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# Nutrient Content, Uptake, Nutrient Use Efficiency, Agronomic Efficiency in Kalmegh (*Andrographis paniculata* Nees.) as Influenced by Nutrient Levels under Ratooning

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**ABSTRACT**

*Kalmegh (Andrographis paniculata) belongs to the family Acanthaceae a high value medicinal crop known for its prime active constituent Andrographolide. Kalmegh is mainly used for treating fever, liver diseases, diabetes, snake bite, common cold, bronchitis and a variety of ailments. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with 9 treatments replicated thrice having three levels of nitrogen and potassium respectively. The results revealed that, application of FYM @ 25 t ha$^{-1}$ along with 75 per cent nitrogen and 100 per cent potassium has recorded highest accumulation of nutrients in plant parts and increased efficiency of supplied nutrients in first and second ratoon crops of kalmegh.*

***Key words:*** *Andrographis paniculata, FRCBD, Efficiency*

## INTRODUCTION

India with a rich biodiversity supports many systems of medicines by producing and exporting various medicinal and aromatic crops. Approximately, one third of pharmaceuticals are of plant origin and are used for relieving and curing ailments. Kalmegh is one of the most important medicinal plant, known for its preventive and curative properties[1]. It is a herbaceous plant belongs to the family Acanthaceae, native to India and Sri Lanka. It 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 having whitish flowers borne on spreading racemes forms fruit is capsule, 2 cm long and a few millimetres wide and contains several brownish yellow seeds. The heavy demand of andrographolide in Indian as well as international markets has motivated Indian farmers to take up commercial cultivation of kalmegh[2].

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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 are 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 is necessary to assess the nutrient content and uptake, nutrient use efficiency and agronomic efficiency. 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 " was carried out.

## MATERIALS AND METHODS

The field experiment was carried out 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 viz., $T_1$ ($N_1K_0$), $T_2$ ($N_1K_1$), $T_3$ ($N_1K_2$), $T_4$ ($N_2K_0$), $T_5$ ($N_2K_1$), $T_6$ ($N_2K_2$), $T_7$ ($N_3K_0$), $T_8$ ($N_3K_1$), $T_9$ ($N_3K_2$) and replicated thrice. The 'IIHR local' variety was raised in nursery and seedlings of 45 days old were transplanted 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 main crop. The main crop was harvested at 60 days after transplanting when, 50 per cent of plant population attained flowering. The Rec. dosage of FYM 25 t FYM $ha^{-1}$ along with nitrogen in the form of 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 as per treatment details without phosphorous for both the ratoon crops.Five representative plants in each treatment and in each replication, leaving the border plants, were randomly selected and tagged. The mean data recorded on five plants from each treatment was used for statistical analysis. The nitrogen content in the leaf and stem was determined using Micro-Kjeldhal digestion and distillation method as outlined by Piper[4] and expressed in percentage on dry weight basis. These values were used for estimating the nitrogen uptake by the plant. The potassium content in the leaf and stem was determined by flame photometer method after digestion with di-acid as outlined by Piper[4] and expressed in percentage on dry weight basis. This data was used for estimating the potassium uptake by the plant. The following formulaes were used to calculate nutrient uptake,nutrient use efficiency and agronomic efficiency.

**Nutrient uptake (kg $ha^{-1}$)**

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient conc. (\%)} \ \mathbf{X} \ \text{Dry Biomass yield (kg ha}^{-1})}{100}$$

**Nutrient use efficiency (NUE)**

$$\text{NUE} = \frac{\text{Dry herb yield (kg ha}^{-1})}{\text{Nutrient uptake (kg ha}^{-1})}$$

**Agronomic efficiency (AE)**

$$\text{AE} = \frac{\text{Dry herb yield (kg ha}^{-1})}{\text{Nutrient applied (kg ha}^{-1})}$$

## RESULTS AND DISCUSSION

Nitrogen level at 75 per cent and 50 per cent and potassium level at 100 per cent and 50 per cent recorded increased nutrient content and uptake in leaves and stem as compared to 25 per cent nitrogen and no potassium. The mechanism causing higher content and uptake of applied nutrients may be attributed to the combined influence of optimal soil moisture availability in the root zone and reduction in

loss of applied nutrients due to application of optimum dosage at a time to match crop uptake requirement. The precision application of fertilizer in right quantity at right time to match with the crop demand resulted in higher nutrient uptake in both the ratoon crops. The impact of higher nutrient uptake due to nutrient supply has manifested to a greater extent when nitrogen and potassium fertilizers were applied to ratoon crops. Similar results of beneficial effects of application of N and K have been reported by Prakasa *et al*.[5] in French basil and Munnu Singh and Ganesh Rao[3]. in patchouli.

