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Dhanraj P
Assistant Professor, Department of PSMA College of Horticulture, Sirsi, Karnataka, India

Gangadharappa PM
Retired Director of Extension University of Horticultural Sciences, Bagalkot, Karnataka, India

Hiremath JS
Assistant Professor and Head Department of PSMA, KRCCH, Arabhavi, Karnataka, India

Srikantprasad D
Assistant Professor, Department of PSMA, HREC, Hogalagere, Kolar, Karnataka, India

Yogeeshappa H
Assistant Professor, Department of Soil Science and Agri chemistry COH, Munirabad, Karnataka, India

Ashoka N
Assistant Professor, Department of Agricultural Economics COH, Sirsi, Karnataka, India

Avinash M
Ph.D Scholar Department of PSMA COH, Bagalkot, Karnataka, India

Corresponding Author:
Dhanraj P
Assistant Professor, Department of PSMA College of Horticulture, Sirsi, Karnataka, India

Effect of different levels of nitrogen and phosphorous on yield attributes and economics of kalmegh (*Andrographis paniculata* Nees)

Dhanraj P, Gangadharappa PM, Hiremath JS, Srikantprasad D, Yogeeshappa H, Ashoka N and Avinash M

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Abstract
A field experiment at Kitturu Rani Channamma College of Horticulture, Arabhavi, assessed the impact of different levels of nitrogen and phosphorous on yield attributes and economics of kalmegh (*Andrographis paniculata* Nees.) in the northern dry zone of Karnataka during 2019-2020. With twelve treatments replicated thrice in Factorial Randomized Complete Block design (FRCBD). The maximum fresh and dry weight of leaves (24.17 & 8.29 g), fresh and dry weight of stem (29.47 & 11.29 g), fresh and dry weight of herb plant^{-1} (53.65 & 19.58 g), fresh and dry weight of herb plot^{-1}(5.36 & 1.96 kg) and fresh and dry weight of herb ha^{-1} (7.63 & 4.35 t ha^{-1}) were recorded with the application of nitrogen at 125 kg ha^{-1} (N_4) along with application of phosphorous at 50 kg ha^{-1} (P_2) treatment combination (N_4P_2). Further, the higher net return (126984.85 & 170277.44 Rs. per ha during 2019 and 2020, respectively) and B:C ratio (2.82 & 3.19 during 2019 and 2020, respectively) was found with the application of nitrogen at 125 kg ha^{-1} (N_4) along with application of phosphorous at 50 kg ha^{-1} (P_2) treatment combination (N_4P_2). These findings highlight the positive influence of nitrogen and phosphorous nutrition on Kalmegh, offering valuable insights for agricultural practices in similar agro-ecological contexts and enriching our understanding of nutrient management in horticulture.

Keywords: Kalmegh, nitrogen and phosphorous

Introduction
Kalmegh, scientifically known as *Andrographis paniculata* Nees, is part of the Andrographis genus, comprising twenty-six species, primarily found in South India. Commonly referred to as 'kalmegh,' this herbaceous plant belongs to the Acanthaceae family and is indigenous to India and Sri Lanka (Kirtikar and Basu, 1975) [5]. The plant's fresh and dried leaves, as well as the extracted juice, are recognized as official drugs in the Indian pharmacopoeia, employed in traditional medicine across China, India, and Southeast Asia.

