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Influence of Nutrient Levels on Growth, Yield, Quality and Economics of First Ratoon Crop in Kalmegh (*Andrographis paniculata* Nees.)

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Abstract

The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with 9 treatments and replicated thrice. The application of FYM @ 25 t ha^{-1} along with 75 per cent nitrogen and 100 per cent potassium resulted in maximum plant height, number of primary branches, plant spread, herb yield and andrographilide content and yield. The highest B:C ratio and maximum net returns was also recorded with the same nutrient level in first ratoon crop of Kalmegh.

Kalmegh is one of the most important medicinal plant, known for its preventive and curative properties (Farooqi and Sreeramu., 2010). It is a herbaceous plant belonging to the family Acanthaceae. Kalmegh native to India and Sri Lanka and is known as king of bitters in English meaning dark cloud and *Bhunimba* in Sanskrit, *Nelabevu* in Kannada, whereas, it is more commonly referred as Andrographis across the world. Kalmegh is an erect herb, grows to a height of 30–90 cm, leaves petiolated, 2-3 cm long and 0.5-1.0 cm broad, lanceolate, hairy on the upper part. Small whitish flowers borne on spreading racemes forms fruit, called capsule, 2 cm long and a few millimetres wide and contains several brownish yellow seeds. The leaves contain more than 2 per cent andrographolide before the plant blooms and accounts to less than 0.5 per cent after flowering. The stem contains 0.1-0.4 per cent of andrographolide (Bhattacharya *et al*., 2012)

Andrographis paniculata exists in the list of highly traded Indian medicinal plant and also positioned as the 17th crop among 32 prioritized medicinal plants of India with a production of 5000 tonnes annually from the States of Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and West Bengal as per National Medicinal Plant Board (Anon, 2007).

The herb is known to have anti-inflammatory, anti-biotic, anti-malarial, anti-hepatitic and anti-pyretic properties, besides its general use as an immune stimulant, it is useful in curing dysentry, diarrhoea, cholera, fever, diabetes, bronchitis, itches, hypertension, piles, gonorrhoea. A recent study has documented its anti-HIV properties (Sajwan, 2008). The heavy demand of andrographolide in Indian as well as international markets has motivated Indian farmers to take up commercial cultivation of Kalmegh (Kanjilal *et al*., 2002).

Nutrient management is a critical issue that determine quantity and quality of the harvested produce. Although, plant takes the essential nutrients throughout its life cycle, the nutrients are applied at different dosage at one or more stages of the crop growth, depending on the requirement of the crops. Further, Kalmegh crop is known to express ratoonability, for which optimization of different nutrient levels for higher production at lower cost is the need of the hour. Looking into the medicinal importance of Kalmegh and its ratoonabilty, the present investigation has been conducted.

Material and Methods

The field experiment was carried at College of Horticulture, University of Horticultural Sciences Campus, Gandhi Krishi Vignana Kendra, Bengaluru, during August, 2015 to February, 2016. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with 9 treatments and replicated thrice using IIHR local variety in fairly leveled land of red sandy loam soil with medium fertility status. Nursery was raised and the seedlings were transplanted at 45 days after sowing at a spacing of 30 x 20 cm in 1.8 x 1.4 m plots. The recommended dosage of fertilizers and manures (75:75:50 kg N: P_2O_5: K_2O ha^{-1} and 25 t FYM ha^{-1}) was applied for the main

crop and protective irrigation was given through drip system The main crop was harvested at 60 days after transplanting when, 50 per cent of the plant population attained flowering. While harvesting the plants were cut to a height of 2.5 cm from the ground level to facilitate for next successive ratoon crop. The experiement involves 3 levels of nitrogen (N_1: 75 per cent recommended nitrogen, N_2: 50 per cent recommended nitrogen and N_3: 25 per cent recommended nitrogen) and 3 levels of potassium (K_0: no potassium, K_1: 50 per cent recommended potassium and K_2: 100 per cent recommended potassium) and no phosphorous. The nutrients were applied to ratoon crop as per treatment details viz., T_1 (N_1K_0), T_2 (N_1K_1), T_3 (N_1K_2), T_4 (N_2K_0), T_5 (N_2K_1), T_6 (N_2K_2), T_7 (N_3K_0), T_8 (N_3K_1) and T_9 (N_3K_2) at ten days after harvesting of the main crop.

Five representative plants in each treatment and in each replication, were randomly selected, tagged and observations were recorded. The mean data recorded on plant height, number of primary branches, plant spread, days to initiation of blooming and 50 per cent flowering, herb yield and andrographolide content and yield from five plants were used for statistical analysis. The Andrographolide content was analysed by using Soxhlet apparatus with analytical grade methanol, determined in HPLC (High Performance Liquid Chromatography) equipment using HPLC grade methanol and andrographolide standard (Agarwal and Murali., 2010). The cost of cultivation was worked out by considering market price of different inputs used, the labour charges and miscellaneous expenditures that were prevailing at the time of conducting the experiment.

