bridge TM $C_{18}$ column (4.6 mm × 250 mm, 5.0 µm particle size) was used. The mobile phase consisted of water (A) and a mixture of MeOH and reagent alocohol in ratio of 1:1 (B) which were applied in the following gradient elution from 35A/65B in 25min to 45A/55B. Each run was followed by a 5 min wash with 100 B and an equilibration period of 10 min. The separation temperature was kept constant at 25 ºc, flow rate and sample volumes were monitered at 223nm. Peaks were assigned by spiking the sample with authentic sample followed by comparision of UV spectra and retention time”. [8]

Andrographolide content (%) =
(Calculated conc.of sample in µg/ml x Dilution factor)/10000

### 2.3.2 Andrographolide yield (kg/ha)

The andrographolide yield was calculated by using the formula

Andrographolide yield (kg/ha=(Andrographolide content (%) X Dry herb yield (kg/ha))/100

### 2.3.3 Drying percentage (%)

The drying percentage (**%**) was calculated by using the formula

$$Drying\ percentage\ (\%) = \frac{Weight\ of\ shade\ dried\ herb}{Weight\ of\ fresh\ herb} X\ 100$$

### 2.3.4 Soil analysis

The data recorded on soil analysis like pH, EC (dS/m), Organic carbon (%), Available nitrogen (kg/ha), Available phosphorus (kg/ha), Available potassium (kg/ha) were analysed.

# 3. RESULTS AND DISCUSSION

## 3.1 Quality Parameters

### 3.1.1 Andrographolide content (%)

The data from Table 1 revealed that the andrographolide content did not differ significantly among the treatments. However, the highest andrographolide content (%) was recorded in $T_{10}$: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (1.93 %).

### 3.1.2 Andrographolide yield (kg/ha)

The data from Table 1 revealed that significantly maximum andrographolide yield (44.07 kg) was observed with $T_{13}$ : Control (100% RDF- 87:75:50 kg NPK/ha) followed by $T_6$ :(75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) (36.77 kg), $T_{10}$: (50 % N through VC + 25 % N through NC + 25 % N through PM + AMC) (34.93 kg), $T_5$ : (75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC) of 34.67 kg. The minimum andrographolide yield (23.66 kg) was recorded with $T_{4:}$100 % N through PM + AMC.

The maximum yield in the treatment $T_{13}$: Control (100 % RDF- 87:75:50 kg NPK/ha) could be ascribed to the maximum dry herb yield/ha (44.07 kg/ha) coupled with andrographolide content (1.81 %).

### 3.1.3 Drying percentage (%)

The data from Table 1 revealed that significantly maximum drying percentage (33.92 %) was observed with $T_{10}$: 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC which was at par with $T_6$ (33.28 %), $T_3$ (33.22 %), $T_5$ (33.21 %), T2(33.15 %), $T_7$ (33.13 %), $T_9$ (33.06 %), followed by $T_{13}$ and $T_{11}$ (32.54 %). The minimum drying percentage (31.24 %) was recorded with $T_{4:}$100 % N through PM + AMC.

The addition of organic manures *viz.,* Farm Yard Manure, Vermicompost, Neemcake along with biofertilizer (Arka microbial consortium) combination might have resulted in higher stimulating effect on increased nutrient uptake resulting in highest drying percentage in treatment $T_{10}$ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC. The present investigation is in concurrence with earlier findings of Velmurugan [9] and Amala et al. [10] in turmeric, Mohmoud and Younis [11] in mint and Befrozfar et al. [12] in french basil.

## 3.2 Soil Parameters

### 3.2.1 $P^H$

The data presented in Table 2 clearly indicated that pH did not differ significantly with different treatments.

### 3.2.2 EC (ds/m)

The data presented in Table 2 clearly indicated that EC did not differsignificantly with different treatments.

### 3.2.3 Organic carbon (%)

The organic carbon of the soil as influenced by the effect of organic manures and biofertilizers among different treatments was recorded and the relevant data is presented in Table 2. The highest organic carbon (0.78 %) was recorded in both $T_6$: (75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC) and $T_{10:}$ 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC which was at par with $T_1$& $T_9$ (0.77 %), $T_2$& $T_8$ (0.76 %), $T_4$& $T_5$ (0.75 %), The organic carbon was lowest in complete inorganic treatment $T_{13}$: Control (100 % RDF- 87:75:50 kg NPK/ha) (0.70 %). Hence, low percentage of organic carbon.

This might be due to the reason that, application of bulky organic manures like Farm Yard Manure, Vermicompost, and Poultry manure had shown increased levels of soil organic carbon when compare to straight fertilizer. These results are in agreement with the earlier findings of Rajamani et al. [13] in turmeric, Das et al. [14] in stevia and Choudhary et al. [15] in pomegranate.