Characterized by its erect herbaceous structure, Kalmegh grows to a height of 30–90 cm, featuring petiolated lanceolate leaves with whitish flowers borne on spreading racemes. The fruit, known as a capsule, measures 2 cm in length, contains several brownish-yellow seeds, and holds significance as the 17th prioritized crop among 32 medicinal plants in India (Kala *et al*., 2006; Anon., 2015; Sharma *et al*., 2009) [2, 1, 8]. Traditionally regarded as a "cold property" herb, Kalmegh is utilized to alleviate body heat during fevers and eliminate toxins. Its therapeutic properties stem from an enzyme induction mechanism, offering anti-inflammatory, antibiotic, anti-malarial, anti-hepatitic, and anti-pyretic benefits. Notably, its immune-stimulating properties aid in treating various ailments, including dysentery, diarrhea, cholera, fever, diabetes, bronchitis, hypertension, piles, and gonorrhea. Research has documented the plant's anti-HIV properties attributed to the presence of the active constituent Andrographolide (Sajwan, 2008) [7]. Key constituents like andrographolide-A, andrographolide-B, and related diterpenoids contribute to immune stimulation, anti-inflammatory effects, fertility enhancement, liver protection, and bile secretion stimulation (Kataky and Handique, 2010) [4].

Nutrient management is a critical issue that determines the quantity and quality of harvested produce. Nitrogen and phosphorus are the nutrients largely support growth and development of crop. Nitrogen is an important component of enzymes and nucleic acids. It is an integral constituent of chlorophyll, which promotes photosynthesis and formation of photosynthates from which the vegetative parts are developed. These vegetative structures have a direct bearing on yield (Kanwar, 1978) [3]. However, availability of nitrogen is of prime importance for growing of plants as it is a major and indispensable constituent of protein and nucleic acid molecules (Nasiri *et al*., 2015) [6]. Further, it accelerates the synthesis of chlorophyll and aminoacids resulting in increased vegetative growth. Phosphorus is essential for all living organisms. Plants must have phosphorus for normal growth and maturity. It is an essential constituent of enzymes, positively correlated with carbohydrate metabolism. Further, phosphorus improves the supply of nutrients and water resulting in increasing the photosynthetic area and there by leads to excess accumulation of dry matter and production of higher yield (Nasiri *et al*., 2015) [6]

Materials and Methods

A field experiment titled "Standardization of Nutrient Requirement in Kalmegh (*Andrographis paniculata* Nees.)" was conducted at the Department of Plantation, Spices, Medicinal, and Aromatic Crops, Kittur Rani Channamma College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot, Karnataka. The experimental site's soil composition consisted of sandy loam. The study, carried out during the rabi season of 2019 and 2020, adopted a Factorial Randomized Complete Block Design with three replications. The chosen variety for experimentation was kalmegh var. CIM-Megha, developed by the Central Institute of Medicinal and Aromatic Plants, Lucknow. This particular variety is distinguished by its early maturation, tolerance to iron deficiency, and superior performance in terms of dry biomass yield and andrographolide content.

Treatment Details

Factor A: Nitrogen levels

N_1 : 50 kg ha^{-1} Nitrogen
N_2 : 75 kg ha^{-1} Nitrogen
N_3 : 100 kg ha^{-1} Nitrogen
N_4 : 125 kg ha^{-1} Nitrogen

Factor B: Phosphorus levels

P_1 : 50 kg ha^{-1} Phosphorus
P_2 : 75 kg ha^{-1} Phosphorus
P_3 : 100 kg ha^{-1} Phosphorus

Treatment combinations (A X B)

T_1 – (N_1 P_1) – 50 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_2 – (N_1 P_2) – 50 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_3 – (N_1 P_3) – 50 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}
T_4 – (N_2 P_1) – 75 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_5 – (N_2 P2) – 75 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_6 – (N_2 P_3) – 75 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}
T_7– (N_3 P_1) – 100 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_8– (N_3 P_2) – 100 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_9– ((N_3 P_3) – 100 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}
T_{10}– (N_4 P_1) – 125 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_{11}– (N_4 P_2) – 125 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_{12}– (N_4 P_3) – 125 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}

Note: Recommended dose of FYM @ 25 t and 50 kg potassium per hectare were applied equally to all the treatments.

Healthy and uniformly sized seedlings, aged forty-five days, were meticulously chosen and transplanted into the main field. The transplantation process involved placing the seedlings at a specific spacing of 30 cm between rows and 15 cm between individual plants. This careful arrangement aims to optimize the utilization of available space and promote optimal growth and development of the transplanted seedlings in the main field.

