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Growth, Yield, Quality and Economics of Kalmegh (*Andrographis paniculata* Nees.) under Ratooning as Influenced by Nutrient Levels

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ABSTRACT

Kalmegh (Andrographis paniculata) is high value medicinal crop known for its important active constituent Andrographolide. The village and ethnic communities in India have been using kalmegh, mainly for treating fever, liver diseases, diabetes, snake bite, common cold, bronchitis and a variety of ailments since time immemorial. The kalmegh has tendency of ratooning and balanced application of nitrogen and potassium helps in obtaining higher herbage yield of good quality produce in ratoon crops. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with 9 treatments replicated thrice. The application of FYM @ 25 t ha^{-1} along with 75 per cent nitrogen and 100 per cent potassium recorded maximum plant height, number of primary branches, plant spread, fresh and dry weight of leaves, stems, herb yield, andrographilide content and andrographilide yield which were at par with 50 per cent nitrogen and potassium. The highest B:C ratio and maximum net returns was also obtained with the above mentioned dosage of nutrients.

Key words: *Andrographis paniculata, FRCBD, Andrographilide*

INTRODUCTION

India with a rich biodiversity supports many systems of medicines by producing and exporting various medicinal and aromatic crops. In India more than 9,000 native plants were identified for curative properties, of which 1500 species provide raw materials to the pharmaceutical, cosmetic, fragrance and flavour industries. As per the estimations of World Health Organization, the global market for plant based medicines will hit 5.5 trillion US dollar by the year 2030[4]. Further, there is a increasing shift towards natural derived biomaterials since three decades owing to greater ill effects of synthetic chemicals. Kalmegh is one of the most important medicinal plant, known for its preventive and curative properties belonging to the family Acanthaceae[5] and Sreeramu.

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The genus *Andrographis* consists of twenty six species, with maximum species diversity occurring in South India. Among them, *Andrographis paniculata* Nees. commonly known as 'kalmegh' is an important medicinal crop, native to India and Sri Lanka[7]. The kalmegh is also 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. The total kalmegh herb yield is estimated to be 5,000 tonnes annually from the States of Assam, Bihar, Karnataka, Kerala, Madhya Pradesh, Andhra Pradesh, Uttar Pradesh and West Bengal[8,10] . Kalmegh is an erect herb, grows to a height of 30–90 cm, petiolated leaves, 2-3 cm long and 0.5-1.0 cm broad, lanceolate, hairy on the upper part, small whitish flowers borne on spreading racemes, fruit is capsule, 2 cm long and a few millimetres wide and contains several brownish yellow seeds. Nutrient management is critical issue that determine quantity and quality of harvested produce. Although, plant takes the essential nutrients throughout its life cycle, the nutrients applied at different dosage either as basal dose or top dressing 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 need of the hour. Looking into the medicinal importance of kalmegh and its ratoonabilty, the present investigation on "Influence of nutrient levels on growth, yield and quality of kalmegh (*Andrographis paniculata* Nees) under ratooning " is carried out.

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 3 replications in fairly leveled land of red sandy loam soil with medium fertility status. The seeds were sown in raised nursery beds and 45 days old seedlings were transplanted at a spacing of 30 x 20 cm in plots of 1.8 x 1.4 m. The 'IIHR local' variety was used for experiment and the main crop was harvested at 60 days after transplanting when 50 per cent of plant population attained flowering. The plants were harvested to a height of 2.5 cm from the ground level to facilitate for successive ratoon crops. The recommended dose of nutrients (75:75:50 Kg N: P_2O_5: K_2O ha^{-1}), were applied for the main crop. The Rec. dosage of FYM along with Nitrogen (urea) at 3 levels (N_1: 75 per cent, N_2: 50 per cent, N_3: 25 per cent) and potassium in the form muriate of potash at 3 levels (K_0: no potassium, K_1: 50 per cent, K_2: 100 per cent) were given to successive two ratoon crops as per treatment details with no phosphorous 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), T_9 (N_3K_2). Five representative plants in each treatment were randomly selected and tagged and observation on various growth and yield parameters were recorded at the time of harvesting. 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[1].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. The mean value of growth, yield and quality attributes of both the ratoon crops were computed and analysed statistically.