### 3.2.4 Available nitrogen (kg/ha)

The data pertaining to available nitrogen in the soil after harvest as influenced by the effect of organic manures and biofertilizers are presented in Table 3.The data indicated that among the treatments evaluated, significantly maximum available nitrogen content in the soil (193.27 kg) was observed with $T_{10}$: 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC which was at par with $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC ( 193.24 kg), $T_5$ (192.13 %), $T_{11}$ (190.51 %), $T_9$ (190.18 %), $T_7$ (190.16 %), $T_8$ (189.37 %), $T_{12}$ (187.45 %), while the minimum nitrogen content in the soil (173.16 kg) was recorded with $T_{13}$ : Control:(100% RDF- 87:75:50 kg NPK/ha).

The increase in available nitrogen might be due to the improvement of soil physical condition which might have favored the microbial activity and mineralization process by the application of organics and AMC. Many workers have observed improvement in available soil nitrogen due to

**Table 1. Effect of organic manures and biofertilizers on andrographolide content (%), anandrographolide yield/ha (kg) and drying percentage (%)**

| Treatments | Andrographolide content (%) | Adrographolide Yield (kg/ha) | Drying Percentage(%) |
|---|---|---|---|
| $T_1$ : 100 % N through FYM + AMC | 1.80 | 23.14 | 32.39 |
| $T_2$ : 100 % N through VC + AMC | 1.83 | 31.59 | 33.15 |
| $T_3$ : 100 % N through NC + AMC | 1.82 | 30.91 | 33.22 |
| $T_4$ : 100 % N through PM + AMC | 1.82 | 23.66 | 31.24 |
| $T_5$ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC | 1.91 | 34.67 | 33.21 |
| $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC | 1.92 | 36.77 | 33.28 |
| $T_7$ : 75 % N through NC + 12.5 % N through PM + 12.5 % N through FYM + AMC | 1.84 | 33.33 | 33.13 |
| $T_8$ : 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC | 1.82 | 26.83 | 32.30 |
| $T_9$ : 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC | 1.88 | 33.50 | 33.06 |
| $T_{10}$ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC | 1.93 | 34.93 | 33.92 |
| $T_{11}$ : 50 % N through NC + 25 % N through PM + 25 % N through FYM + AMC | 1.84 | 31.93 | 32.54 |
| $T_{12}$ : 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC | 1.86 | 29.50 | 32.07 |
| $T_{13}$ : Control(100 % RDF:87:75:50 kg NPK/ha) | 1.81 | 44.07 | 32.54 |
| **S.Em±** | **0.02** | **1.09** | **0.42** |
| **C.D.at 5%** | **NS** | **3.20** | **1.21** |

application of organic manures and attributed to greater capacity of organic colloids to adsorb $NO_3$ and $NH_4$ in the form of Nitrogen. These results are in line with the findings of Das et al. [14] in stevia and Hassan [16] in periwinkle.

### 3.2.5 Available phosphorus (kg/ha)

The data on available phosphorus in the soil after harvest as influenced by the effect of organic manures and biofertilizersare presented in Table 3.The data indicated that among the treatments evaluated, significantly maximum available phosphorus content in the soil (28.84 kg) was observed with $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC and was at par with $T_8$ : 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC (28.14 kg) followed by $T_{12}$ : 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC (27.72 kg), while the minimum phosphorus content in the soil) (19.67 kg) was recorded with $T_{13}$ : Control (100% RDF- 87:75:50 kg NPK/ha.

### 3.2.6 Available potassium (kg/ha)

The data on available potassium in the soil could be after harvest as influenced by the effect of organic manures and biofertilizersare presented in Table 3.

The data indicated that among the treatments evaluated, significantly maximum available potassium content in the soil (171.23 kg) was observed with $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC and was at par with$T_{10}$ : 50 % N through VC + 25

**Table 2. Effect of organic manures and biofertilizers on $p^H$, Electrical conductivity (ds/m) and organic carbon (%) after harvest of kalmegh**