Observation recorded

Fresh weight of leaves (g)

The leaves were separated from the randomly selected five plants and the average fresh weight was recorded at harvest and expressed as grams per plant.

Dry weight of leaves (g)

The leaves were shade dried for 5 days and again kept in oven at 60 °C till attaining the constant weight and the average weight was recorded dry weight and expressed as grams per plant.

Fresh weight of stem (g)

The stems were separated from the five randomly selected plants and the average fresh weight was recorded at harvest and expressed as grams per plant.

Dry weight of stem (g)

The stems were shade dried for 5 days and again kept in oven at 60 °C till attaining constant weight and the average weight was recorded as dry weight and expressed as gram per plant.

Fresh herb yield $plant^{-1}$ (g)

The fresh whole herb of individual labelled plants was harvested and weighed by using the electronic balance and the mean was worked out and expressed in gram per plant.

Dry herb yield $plant^{-1}$ (g)

Freshly harvested herb of five tagged plants was kept in hot air oven for drying at a temperature of 65 °C till a constant weight was reached. The herb was weighed on an electronic balance and the mean was recorded and expressed in grams.

Fresh herb yield $plot^{-1}$ (kg)

The freshly harvested herb from the plot was weighed by using the electronic balance and expressed in kg.

Dry herb yield $plot^{-1}$ (kg)

The freshly harvested herb of the plot was cleaned and dried in hot air oven at 65 °C till a constant weight was obtained and expressed in kg.

Fresh herb yield (ton ha^{-1})

The fresh yield per hectare was estimated on the basis of fresh yield per plot and it was reduced by 10 per cent considering path and irrigation channels in the field. The fresh yield per hectare was expressed in terms of tonnes.

Dry herb yield (ton ha^{-1})

Dry yield per hectare was calculated on the basis of dry yield per plot, the final yield was reduced by 10 per cent considering paths, irrigation channels in the field and expressed in quintals per hectare.

Results and Discussion

The pooled data revealed that, the treatment N_4 (125 kg ha^{-1}) recorded maximum fresh (22.51 g) and dry weight (7.72 g) of leaves per plant which was followed nitrogen at 100 kg ha^{-1} (N_3).While, the minimum fresh (17.48 g) and dry weight (4.98 g) of leaves per plant was noticed with N_1-50 kg ha^{-1}. Further, the maximum fresh and dry weight of leaves per plant (21.06 g) and dry (6.63 g) obtained with phosphorous application at 75 kg ha^{-1} (P_2) and which was found on par with P_3 (19.62 and 6.47 g, respectively). Whereas, the least fresh and dry weight of leaves per plant was observed with P_1: 50 kg ha^{-1} (18.56 g and 5.81 g, respectively). The interaction effect of nutrients for fresh and dry weight of leaves per plant was found non significant. However, maximum fresh and dry weight of leaves per plant (24.17 and 8.29 g, respectively) was noticed in N_4 P_2 treatment combination and on the other hand it was found minimum (16.36 and 4.61 g, respectively) in N_1 P_1 treatment combination (Table. 1).

Similarly, application of nitrogen at 125 kg ha^{-1} (N_4) recorded maximum fresh (27.40 g) and dry weight (10.40 g) of stem per plant and was followed by N_3-100 kg ha^{-1}.While, the least fresh (20.23 g) and dry weight (7.71 g) of stem per plant was noticed with N_1- 50 kg ha^{-1}. The different levels of phosphorous showed significant influence on fresh and dry weight of stem per plant. P_2: 75 kg ha^{-1} recorded maximum fresh (25.73 g) and dry (9.69 g) weight of stem per plant followed by plants supplied with P_3: 100 kg ha^{-1}. Whereas least fresh and dry weight of stem per plant was observed with P_1: 50 kg ha^{-1} (22.30 g and 8.32 g, respectively). The interaction effect of nitrogen and phosphorus for fresh and dry weight of stem per plant was found non significant. (Table. 2).

