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Integrated Nutrient Management in *Andrographis paniculata*

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Abstract: Since time immemorial, village and ethnic communities in India have been using a medicinal plant, *Andrographis paniculata* (Kalmegh), mainly for treating fever, liver diseases, diabetes, snake bite, common cold and bronchitis and a variety of ailments. While the demand of Kalmegh is increasing, it is mandatory to standardise the cultivation practices. The experiment was laid out in a Randomized Block Design (RBD) with 12 treatments replicated thrice. As a result, application of FYM @ 15 t ha^{-1} + NPK @ 75:75:50 Kg ha^{-1} + Panchagavya @ 3 per cent foliar spray recorded the highest growth parameters, nutrient uptake, yield and andrographolide content followed by FYM @ 15 t ha^{-1} + Panchagavya @ 3 per cent foliar spray recorded the next best yield.

Key words: Fertilizers, Manures, Panchagavya, Foliar spray, Yield, Andrographolide

INTRODUCTION

Kalmegh (*Andrographis paniculata*) also known as king of bitters is one among the prioritized medicinal plants in India, and this herb is being used mainly for treating fever, liver diseases, diabetes, snake bite. The leaf and the whole herb contain the medicinal properties. It is mandatory to standardise the cultivation practices for medicinal plants by considering the overexploitation from their reserved forest areas, because of the virtue of its therapeutic values. Hence the attempt has been made here with the objective of standardising nutrient requirements and to study the effect of nutrient integration with Panchagavya, a bioregulator slurry alone and in combination with other organic manures and conventional manurial schedule on growth, yield and nutrient (NPK) content, uptake and Andrographolide content in Kalmegh.

MATERIALS AND METHODS

Experimental Site, Planting and Design of Experiment: An experiment was laid out in a Randomized Block Design (RBD) with 12 treatments and 3 replications at TNAU, Coimbatore, India. Nursery was raised and Kalmegh plants were transplanted 45 days after planting at 30 x 15 cm spacing in a plot size of 3 x 1.5 m in Randomized Block Design consisting of 12 treatments replicated thrice.

Treatment Details and Application Methods: The treatments include basal organic manures *viz*., Farm Yard Manure (FYM), Digested Coir Compost (DCC) and Vermicompost. The recommended manurial schedule was used for comparing the organic manures. Treatment details are given in table-1. Foliar spray of organic bioregulator slurry, Panchagavya @ 3 per cent was given 3 times in the respective plot as per the treatment schedule at 20 days interval from 30 to 70 days after planting (DAP).

Biometry, Yield and Quality Observations: The periodical observations on growth and quality characters were taken and the crop was harvested and the biomass yield was calculated when the plants started to flowering (90DAP). The active ingredient present in the crop andrographolide was extracted at this period, since it attains its peak during flowering season only. By using Soxhlet apparatus with analytical grade methanol the andrographolide content was determined with HPLC (High Performance Liquid Chromatography) equipment using HPLC grade methanol and andrographolide standard.

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Table 1: Treatment schedule

Sl. No.	Treatment notation	Treatment details
1	T_1	Soil drenching with 3 % Panchagavya
2	T_2	FYM @ 15 t ha^{-1}
3	T_3	Digested Coir Compost (DCC) @ 7 t ha^{-1}
4	T_4	Vermicompost @ 5 t ha^{-1}
5	T_5	Conventional manurial schedule (FYM @ 15 t ha^{-1} + NPK @ 75:75:50 Kg ha^{-1})
6	T_6	Soil drenching and foliar application with 3 % Panchagavya
7	T_7	FYM @ 15 t ha^{-1} + Panchagavya @ 3 % foliar application
8	T_8	Digested Coir Compost (DCC) @ 7 t ha^{-1} + Panchagavya @ 3 % foliar application
9	T_9	Vermicompost @ 5 t ha^{-1} + Panchagavya @ 3 % foliar application
10	T_{10}	Conventional manurial schedule (FYM @15 t ha^{-1} +NPK @ 75:75:50 Kg ha^{-1})+ Panchagavya @ 3 % foliar application
11	T_{11}	Panchagavya @ 3 % as foliar spray
12	T_{12}	Control (no manure)

Table 2: Effect of Integrated Nutrient Management on growth and yield characters in *Andrographis paniculata* at the time of harvest