| Treatments | $p^H$ | EC (ds/m) | OC (%) |
|---|---|---|---|
| $T_1$ : 100 % N through FYM + AMC | 7.36 | 0.27 | 0.77 |
| $T_2$ : 100 % N through VC + AMC | 7.44 | 0.26 | 0.76 |
| $T_3$ : 100 % N through NC + AMC | 7.56 | 0.26 | 0.75 |
| $T_4$ : 100 % N through PM + AMC | 7.67 | 0.28 | 0.74 |
| $T_5$ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC | 7.53 | 0.26 | 0.75 |
| $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC | 7.55 | 0.27 | 0.78 |
| $T_7$ : 75 % N through NC + 12.5 % N through PM + 12.5 % N through FYM + AMC | 7.49 | 0.25 | 0.75 |
| $T_8$ : 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC | 7.50 | 0.26 | 0.76 |
| $T_9$ : 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC | 7.48 | 0.29 | 0.77 |
| $T_{10}$ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC | 7.35 | 0.26 | 0.78 |
| $T_{11}$ : 50 % N through NC + 25 % N through PM + 25 % N through FYM + AMC | 7.37 | 0.27 | 0.75 |
| $T_{12}$ : 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC | 7.41 | 0.26 | 0.73 |
| $T_{13}$ : Control(100 % RDF:87:75:50 kg NPK/ha) | 7.55 | 0.27 | 0.73 |
| **S.Em±** | **0.11** | **0.01** | **0.01** |
| **C.D.at 5%** | **NS** | **NS** | **0.03** |

**Table 3. Effect of organic manures and biofertilizers on available NPK kg/ha after harvest of kalmegh**

| Treatments | N (kg/ha) | P (kg/ha) | K (kg/ha) |
|---|---|---|---|
| $T_1$ : 100 % N through FYM + AMC | 184.19 | 22.74 | 153.61 |
| $T_2$ : 100 % N through VC + AMC | 185.46 | 24.91 | 155.28 |
| $T_3$ : 100 % N through NC + AMC | 182.37 | 23.38 | 154.26 |
| $T_4$ : 100 % N through PM + AMC | 180.89 | 24.93 | 152.35 |
| $T_5$ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC | 192.13 | 26.43 | 167.26 |
| $T_6$ : 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC | 193.24 | 28.84 | 171.23 |
| $T_7$ : 75 % N through NC + 12.5 % N through PM + 12.5 % N through FYM + AMC | 190.16 | 23.09 | 159.87 |
| $T_8$ : 75 % N through PM + 12.5 % N through FYM + 12.5 % N through VC + AMC | 187.45 | 28.14 | 158.43 |
| $T_9$ : 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC | 190.18 | 23.16 | 164.40 |
| $T_{10}$ : 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC | 193.27 | 27.68 | 169.18 |
| $T_{11}$ : 50 % N through NC + 25 % N through PM + 25 % N through FYM + AMC | 190.51 | 25.44 | 158.07 |
| $T_{12}$ : 50 % N through PM + 25 % N through FYM + 25 % N through VC + AMC | 189.37 | 27.72 | 162.57 |
| $T_{13}$ : Control(100 % RDF:87:75:50 kg NPK/ha) | 173.16 | 19.67 | 145.19 |
| S.Em± | 2.63 | 0.36 | 2.22 |
| C.D.at 5% | 7.66 | 1.05 | 6.49 |

% N through NC + 25 % N through PM + AMC (169.18 kg), $T_5$ : 75 % N through FYM + 12.5 % N through VC + 12.5 % N through NC+ AMC (167.26 kg) followed by $T_9$ : 50 % N through FYM + 25 % N through VC + 25 % N through NC + AMC (164.40 kg), while the minimum potassium content in the soil (145.19 kg) was recorded with $T_{13}$ : Control (100% RDF- 87:75:50 kg NPK/ha).

Higher availability of nutrients in the soil due to residual effect of organic sources which improves physiological and metabolic functions inside the plant that might have been responsible for better nutrient uptake. The more amounts of nitrogen, phosphorus and potassium in soils of $T_{6:}$ 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC might be due to increased availability of N, $P_2O_5$ and $K_2O$ at higher levels, as the application of organic manures in combination with biofertilizer (AMC) helps in microbial build up in the soil which in turn provides higher amount of major nutrients in the soil. Similar findings are reported by Gajbhiye et al. [17] in lemon grass, Hassan [15] in periwinkle and Jat et al.[18] in ashwagandha.

## 4. CONCLUSION

In quality parameters, $T_{13}$: Control (100 % RDF-87: 75: 50 kg NPK/ha) recorded significantly highest andrographolide yield/ha (44.07 kg) while, $T_6$: 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC recorded significantly highest andrographolide yield (36.77 kg/ha) and drying percentage (33.92 %) in $T_{10:}$ 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC among the organic manures and biofertilizer combination.

The soil nutrient status showed that among all treatments, $T_6$: 75 % N through VC + 12.5 % N through NC + 12.5 % N through PM + AMC recorded significantly maximum organic carbon (0.78 %), highest phosphorous (28.84 kg/ha) and potassium content (171.23 kg/ha) whereas, availability of nitrogen (193.27 kg/ha) was observed highest in $T_{10}$: 50 % N through VC + 25 % N through NC + 25 % N through PM + AMC.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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