The maximum fresh and dry weight of herb per plant was recorded with the application of nitrogen at (N_4) 125 kg ha^{-1} (49.91 g plant^{-1} and 18.11 g plant^{-1}, respectively). The application of phosphorus 75 kg ha^{-1} (P_2) recorded maximum fresh and dry weight of herb per plant (46.79 g plant^{-1} and 16.33 g plant^{-1}, respectively). The interaction effect of nitrogen and phosphorus levels was non significant for the fresh and dry weight of herb per plant. (Table. 3). Fresh and dry weight of herb plot^{-1} was maximum at N_4-125 kg ha^{-1} (4.99 kg and 1.81 kg, respectively) and was followed by N_3-100 Kg ha^{-1} (4.53 kg and 1.58 kg, respectively). The least fresh (3.77 kg) and dry weight (1.26 kg) of herb plot^{-1} was observed with the treatment N_1: 50 Kg ha^{-1}. The application of P_2: 75 kg ha^{-1} recorded maximum fresh and dry weight of herb plot^{-1} (4.68 kg and 1.63 kg, respectively) and was followed by P_3 - 100 kg ha^{-1} (4.33 kg and 1.55 kg, respectively). The least yield was obtained with P_1: 50 kg ha^{-1} (4.09 kg and 1.41 kg, respectively). The interaction effect was found to be non significant for the fresh and dry weight of herb plot^{-1} (Table. 4).

The pooled data pertaining to fresh and dry weight of herb per hectare (t ha^{-1}) showed significant influence of nitrogen. The highest fresh (7.12 t/ha) and dry weight (4.03 t ha^{-1}) of herb per hectare was obtained with the application of nitrogen at N_4 -125 kg ha^{-1}. The lowest fresh (4.94 t ha^{-1}) and dry weight (2.80 t ha^{-1}) of herb per hectare was obtained when supplied with N_1 -50 Kg ha^{-1}. The highest fresh (6.52 t ha^{-1}) and dry weight (3.63 t ha^{-1}) of herb per hectare was recorded with the application of 75 kg ha^{-1} of phosphorous (P_2). The lowest fresh (5.49 t/ha) and dry weight (3.13 t ha^{-1}) of herb per hectare was recorded in treatment of P_1 (50 kg ha^{-1}). The interaction effect was found to be non significant for the fresh and dry weight of herb per hectare (Table. 5).

Regarding the data on economics, the maximum gross return of Rs. 196667 (2019) and 248059.26 (2020) per hectare was realized with the application of nitrogen at 125 kg ha^{-1} along with application of phosphorous at 75 kg ha^{-1} (N_4 P_2) treatment combination. While, the least return Rs 101852 (2019) and 155243.75(2020) was recorded with N_1 P_1 treatment combination. Maximum net profit of Rs. 126984.85 and 170277.44 per hectare was obtained with the application of nitrogen at 125 kg ha^{-1} along with application of phosphorous at 75 kg ha^{-1} (N_4 P_2) treatment combination (N_4 P_2) during both seasons (2019 & 2020, respectively). While, the least net returns of Rs. 33900.63 and 79192.53 per hectare was obtained with application of nitrogen and phosphorus at the rate of 50 kg ha^{-1} in N_1 P_1 treatment combination during both seasons (2019 & 2020, respectively). Maximum benefit per rupee invested (2.82 and 3.19) was obtained from kalmegh dry herb with the treatment combination of (N_4 P_2) during both seasons (2019 & 2020, respectively). Whereas, N_1 P_1 treatment combination recorded the least B:C ratio of 1.50 and 2.04 during 2019 & 2020, respectively) (Table 6).

Table 1: Effect of nitrogen and phosphorus levels on fresh and dry weight of leaves per plant in kalmegh (*Andrographis paniculata* Nees.)