Treatments	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Leaf area index (LAI)	Chlorophyll content (SPAD reading)	Total Dry Matter Production (Kg ha^{-1})	Dry leaf yield (Kg ha^{-1})	Dry herbage yield (Kg ha^{-1})
T_1	28.83	15.00	60.00	0.40	40.67	888.89	90.40	451.98
T_2	36.05	19.90	79.60	0.71	41.88	2075.56	340.01	1483.43
T_3	35.63	19.26	77.04	0.68	40.35	1963.70	284.34	1393.28
T_4	34.10	18.00	72.00	0.63	40.08	1866.67	272.78	1363.91
T_5	40.80	21.13	84.53	0.79	41.93	2244.44	388.63	1653.62
T_6	32.64	17.80	71.20	0.54	41.52	1066.67	109.61	548.05
T_7	50.10	25.33	101.33	0.95	50.56	2625.18	542.44	1877.62
T_8	47.23	25.13	100.53	0.92	49.69	2511.11	459.49	1764.12
T_9	44.80	24.25	97.00	0.91	48.86	2451.11	445.99	1677.51
T_{10}	54.10	27.40	105.67	1.03	52.42	2794.07	619.06	1993.10
T_{11}	29.20	15.70	62.80	0.49	41.21	966.67	103.54	517.69
T_{12}	28.24	14.00	52.32	0.35	33.54	722.22	83.63	418.13
$SE_{(d)}$	0.5750	0.2169	1.0135	0.0133	0.3178	30.4002	12.1676	39.3905
CD 0.05	1.19**	0.45**	2.10**	13.81**	0.66**	63.05**	332.21**	81.69

**** highly significant

Leaf Nutrient Analysis: Leaf samples for chemical analysis were collected at the time of harvest. The collected samples were shade dried for two days and then dried in a hot air oven at a temperature of 50°C for 24 hours. The leaf samples were ground into fine powder with pestle and mortar and subjected to analysis.

Leaf Nitrogen (N) Content: Nitrogen content in the leaf sample on dry weight basis was estimated with a diacid extract by Micro Kjeldhal method[1] and expressed in per cent.

Leaf Phosphorus (P) Content: Phosphorus content in the leaf sample on dry weight basis was estimated with

Table 3: Effect of Integrated Nutrient Management on Nutrient content, Uptake and Andrographolide content in *Andrographis paniculata* at the time of harvest

Treatments	Nutrient content (%)			Nutrient uptake (Kg ha^{-1})			Quality parameter	
	N	P	K	N	P	K	Andrographolide content (%)	Andrographolide yield (Kg ha^{-1})
T_1	2.17	0.21	2.44	19.29	1.87	21.69	0.77	0.70
T_2	2.63	0.27	2.78	54.59	5.60	57.70	0.98	3.33
T_3	2.51	0.26	2.77	49.29	5.11	54.39	0.97	2.76
T_4	2.50	0.26	2.74	46.67	4.85	51.15	0.94	2.56
T_5	2.67	0.29	2.93	59.93	6.51	65.76	1.05	4.08
T_6	2.33	0.23	2.47	24.85	2.45	26.35	0.83	0.91
T_7	2.85	0.30	2.99	74.82	7.88	78.49	1.28	6.94
T_8	2.82	0.30	2.95	70.81	7.53	74.08	1.21	5.56
T_9	2.80	0.29	2.93	68.63	7.11	71.82	1.21	5.40
T_{10}	2.88	0.32	3.12	80.47	8.94	87.18	1.31	8.11
T_{11}	2.30	0.23	2.49	22.23	2.22	24.07	0.81	0.84
T_{12}	2.12	0.20	2.41	15.31	1.44	17.41	0.74	0.62
SE (d)	0.010	0.002	0.018	0.952	0.170	1.800	0.008	0.105
CD (0.05)	0.020**	0.005**	0.038**	1.975**	0.352**	3.733**	0.017**	0.219