Results and Discussion

Influence of nutrient levels (N & K) on growth attributes of Kalmegh in first ratoon crop : In the first ratoon crop, the plants supplied with 75 per cent nitrogen (122.28 kg ha^{-1}) recorded significantly taller plants (26.01 cm), maximum number of primary branches (14.98), plant spread (408.13 cm^2) which was *at par* with 50 per cent nitrogen (81.52 kg ha^{-1}) Table I. Similar results were obtained by Ram *et al*. (2008) and Gudade (2013) in Kalmegh, The enhanced growth with 75 and 50 per cent nitrogen might be due to increased availability of nitrogen supply which would have promoted protein synthesis from reserved carbohydrate source leading to enhancement of growth parameters.

The 100 per cent potassium (83.33 kg ha^{-1}) recorded significantly maximum plant height (25.60 cm), number of primary branches (14.40), plant spread (396.91 cm^2) in first ratoon crop which was *at par* with 50 per cent potassium (41.66 kg ha^{-1}) (Table 1). The increased nutrient availability and higher uptake of nutrients perhaps enhanced the physiological activity, which might have resulted in better growth. These results are in line with the result obtained by Rasmia Ali *et al*. (2009) in Periwinkle. Nitrogen and potassium at all levels showed non-significant differences on days to initiation of blooming and days to 50 per cent flowering.

Influence of nutrient levels (N & K) on yield and quality parameters in first ratoon crop of Kalmegh : The plants fertilized with 75 per cent nitrogen and 100 per cent potassium recorded significantly maximum fresh and dry weights of leaves, stem and herb yield, andrographolide content and andrographolide yield which was *on par* with 50 per cent nitrogen and potassium (Table II). Better availability of nutrients would have resulted in maximum production of herb. Similar, results were reported by Tiwari. (2012) in Kalmegh who reported increased herb yield with higher dosage of 60 kg N ha^{-1} applied through FYM along with 60 kg N ha^{-1} through urea. This is due to the fact that, nitrogen is an essential constituent of chlorophyll, which helps in capturing the solar energy and production of more photosynthates. The potassium application at appropriate time and required concentration is known to increase the abscisic acid content, rendering closure of stomata causing reduction in transpiration rate which maintains higher water potential leading to increased fresh weight (Renata *et al*., 2011).

The Nitrogen and potassium levels had a significant influence on quality parameters. The 75 and 50 percent dosage of N and K, might have resulted in better accumulation of assimilates, leading to improved quality. Potassium is responsible for energy production in the form of ATP and NADPH in chloroplasts by

TABLE I

Influence of nutrient levels (N & K) on growth attributes of Kalmegh in first ratoon crop

Treatment	Plant height (cm)	Number of Primary branches	Plant Spread (cm^2)	Days to initiation of blooming	Days to 50 % flowering
N_1	26.01	14.98	408.13	29.53	42.42
N_2	23.80	13.40	365.44	29.99	43.89
N_3	22.14	12.47	325.96	29.16	44.27
S.Em.±	0.73	0.50	13.96	1.21	1.58
CD (P=0.05)	2.18	1.50	41.85	NS	NS
K_0	22.89	12.00	339.87	29.38	43.93
K_1	23.30	12.86	354.76	29.52	43.23
K_2	25.60	14.40	396.91	29.78	43.40
S.Em.±	0.73	0.50	13.96	1.21	1.58
CD (P=0.05)	2.18	1.50	41.85	NS	NS
N_1K_0	24.23	13.73	364.60	29.47	43.53
N_1K_1	26.67	15.33	402.40	29.13	42.60
N_1K_2	27.13	15.87	457.40	28.87	42.53
N_2K_0	23.93	13.40	352.87	29.80	43.87
N_2K_1	25.87	14.07	387.07	29.47	43.33
N_2K_2	26.20	14.27	392.40	29.33	43.07
N_3K_0	20.50	11.87	302.13	30.07	44.40
N_3K_1	22.47	12.47	334.80	29.97	44.27
N_3K_2	23.47	13.07	340.93	29.93	44.13
S.Em.±	1.26	0.87	24.18	2.09	2.74
CD (P=0.05)	NS	NS	NS	NS	NS
CV	8.92	10.88	11.30	12.23	10.90

Note:

T_1 (N_1K_0) - Rec. dosage of FYM + 75 per cent N + 0 per cent K
T_2 (N_1K_1) - Rec. dosage of FYM + 75 per cent N + 50 per cent K
T_3 (N_1K_2) - Rec. dosage of FYM + 75 per cent N + 100 per cent K
T_4 (N_2K_0) - Rec. dosage of FYM + 50 per cent N + 0 per cent K
T_5 (N_2K_1) - Rec. dosage of FYM + 50 per cent N + 50 per cent K
T_6 (N_2K_2) - Rec. dosage of FYM + 50 per cent N + 100 per cent K
T_7 (N_3K_0) - Rec. dosage of FYM + 25 per cent N + 0 per cent K
T_8 (N_3K_1) - Rec. dosage of FYM + 25 per cent N + 50 per cent K
T_9 (N_3K_2) - Rec. dosage of FYM + 25 per cent N + 100 per cent K