**Nutrient use efficiency in kalmegh**

The highest NUE of 44.21 and 22.54 kg $kg^{-1}$ nutrient uptake was observed with 25 per cent nitrogen with no potassium application followed by 50 per cent nitrogen and potassium in first ratoon crop. The same trend was observed in second ratoon crop also. The increased NUE might be due to the fact that, higher the efficiency lesser the usage of nutrients by the plants during its active growth and development period. The varied levels of nitrogen and potassium has no influence on NUE of phosphorous over different nutrient levels in both the ratoon crops. The interaction between nitrogen and potassium levels was found non-significant on nutrient use efficiency.

**Agronomic efficiency**

The highest agronomic efficiency in both ratoon crops was observed with 25 per cent nitrogen (36.23 and 40.26 kg $kg^{-1}$ nutrient applied) which was followed by 50 per cent nitrogen. Among potassium levels, 50 per cent potassium has recorded maximum agronomic efficiency of 41.21 and 45.21 kg $kg^{-1}$ nutrient applied followed with 100 per cent potassium in both the ratoon crops, respectively.

**Table 1: Nitrogen content (%) and uptake (kg $ha^{-1}$) as influenced by nutrient levels in first and second ratoon crop of kalmegh**

| | 1st ratoon | | | | | 2nd ratoon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N content | | N uptake | | Total N | N content | | N uptake | | Total N |
| Treatment | Leaf | Stem | Leaf | Stem | uptake | Leaf | Stem | Leaf | Stem | uptake |
| $N_1$ | 1.60 | 0.79 | 15.46 | 1.65 | 17.11 | 1.62 | 0.83 | 16.06 | 1.76 | 17.82 |
| $N_2$ | 1.40 | 0.72 | 10.74 | 1.20 | 12.11 | 1.40 | 0.75 | 11.48 | 1.40 | 12.89 |
| $N_3$ | 1.34 | 0.61 | 9.49 | 1.13 | 10.61 | 1.36 | 0.64 | 10.46 | 1.28 | 11.73 |
| S.Em. ± | 0.06 | 0.03 | 1.55 | 0.14 | 1.68 | 0.07 | 0.03 | 1.47 | 0.13 | 1.60 |
| CD (P=0.05) | 0.19 | 0.08 | 4.64 | 0.41 | 5.04 | 0.20 | 0.08 | 4.41 | 0.35 | 4.79 |
| $K_0$ | 1.32 | 0.66 | 11.56 | 1.31 | 12.87 | 1.52 | 0.71 | 12.27 | 1.33 | 13.70 |
| $K_1$ | 1.43 | 0.69 | 12.27 | 1.40 | 13.67 | 1.55 | 0.74 | 13.02 | 1.48 | 14.49 |
| $K_2$ | 1.55 | 0.73 | 12.86 | 1.44 | 14.30 | 1.57 | 0.77 | 13.71 | 1.53 | 15.25 |
| S.Em. ± | 0.06 | 0.03 | 1.55 | 0.14 | 1.68 | 0.07 | 0.03 | 1.47 | 0.13 | 1.60 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| $N_1K_0$ | 1.59 | 0.77 | 45.53 | 4.78 | 50.31 | 1.61 | 0.81 | 46.85 | 5.10 | 51.95 |
| $N_1K_1$ | 1.60 | 0.79 | 46.23 | 4.99 | 51.22 | 1.62 | 0.83 | 48.44 | 5.24 | 53.68 |
| $N_1K_2$ | 1.61 | 0.82 | 47.36 | 5.11 | 52.47 | 1.63 | 0.86 | 49.23 | 5.51 | 54.74 |
| $N_2K_0$ | 1.49 | 0.68 | 32.67 | 3.85 | 36.52 | 1.51 | 0.72 | 34.27 | 4.09 | 38.36 |
| $N_2K_1$ | 1.55 | 0.70 | 35.38 | 4.19 | 39.57 | 1.58 | 0.75 | 37.35 | 4.23 | 41.58 |
| $N_2K_2$ | 1.57 | 0.73 | 37.63 | 4.25 | 41.88 | 1.59 | 0.78 | 40.73 | 4.30 | 45.03 |
| $N_3K_0$ | 1.40 | 0.58 | 25.84 | 3.15 | 28.99 | 1.43 | 0.61 | 29.28 | 3.69 | 32.97 |
| $N_3K_1$ | 1.43 | 0.59 | 28.80 | 3.40 | 32.20 | 1.46 | 0.63 | 31.35 | 3.84 | 35.19 |
| $N_3K_2$ | 1.48 | 0.65 | 30.73 | 3.61 | 34.34 | 1.49 | 0.68 | 33.47 | 3.98 | 37.45 |
| S.Em. ± | 0.10 | 0.05 | 2.68 | 0.24 | 2.91 | 0.12 | 0.05 | 2.55 | 0.22 | 2.76 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| CV | 11.88 | 11.15 | 12.65 | 9.82 | 12.36 | 13.83 | 11.03 | 11.31 | 8.65 | 11.02 |