Treatments	*Rabi* -2019		*Rabi*- 2020		Pooled data	
	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)
Nitrogen levels (N)						
N_1 : 50 Kg ha^{-1}	15.17	4.02	19.78	5.93	17.48	4.98
N_2 : 75 Kg ha^{-1}	16.79	4.22	20.27	7.58	18.53	5.90
N_3 : 100 Kg ha^{-1}	19.41	5.67	21.54	7.58	20.47	6.63
N_4 : 125 Kg ha^{1}	21.21	6.44	23.81	9.00	22.51	7.72
S.Em ±	1.03	0.33	0.51	0.21	0.66	0.21
CD @ 5%	3.03	0.96	1.50	0.60	1.95	0.60
Phosphorus levels (P)						
P_1 : 50 Kg ha^{-1}	16.58	4.57	20.54	7.06	18.56	5.81
P_2 : 75 Kg ha^{-1}	19.92	5.62	22.20	7.64	21.06	6.63
P_3 : 100 Kg ha^{-1}	17.93	5.07	21.31	7.86	19.62	6.47
S.Em ±	0.89	0.28	0.44	0.18	0.58	0.18
CD @ 5%	2.62	0.83	1.30	0.52	1.69	0.52
Interaction (NXP)						
N_1 P_1	13.59	4.00	19.13	5.23	16.36	4.61
N_1 P_2	16.18	4.39	20.67	5.73	18.43	5.06
N_1 P_3	15.74	3.67	19.56	6.83	17.65	5.25
N_2 P_1	15.41	4.22	19.52	7.56	17.46	5.89
N_2 P_2	18.96	4.72	20.89	7.58	19.93	6.15
N_2 P_3	16.00	3.72	20.41	7.59	18.20	5.66
N_3 P_1	17.00	4.22	21.50	7.54	19.25	5.88
N_3 P_2	21.89	6.44	21.56	7.62	21.72	7.03
N_3 P_3	19.33	6.33	21.56	7.58	20.44	6.96
N_4 P_1	20.33	5.83	22.00	7.89	21.17	6.86
N_4 P_2	22.66	6.93	25.68	9.64	24.17	8.29
N_4 P_3	20.63	6.56	23.74	9.45	22.18	8.00
S.Em ±	1.79	0.57	0.89	0.36	1.15	0.36
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 2: Effect of nitrogen and phosphorus levels on fresh and dry weight of stem per plant in kalmegh (*Andrographis paniculata* Nees.)

Treatments	*Rabi* -2019		*Rabi*- 2020		Pooled data	
	Fresh weight of stem (g)	Dry weight of stem (g)	Fresh weight of stem (g)	Dry weight of stem (g)	Fresh weight of stem (g)	Dry weight of stem (g)
Nitrogen levels (N)						
N_1 : 50 Kg ha^{-1}	14.27	6.31	26.19	9.12	20.23	7.71
N_2 : 75 Kg ha^{-1}	16.97	7.59	29.27	9.87	23.12	8.73
N_3 : 100 Kg ha^{-1}	18.62	7.87	31.04	10.57	24.83	9.22
N_4 : 125 Kg ha^{1}	22.44	9.34	32.35	11.45	27.40	10.40
S.Em ±	1.25	0.43	0.84	0.41	0.72	0.26
CD @ 5%	3.65	1.27	2.48	1.21	2.11	0.76
Phosphorus levels (P)						
P_1 : 50 Kg ha^{-1}	16.20	7.07	28.39	9.58	22.30	8.32
P_2 : 75 Kg ha^{-1}	20.19	8.48	31.27	10.91	25.73	9.69
P_3 : 100 Kg ha^{-1}	17.84	7.78	29.47	10.27	23.66	9.03
S.Em ±	1.08	0.37	0.73	0.36	0.62	0.23
CD @ 5%	3.16	1.10	2.15	1.05	1.83	0.66
Interaction (NXP)						
N_1 P_1	13.39	5.67	24.22	8.21	18.81	6.94
N_1 P_2	15.37	6.81	26.28	9.88	20.82	8.35
N_1 P_3	14.07	6.44	28.06	9.27	21.06	7.86
N_2 P_1	15.02	8.24	28.79	8.88	21.91	8.56
N_2 P_2	19.56	7.67	30.35	10.62	24.95	9.14
N_2 P_3	16.35	6.87	28.67	10.11	22.51	8.49
N_3 P_1	15.96	6.49	29.28	10.19	22.62	8.34
N_3 P_2	21.33	8.67	34.00	11.31	27.67	9.99
N_3 P_3	18.56	8.44	29.83	10.21	24.19	9.33
N_4 P_1	20.44	7.88	31.28	11.04	25.86	9.46
N_4 P_2	24.50	10.77	34.44	11.82	29.47	11.29
N_4 P_3	22.39	9.37	31.33	11.49	26.86	10.43
S.Em ±	2.16	0.75	1.46	0.71	1.25	0.45
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 3: Effect of nitrogen and phosphorus levels on fresh and dry weight of herb plant^{-1}in kalmegh (*Andrographis paniculata* Nees.)