**** highly significant

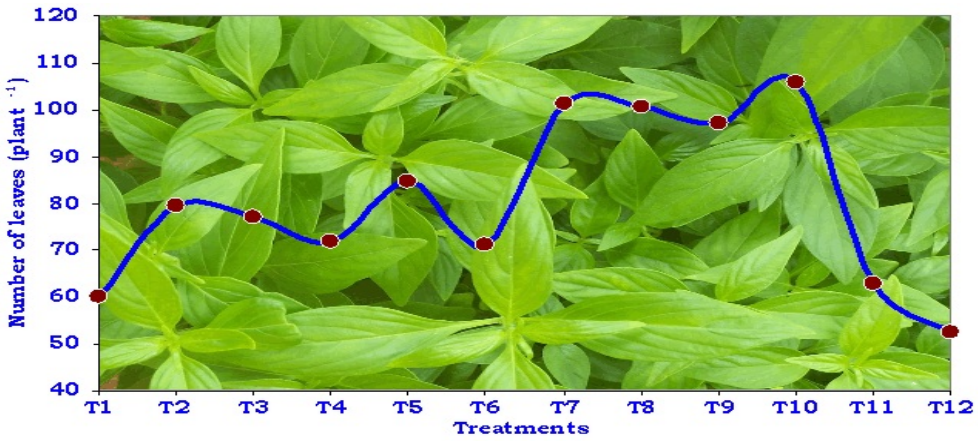

Fig. 1: Integrated Nutrient Management in *Andrographis paniculata*

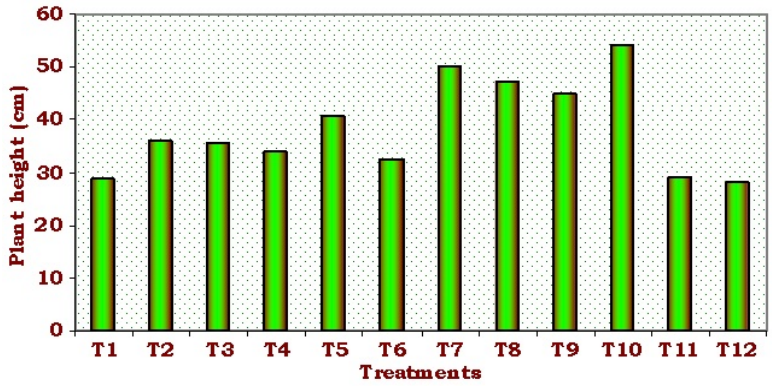

Fig. 2: Integrated Nutrient Management in *Andrographis paniculata*

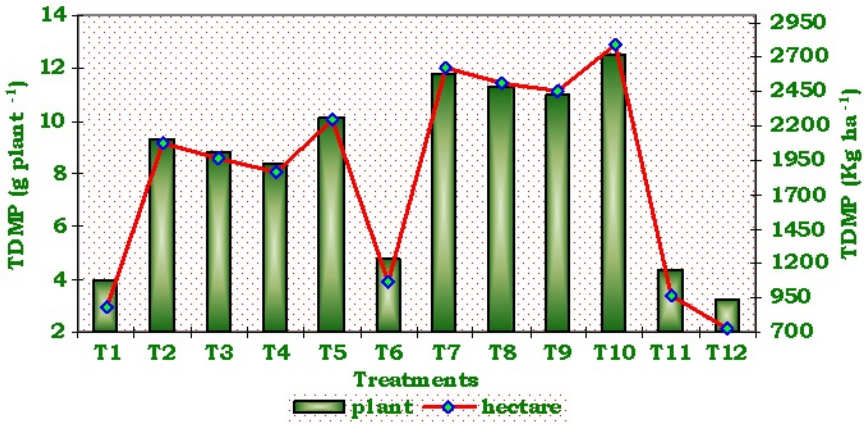

Fig. 3: Integrated Nutrient Management in *Andrographis paniculata*

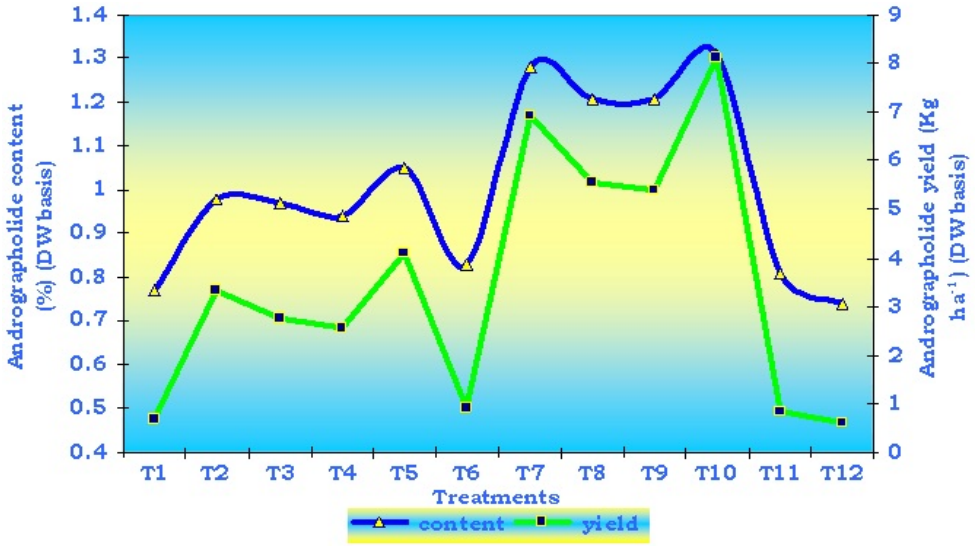

Fig. 4: Integrated Nutrient Management in *Andrographis paniculata*

a triple acid extract by adopting Vanadomolybdate phosphoric yellow colour method[2] and expressed in per cent.