**Table 2: Potassium content (%) and uptake (kg ha$^{-1}$) as influenced by nutrient levels in first and second ratoon crop of kalmegh**

| | 1st ratoon | | | | | 2nd ratoon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | K content | | K uptake | | Total K uptake | K content | | K uptake | | Total K |
| Treatment | Leaf | Stem | Leaf | Stem | | Leaf | Stem | Leaf | Stem | uptake |
| $N_1$ | 0.39 | 0.16 | 10.96 | 3.98 | 14.94 | 0.45 | 0.19 | 11.30 | 1.45 | 12.75 |
| $N_2$ | 0.37 | 0.15 | 10.09 | 3.83 | 13.92 | 0.38 | 0.17 | 10.61 | 1.33 | 11.90 |
| $N_3$ | 0.34 | 0.14 | 9.08 | 3.58 | 12.66 | 0.36 | 0.17 | 9.83 | 1.26 | 11.09 |
| S.Em. ± | 0.05 | 0.01 | 0.65 | 0.15 | 0.52 | 0.05 | 0.02 | 0.67 | 0.12 | 0.48 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| $K_0$ | 0.15 | 0.14 | 9.55 | 2.03 | 11.58 | 0.24 | 0.13 | 8.54 | 0.73 | 9.27 |
| $K_1$ | 0.26 | 0.16 | 10.45 | 4.16 | 14.61 | 0.30 | 0.15 | 10.83 | 1.49 | 12.32 |
| $K_2$ | 0.44 | 0.19 | 12.48 | 5.21 | 17.69 | 0.45 | 0.21 | 12.89 | 1.82 | 14.71 |
| S.Em. ± | 0.05 | 0.01 | 0.65 | 0.15 | 0.52 | 0.05 | 0.02 | 0.67 | 0.12 | 0.48 |
| CD (P=0.05) | 0.16 | 0.03 | 1.90 | 0.44 | 1.58 | 0.14 | 0.06 | 1.99 | 0.33 | 1.46 |
| $N_1K_0$ | 0.90 | 0.41 | 25.50 | 2.13 | 27.63 | 0.96 | 0.43 | 27.79 | 2.39 | 30.18 |
| $N_1K_1$ | 1.26 | 0.54 | 33.20 | 4.39 | 37.59 | 1.28 | 0.57 | 35.52 | 4.86 | 40.38 |
| $N_1K_2$ | 1.37 | 0.65 | 39.92 | 5.43 | 45.35 | 1.39 | 0.68 | 40.59 | 5.15 | 45.74 |
| $N_2K_0$ | 0.84 | 0.34 | 22.47 | 2.10 | 24.57 | 0.87 | 0.37 | 25.29 | 2.22 | 27.51 |
| $N_2K_1$ | 1.20 | 0.48 | 30.35 | 4.19 | 34.54 | 1.23 | 0.51 | 32.65 | 4.51 | 37.16 |
| $N_2K_2$ | 1.33 | 0.57 | 37.96 | 5.21 | 43.17 | 1.35 | 0.61 | 38.96 | 5.32 | 44.27 |
| $N_3K_0$ | 0.60 | 0.32 | 20.00 | 1.86 | 21.86 | 0.69 | 0.38 | 23.77 | 2.01 | 25.78 |
| $N_3K_1$ | 1.16 | 0.46 | 27.27 | 3.89 | 31.16 | 1.20 | 0.51 | 29.27 | 4.11 | 33.38 |
| $N_3K_2$ | 1.29 | 0.52 | 34.46 | 4.99 | 39.45 | 1.31 | 0.60 | 35.46 | 5.19 | 40.65 |
| S.Em. ± | 0.09 | 0.04 | 0.93 | 0.25 | 0.91 | 0.08 | 0.04 | 1.05 | 0.29 | 0.84 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| CV | 13.76 | 13.03 | 13.14 | 11.50 | 13.99 | 12.28 | 12.02 | 11.01 | 12.34 | 12.03 |