Treatments	*Rabi* -2019		*Rabi*- 2020		Pooled data	
	Fresh weight of herb plant^{-1} (g)	Dry weight of herb plant^{-1} (g)	Fresh weight of herb plant^{-1} (g)	Dry weight of herb plant^{-1} (g)	Fresh weight of herb plant^{-1} (g)	Dry weight of herb plant^{-1} (g)
Nitrogen levels (N)						
N_1 : 50 Kg ha^{-1}	29.44	10.16	45.97	15.05	37.71	12.61
N_2 : 75 Kg ha^{-1}	33.76	11.81	49.54	17.44	41.65	14.63
N_3 : 100 Kg ha^{-1}	38.02	13.53	52.57	18.15	45.30	15.84
N_4 : 125 Kg ha^{1}	43.41	15.78	56.16	20.45	49.91	18.11
S.Em ±	1.32	0.50	0.99	0.51	0.74	0.31
CD @ 5%	3.87	1.46	2.90	1.49	2.18	0.92
Phosphorus levels (P)						
P_1 : 50 Kg ha^{-1}	32.78	11.51	48.93	16.64	40.86	14.07
P_2 : 75 Kg ha^{-1}	39.90	14.10	53.47	18.55	46.79	16.33
P_3 : 100 Kg ha^{-1}	35.79	12.85	50.79	18.14	43.28	15.49
S.Em ±	1.14	0.43	0.86	0.44	0.64	0.27
CD @ 5%	3.35	1.26	2.51	1.29	1.89	0.80
Interaction (NXP)						
N_1 P_1	26.98	9.17	43.35	13.43	35.16	11.30
N_1 P_2	31.55	11.20	46.94	15.62	39.25	13.41
N_1 P_3	29.81	10.11	47.61	16.11	38.71	13.11
N_2 P_1	30.42	12.46	48.31	16.44	39.37	14.45
N_2 P_2	38.52	12.39	51.24	18.19	44.88	15.29
N_2 P_3	32.35	10.59	49.07	17.70	40.71	14.15
N_3 P_1	32.96	10.71	50.78	17.73	41.87	14.22
N_3 P_2	43.22	15.11	55.56	18.93	49.39	17.02
N_3 P_3	37.89	14.78	51.39	17.80	44.64	16.29
N_4 P_1	40.78	13.71	53.28	18.94	47.03	16.33
N_4 P_2	46.33	17.70	60.13	21.47	53.65	19.58
N_4 P_3	43.13	15.92	55.07	20.94	49.04	18.43
S.Em ±	2.29	0.86	1.71	0.88	1.29	0.54
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 4: Effect of nitrogen and phosphorus levels on fresh and dry herb weight plot^{-1} in kalmegh (*Andrographis paniculata* Nees.)