RESULT AND DISCUSSION

The plants fertilized with 75 per cent nitrogen recorded significantly taller plants 25.86 cm, maximum number of primary branches (15.46), plant spread (429.22 cm^2) which were *at par* with 50 per cent nitrogen (Table 1). Similar results have been reported in sweet basil, fennel and *Solanum nigrum* by Aliezera

et al.[3], Khalid and Mohmoud[6] and Venkatesan and Arumugam[13] respectively. The enhanced growth of plants with 75 per cent nitrogen 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 the enhancement of growth.The 100 per cent potassium recorded significantly maximum plant height (25.00 cm), number of primary branches (14.79), plant spread (414.44 cm^2) which were *on par* with 50 per cent potassium (Table 1). These results are in line with the findings of Rasmia Ali *et al*.[9] in periwinkle. Nitrogen and potassium at all levels showed non-significant difference on days to initiation of blooming and days to 50 per cent flowering. This may be due to the fact that, flowering is a genetic behavior and also regulated by climatic situation (table 1).The plants supplied with 75 per cent nitrogen and 100 per cent potassium has recorded significantly maximum fresh and dry weight of leaves, stem and herb yield, andrographolide content and andrographolide yield which were *on par* with 50 per cent nitrogen and potassium (Table 2). It may be due to 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 and inturn leading to increased fresh weight. The nitrogen and potassium levels had a significant influence on quality parameters. The increase in andrographolide content and yield may be due to supply of optimum dosage of N and K, which might have resulted in better accumulation of assimilates, leading to improved quality. Further, potassium is also responsible for energy production in the form of ATP and NADPH in chloroplasts by maintaining balanced electric charges. The higher the production of photosynthates may be attributed for increased andrographolide content and yield in kalmegh. These results are in conformity with findings of Sanjutha *et al*.[11] in kalmegh.

Table 1: Influence of nutrient levels (N & K) on growth attributes of kalmegh in ratoon crop

	Plant height (cm)	Number of primary branches	Plant spread (cm^2)	Days to initiation of blooming	Days to 50 % flowering
Treatment					
N_1	25.86	15.47	429.22	29.56	43.39
N_2	23.63	14.02	386.48	29.12	43.89
N_3	20.85	12.66	338.68	29.82	44.19
S.Em. ±	0.71	0.46	13.71	1.14	1.69
CD (P=0.05)	2.14	1.36	41.10	NS	NS
K_0	22.15	12.85	357.22	29.76	44.67
K_1	22.70	13.36	372.73	29.29	43.20
K_2	25.00	14.79	414.45	29.46	43.54
S.Em. ±	0.71	0.46	13.71	1.14	1.69
CD (P=0.05)	2.14	1.36	41.10	NS	NS
N_1K_0	24.18	14.33	389.57	29.63	44.00
N_IK_1	26.37	15.83	423.77	29.07	42.73
N_1K_2	27.03	16.24	474.34	28.67	42.67
N_2K_0	22.80	13.74	366.60	29.73	44.20
N_2K_1	24.63	14.64	396.44	29.47	43.80
N_2K_2	25.76	14.90	412.90	29.47	43.67
N_3K_0	19.48	11.97	315.47	29.90	44.40
N_3K_1	20.87	12.77	344.47	29.83	44.47
N_3K_2	22.20	13.24	356.10	29.73	44.30
S.Em. ±	1.23	0.79	23.75	1.98	2.93
CD (P=0.05)	NS	NS	NS	NS	NS
CV	9.05	9.63	10.66	11.63	11.58

Table 2: Effect of nutrient levels (N & K) on yield and quality parameters in ratoon crop of kalmegh