Factor A: Nitrogen levels
N_1 : 75 per cent Nitrogen
N_2 : 50 per cent Nitrogen
N_3 : 25 per cent Nitrogen

Factor B: Potassium levels
K_0 : 0 per cent Potassium
K_1 : 50 per cent Potassium
K_2 : 100 per cent Potassium

TABLE II

Influence of nutrient levels (N & K) on yield and quality parameters in first ratoon crop of Kalmegh

Treatment	Fresh weight of leaves (g)	Dry weight of leaves (g)	Fresh weight of leaves (g)	Dry weight of leaves (g)	Fresh weight of leaves (g)	Dry weight of leaves (g)	Andrographolide content (%)	Andrographolide yield (kg ha $^{-1}$)
N_1	28.23	10.15	17.21	8.04	4.91	1.96	2.18	42.79
N_2	25.12	9.41	15.66	7.61	4.47	1.80	1.93	37.45
N_3	22.20	8.70	13.48	5.81	3.70	1.48	1.82	28.56
S.Em.±	1.00	0.24	0.18	0.10	0.15	0.06	0.08	1.10
CD (P=0.05)	2.99	0.71	0.52	0.29	0.43	0.18	0.23	3.31
K_0	22.26	8.37	14.33	6.59	3.95	1.54	1.75	28.70
K_1	23.69	9.06	15.71	7.25	4.00	1.60	1.95	37.00
K_2	26.91	9.86	16.30	7.60	4.51	1.80	2.23	40.36
S.Em.±	1.00	0.24	0.18	0.10	0.15	0.06	0.08	1.10
CD (P=0.05)	2.99	0.71	0.52	0.29	0.43	0.18	0.23	3.31
N_1K_0	26.23	9.64	15.80	7.64	4.68	1.87	1.91	35.71
N_1K_1	27.83	10.34	17.43	8.12	4.85	1.94	2.29	44.42
N_1K_2	30.63	10.47	18.40	8.35	5.19	2.07	2.33	48.23
N_2K_0	25.93	9.40	14.80	7.14	4.00	1.60	1.81	28.96
N_2K_1	26.40	9.84	15.97	7.78	4.32	1.72	2.19	37.66
N_2K_2	26.93	10.19	16.20	7.90	4.49	1.79	2.22	39.73
N_3K_0	20.60	8.46	12.40	5.00	3.50	1.40	1.53	21.42
N_3K_1	22.83	8.73	13.73	5.86	3.73	1.49	2.09	31.14
N_3K_2	23.17	8.92	14.30	6.56	3.86	1.54	2.15	33.11
S.Em.±	1.73	0.41	0.33	0.32	0.27	0.10	0.13	1.91
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS : Non-Significant

TABLE III

Economics of first ratoon crop of Kalmegh as influenced by nutrient levels

Treatment	Cost of Cultivation (Rs.ha^{-1})	Gross Returns (Rs.ha^{-1})	Net Returns (Rs.ha^{-1})	B : C ratio
T_1 (N_1K_0) – Rec. dosage of FYM + 75%N + 0%K	39834	112200	72366	1.81
T_2 (N_1K_1) – Rec. dosage of FYM + 75%N + 50%K	40626	116400	75774	1.86
T_3 (N_1K_2) – Rec. dosage of FYM + 75%N + 100%K	41417	124200	82783	1.99
T_4 (N_2K_0) – Rec. dosage of FYM + 50%N + 0%K	39589	96000	56411	1.42
T_5 (N_2K_1) – Rec. dosage of FYM + 50%N + 50%K	40381	103200	62819	1.55
T_6 (N_2K_2) – Rec. dosage of FYM + 50%N + 100%K	41172	107400	66228	1.60
T_7 (N_3K_0) – Rec. dosage of FYM + 25%N + 0%K	39345	84000	44655	1.13
T_8 (N_3K_1) – Rec. dosage of FYM + 25%N + 50%K	40136	89400	49264	1.22
T_9 (N_3K_2) – Rec. dosage of FYM + 25%N + 100%K	40927	92400	51473	1.25

Cost of dry leaf of Kalmegh per kg : Rs. 60.

maintaining balanced electric charges, which resulted in higher production of photosynthates may be the reason for increased andrographolide content and yield in Kalmegh. These results are in conformity with findings of Sanjutha *et al*. (2008) in Kalmegh where in the application of FYM @ 15 t ha^{-1} + NPK @ 75:75:50 kg ha^{-1} and panchagavya @ 3 per cent as foliar spray recorded maximum andrographolide content and andrographolide yield.

The interaction between nitrogen and potassium levels was found non-significant with respect to all the growth parameters and yield attributes in the ratoon crop at the time of harvest.

The highest B:C ratio of 1.99:1.00 and net return of Rs 82,783 was realised with combination of 25 tonnes FYM ha$^{-1.}$ + 75 per cent N + 100 per cent K. (Table III). The increase in the return may be attributed enhanced herb yield due to optimum level of nutrients supplied to meet the required demand of the crop. These findings are in line with study conducted by Aladakatti *et al*. (2012).

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