Leaf Potassium (K) Content: Potassium content in the leaf sample on dry weight basis was estimated by reading in the flame photometer values of triple acid extract[2] and expressed in per cent.

Nutrient Uptake: From the total dry matter production and estimated nitrogen, phosphorus and potassium content, total uptake of respective nutrients were worked out using the following formula[3] and was expressed in Kg ha^{-1}.

$$\text{Nutrient uptake (Kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)} \times \text{Total Dry Matter Production (Kg ha}^{-1}\text{)}}{100}$$

Statistical Analysis: All the recorded data were analyzed statistically[4]. Wherever the treatment differences were significant, critical differences were calculated at five per cent probability level and used for interpretations.

RESULTS AND DISCUSSION

The data were statistically analysed and furnished in table-2 & 3. The data from the tables reveal that application of Panchagavya and manures significantly influenced the plant height, number of branches and leaves, nutrient (NPK) content, uptake, total dry matter production and quality characters.

Table-2 reveals that application of FYM @ 15 t ha^{-1} + NPK @ 75:75:50Kg ha^{-1} + Panchagavya @ 3 per cent foliar spray (T_{10}) recorded the highest plant height (54.10 cm), number of branches (27.40), number of leaves (105.67), leaf area index (1.03), chlorophyll content (52.42

SPAD reading), total dry matter production (2794.07 Kg ha^{-1}), dry herbage yield of 1993.10 Kg ha^{-1} and dry leaf yield of 619.06 Kg ha^{-1}.

Increased plant growth and number of leaves (Figure 1) might be due to the improvement in soil physical condition provided for the plant growth along with increased availability of NPK even from the early stage of crop growth especially in FYM + RDF + Panchagavya foliar treated plot. Improvement of soil physical properties such as reduction in bulk density and increase in water holding capacity due to FYM application [5]. In addition to the basal application of nutrients, foliar spray of Panchagavya @ 3 per cent enhanced the growth rate of plant since it contains the favourable micro and macro nutrients, growth hormones and biofertilizers in the liquid formulation. The another possible reason for higher growth characters and increased height (Figure 2) might be due to the growth enzymes present in Panchagavya which favoured rapid cell division and multiplication. This view was supported in Bhumyamalaki[6].

The physiological attributes like leaf area index (LAI), chlorophyll content and total dry matter production (TDMP) are closely related with yield parameters. The treatment plot that received conventional manurial schedule (FYM+RDF) + Panchagavya foliar application (T_{10}) recorded the highest values which was closely followed by FYM + Panchagavya foliar application (T_7). This might be due to the better availability of nutrients from organic and foliar source of nutrients and effective conversion of nutrients such as Fe, Mg and Zn at the site of photosynthesis into pigments. *Azospirillum* present in the Panchagavya and Coconut water which is one of the five ingredient of Panchagavya, contains kinetin along with other enzymes and might have increased the chlorophyll content of leaves since they play a vital role in N fixation and pigment synthesis. In Chilli, dark green coloured leaves and new growth were produced within 10 days of Panchagavya foliar spray[7].

The maximum nutrient content (2.88, 0.32 and 3.12 per cent N, P and K respectively), uptake (80.47, 8.94 and 87.18 Kg ha^{-1} of N, P and K respectively), and quality (andrographolide content 1.31 % and yield 8.11 Kg ha^{-1}) parameters can be referred from table-3.

In addition to the organic and inorganic nutrients, the bioregulator, Panchagavya @ 3% foliar application which contains lot of macro, micro nutrients and growth regulators like auxins, GA_3 along with commercial load of biofertilizers helped in producing higher biomass (Figure 3) and also in better recovery of andrographolide content (Figure 4) in the plant. This is in consonance with the findings in Tulsi[8], in Bhumyamalaki[6], in Brahmi[9] and in Black nightshade[10].

Summary: The study therefore recommends that integrated nutrient application in Kalmegh as FYM @ 15 t ha^{-1} + NPK @ 75:75:50Kg ha^{-1} + Panchagavya @ 3 per cent foliar spray improved the yield. Such application of the inorganic nutrients by integrating with organic manures and foliar spray towards medicinal plants cultivation can be standardized for all species of most important commercial medicinal plants. It will be useful in future to avoid the extinction of those species at their natural habitat due to the overexploitation by the commercial medicinal plant collectors and merchants.

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