Treatment	Fresh weight of leaves (g)	Dry weight of leaves (g)	Fresh weight of stem (g)	Dry weight of stem (g)	Fresh herb yield (t ha^{-1})	Dry herb yield (t ha^{-1})	Andrographolide content (%)	Andrographolide yield (kg ha^{-1})
N_1	32.89	11.80	18.41	8.77	5.12	2.05	2.20	45.05
N_2	29.26	10.36	16.12	7.89	4.65	1.84	1.88	40.00
N_3	26.67	9.38	13.86	6.02	3.90	1.56	1.76	31.20
S.Em. ±	1.17	0.31	0.37	0.16	0.15	0.07	0.10	1.31
CD (P=0.05)	3.51	0.90	1.10	0.48	0.44	0.21	0.28	3.92
K_0	26.96	8.92	14.97	6.93	4.09	1.62	1.79	31.00
K_1	27.94	9.90	16.00	7.50	4.27	1.70	1.93	39.19
K_2	31.59	10.90	17.15	8.03	4.77	1.91	2.26	43.17
S.Em. ±	1.17	0.31	0.37	0.16	0.15	0.07	0.10	1.31
CD (P=0.05)	3.51	0.90	1.10	0.48	0.44	0.21	0.28	3.92
N_1K_0	30.87	10.42	16.66	8.10	4.79	1.91	1.94	36.97
N_1K_1	32.90	10.90	18.39	8.56	5.04	2.02	2.31	46.45
N_1K_2	34.90	11.08	20.19	8.90	5.52	2.21	2.35	51.73
N_2K_0	29.82	9.90	15.36	7.32	4.19	1.68	1.85	31.02
N_2K_1	31.49	10.24	16.40	7.85	4.59	1.83	2.22	40.56
N_2K_2	32.03	10.53	16.60	8.05	4.73	1.89	2.25	42.44
N_3K_0	24.68	9.14	12.90	5.37	3.74	1.50	1.67	25.02
N_3K_1	27.52	9.42	14.02	5.99	3.90	1.56	2.14	33.23
N_3K_2	27.82	9.59	14.65	6.70	4.07	1.62	2.18	35.34
S.Em. ±	2.03	0.52	0.65	0.35	0.26	0.10	0.16	2.27
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV	11.62	9.82	9.91	9.41	10.02	9.84	13.47	10.24

Table 3: Economics of ratoon crop of kalmegh as influenced by nutrient levels

Treatments	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	114600	74766	1.87
T_2 (N_1K_1) – Rec. dosage of FYM + 75%N + 50%K	40626	120900	80274	1.97
T_3 (N_1K_2) – Rec. dosage of FYM + 75%N + 100%K	41417	132300	90883	2.18
T_4 (N_2K_0) – Rec. dosage of FYM + 50%N + 0%K	39589	100500	60911	1.53
T_5 (N_2K_1) – Rec. dosage of FYM + 50%N + 50%K	40381	109800	69419	1.71
T_6 (N_2K_2) – Rec. dosage of FYM + 50%N + 100%K	41172	113100	71928	1.74
T_7 (N_3K_0) – Rec. dosage of FYM + 25%N + 0%K	39345	89700	50355	1.27
T_8 (N_3K_1) – Rec. dosage of FYM + 25%N + 50%K	40136	93300	53164	1.32
T_9 (N_3K_2) – Rec. dosage of FYM + 25%N + 100%K	40927	97200	56273	1.37

❖ The cost of dry herb of kalmegh is considered as Rs. 60/kg.

The interaction between nitrogen and potassium levels was found non-significant with respect to all the growth and yield attributes in the ratoon crop. The application 25 tonnes FYM $ha^{-1.}$ + 75 per cent N + 100 per cent K to ratoon crops has recorded highest B:C ratio of 2.18 and net return of Rs 90,883 observed in ratoon crops (Table 3). The increase in the net return may be attributed to supply of optimum level of nutrients to meet the crop demand at appropriate time which inturn resulted in enhanced herb yield of good quality. These findings are in line with B:C ratio obtained by Aladakatti *et al*.[2] in stevia.

CONCLUSION

In the light of results summarized above, it is concluded that application of 75 per cent nitrogen and 100 per cent potassium along with 25 tonnes FYM ha^{-1} found to be optimumis for maximizing the yield with good quality produce in ratoon crops of kalmegh.

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