Treatments	*Rabi* -2019		*Rabi*- 2020		Pooled data	
	Fresh wt of herb plot^{-1} (kg)	Dry wt of herb plot^{-1} (kg)	Fresh wt of herb plot^{-1} (kg)	Dry wt of herb plot^{-1} (kg)	Fresh wt of herb plot^{-1} (kg)	Dry wt of herb plot^{-1} (kg)
Nitrogen levels (N)						
N_1 : 50 Kg ha^{-1}	2.94	1.02	4.60	1.51	3.77	1.26
N_2 : 75 Kg ha^{-1}	3.38	1.18	4.95	1.74	4.17	1.46
N_3 : 100 Kg ha^{-1}	3.80	1.35	5.26	1.82	4.53	1.58
N_4 : 125 Kg ha^{1}	4.37	1.58	5.62	2.05	4.99	1.81
S.Em ±	0.13	0.05	0.10	0.05	0.07	0.03
CD @ 5%	0.39	0.15	0.29	0.15	0.22	0.09
Phosphorus levels (P)						
P_1 : 50 Kg ha^{-1}	3.28	1.15	4.89	1.66	4.09	1.41
P_2 : 75 Kg ha^{-1}	4.01	1.41	5.35	1.86	4.68	1.63
P_3 : 100 Kg ha^{-1}	3.58	1.29	5.08	1.81	4.33	1.55
S.Em ±	0.11	0.04	0.09	0.04	0.06	0.03
CD @ 5%	0.34	0.13	0.25	0.13	0.19	0.08
Interaction (NXP)						
N_1 P_1	2.70	0.92	4.34	1.34	3.52	1.13
N_1 P_2	3.16	1.12	4.69	1.56	3.92	1.34
N_1 P_3	2.98	1.01	4.76	1.61	3.87	1.31
N_2 P_1	3.04	1.25	4.83	1.64	3.94	1.45
N_2 P_2	3.85	1.24	5.12	1.82	4.49	1.53
N_2 P_3	3.24	1.06	4.91	1.77	4.07	1.41
N_3 P_1	3.30	1.07	5.08	1.77	4.19	1.42
N_3 P_2	4.32	1.51	5.56	1.89	4.94	1.70
N_3 P_3	3.79	1.48	5.14	1.78	4.46	1.63
N_4 P_1	4.08	1.37	5.33	1.89	4.70	1.63
N_4 P_2	4.72	1.77	6.01	2.15	5.36	1.96
N_4 P_3	4.30	1.59	5.51	2.09	4.90	1.84
S.Em ±	0.23	0.09	0.17	0.09	0.13	0.05
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 5: Effect of nitrogen and phosphorus levels on fresh and dry weight of herb per hactere in kalmegh (*Andrographis paniculata* Nees.)