**Table 3: Influence of nutrient levels (N & K) on nutrient use efficiency (N, P and K) of first and second ratoon crop of kalmegh**

| Treatment | 1st ratoon | | | 2nd ratoon | | |
|---|---|---|---|---|---|---|
| | N | P | K | N | P | K |
| $N_1$ | 37.51 | 4.99 | 18.88 | 39.13 | 5.31 | 18.24 |
| $N_2$ | 40.73 | 6.10 | 17.08 | 42.07 | 5.99 | 18.60 |
| $N_3$ | 44.21 | 4.94 | 15.36 | 45.72 | 4.60 | 18.33 |
| S.Em. ± | 1.13 | 0.65 | 1.76 | 1.21 | 0.46 | 1.94 |
| CD (P=0.05) | 3.39 | NS | NS | 3.63 | NS | NS |
| $K_0$ | 41.04 | 5.72 | 22.54 | 42.42 | 5.24 | 22.78 |
| $K_1$ | 39.55 | 5.05 | 16.97 | 42.33 | 5.32 | 16.18 |
| $K_2$ | 36.49 | 4.98 | 15.18 | 42.18 | 5.35 | 16.21 |
| S.Em. ± | 1.13 | 0.65 | 1.76 | 1.21 | 0.46 | 1.94 |
| CD (P=0.05) | NS | NS | 5.28 | NS | NS | 5.82 |
| $N_1K_0$ | 37.29 | 14.50 | 67.07 | 37.81 | 14.66 | 64.61 |
| $N_1K_1$ | 36.64 | 14.70 | 51.69 | 38.43 | 15.37 | 48.62 |
| $N_1K_2$ | 38.61 | 15.68 | 51.14 | 41.15 | 17.73 | 50.94 |
| $N_2K_0$ | 40.62 | 24.24 | 66.23 | 41.84 | 20.35 | 69.42 |
| $N_2K_1$ | 41.85 | 15.50 | 51.42 | 43.59 | 17.48 | 49.57 |
| $N_2K_2$ | 39.72 | 15.17 | 48.38 | 40.79 | 16.10 | 48.43 |
| $N_3K_0$ | 45.21 | 12.73 | 69.55 | 47.62 | 12.14 | 71.01 |
| $N_3K_1$ | 44.57 | 17.74 | 49.58 | 44.96 | 15.00 | 47.48 |
| $N_3K_2$ | 42.86 | 14.00 | 46.09 | 44.58 | 14.29 | 46.49 |
| S.Em. ± | 2.15 | 1.12 | 3.05 | 2.10 | 0.79 | 3.37 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS |
| CV | 9.14 | 12.13 | 9.49 | 10.59 | 9.62 | 10.56 |

**Table 4: Agronomic efficiency as influenced by nutrient levels (N & K) in ratoon crops of kalmegh**

| Treatment | Agronomic efficiency (kg/kg Nutrient applied) | | | |
|---|---|---|---|---|
| | 1st ratoon | | 2nd ratoon | |
| | N | K | N | K |
| $N_1$ | 16.03 | 23.80 | 17.39 | 26.08 |
| $N_2$ | 20.89 | 21.92 | 23.19 | 24.44 |
| $N_3$ | 36.23 | 18.08 | 40.26 | 19.76 |
| S.Em. ± | 0.84 | 0.70 | 0.87 | 0.77 |
| CD (P=0.05) | 2.52 | NS | 2.60 | NS |
| $K_0$ | 23.09 | 0.00 | 25.48 | 0.00 |
| $K_1$ | 24.51 | 41.21 | 26.99 | 45.21 |
| $K_2$ | 25.56 | 21.60 | 28.38 | 24.08 |
| S.Em. ± | 0.84 | 0.70 | 0.87 | 0.77 |
| CD (P=0.05) | NS | 2.11 | NS | 2.31 |
| $N_1K_0$ | 15.29 | 0.00 | 15.95 | 0.00 |
| $N_1K_1$ | 15.87 | 46.57 | 17.09 | 50.17 |
| $N_1K_2$ | 16.93 | 24.84 | 19.14 | 28.08 |
| $N_2K_0$ | 19.63 | 0.00 | 21.47 | 0.00 |
| $N_2K_1$ | 21.10 | 41.29 | 23.80 | 46.57 |
| $N_2K_2$ | 21.96 | 21.48 | 24.29 | 23.76 |
| $N_3K_0$ | 34.35 | 0.00 | 39.01 | 0.00 |
| $N_3K_1$ | 36.56 | 35.77 | 40.07 | 38.89 |
| $N_3K_2$ | 37.78 | 18.48 | 41.71 | 20.40 |
| S.Em. ± | 1.46 | 1.22 | 1.50 | 1.34 |
| CD (P=0.05) | NS | NS | NS | NS |
| CV | 10.34 | 10.07 | 9.64 | 10.03 |

## CONCLUSION

The application of 75 per cent nitrogen and 100 per cent potassium has recorded maximum nutrient content and uptake in kalmegh. While, 25 per cent nitrogen and 0 per cent potassium recorded maximum NUE and AE.

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