Treatments	*Rabi* -2019		*Rabi*- 2020		Pooled data	
	Fresh wt of herb ha^{-1} (t ha^{-1})	Dry wt of herb ha^{-1} (t ha^{-1})	Fresh wt of herb ha^{-1} (t ha^{-1})	Dry wt of herb ha^{-1} (t ha^{-1})	Fresh wt of herb ha^{-1} (t ha^{-1})	Dry wt of herb ha^{-1} (t ha^{-1})
Nitrogen levels (N)						
N_1 : 50 Kg ha^{-1}	6.54	2.26	10.22	3.34	4.94	2.80
N_2 : 75 Kg ha^{-1}	7.50	2.63	11.01	3.88	5.69	3.25
N_3 : 100 Kg ha^{-1}	8.45	3.01	11.68	4.03	6.24	3.52
N_4 : 125 Kg ha^{1}	9.70	3.51	12.48	4.54	7.12	4.03
S.Em ±	0.30	0.11	0.22	0.11	0.15	0.07
CD @ 5%	0.87	0.32	0.64	0.33	0.43	0.20
Phosphorus levels (P)						
P_1 : 50 Kg ha^{-1}	7.29	2.56	10.87	3.70	5.49	3.13
P_2 : 75 Kg ha^{-1}	8.91	3.13	11.88	4.12	6.52	3.63
P_3 : 100 Kg ha^{-1}	7.95	2.86	11.29	4.03	5.99	3.44
S.Em ±	0.26	0.10	0.19	0.10	0.13	0.06
CD @ 5%	0.75	0.28	0.56	0.29	0.37	0.18
Interaction (NXP)						
N_1 P_1	6.00	2.04	9.63	2.99	4.49	2.51
N_1 P_2	7.01	2.49	10.43	3.47	5.24	2.98
N_1 P_3	6.62	2.25	10.58	3.58	5.10	2.91
N_2 P_1	6.76	2.77	10.74	3.65	5.21	3.21
N_2 P_2	8.56	2.75	11.39	4.04	6.30	3.40
N_2 P_3	7.19	2.35	10.90	3.93	5.56	3.14
N_3 P_1	7.32	2.38	11.28	3.94	5.63	3.16
N_3 P_2	9.60	3.36	12.35	4.21	6.91	3.78
N_3 P_3	8.42	3.28	11.42	3.95	6.19	3.62
N_4 P_1	9.06	3.05	11.84	4.21	6.64	3.63
N_4 P_2	10.48	3.93	13.36	4.77	7.63	4.35
N_4 P_3	9.56	3.54	12.24	4.65	7.11	4.10
S.Em ±	0.51	0.19	0.38	0.20	0.25	0.12
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 6: Economics of nitrogen and phosphorus levels in kalmegh (*Andrographis paniculata* Nees.) during 2019 and 2020

Treatments	Dry herb Yield (t/ha)		Cost of Cultivation (Rs. per ha)		Gross Returns (Rs. per ha)		Net Returns (Rs. per ha)		B:C Ratio	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
T_1	2.04	2.99	67951.22	76051.22	101852	155243.75	33900.63	79192.53	1.50	2.04
T_2	2.49	3.47	68726.23	76826.23	124469	180455.41	55742.90	103629.18	1.81	2.35
T_3	2.25	3.58	69506.21	77606.21	112383	186102.22	42876.51	108496.01	1.62	2.40
T_4	2.77	3.65	68271.12	76371.12	138481	189947.65	70210.36	113576.53	2.03	2.49
T_5	2.75	4.04	69046.13	77146.13	137654	210220.34	68608.19	133074.21	1.99	2.72
T_6	2.35	3.93	69821.14	77921.14	117654	204559.01	47833.18	126637.88	1.69	2.63
T_7	2.38	3.94	70136.06	78236.06	119012	204918.52	48876.28	126682.45	1.70	2.62
T_8	3.36	4.21	69361.06	77461.06	167901	218720.99	98540.18	141259.93	2.42	2.82
T_9	3.28	3.95	70136.06	78236.06	164198	205637.53	94061.47	127401.47	2.34	2.63
T_{10}	3.05	4.21	68906.81	77006.81	152346	218849.38	83438.87	141842.57	2.21	2.84
T_{11}	3.93	4.77	69681.82	77781.82	196667	248059.26	126984.85	170277.44	2.82	3.19
T_{12}	3.54	4.65	70456.82	78556.82	176914	242024.69	106456.76	163467.87	2.51	3.08

Treatment combinations (A X B)	
T_1 – (N1 P1) – 50 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}	T_7– (N3 P1) – 100 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_2 – (N1 P2) – 50 kg Nitrogen ha-^{1} + 75 kg Phosphorus ha-^{1}	T_8– (N3 P2) – 100 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_3 – (N1 P3) – 50 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha-^{1}	T_9– ((N3 P3) – 100 kg Nitrogen ha-^{1} + 100 kg Phosphorus ha^{-1}
T_4 – (N2 P1) – 75 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha-^{1}	T_{10}– (N4 P1) – 125 kg Nitrogen ha^{-1} + 50 kg Phosphorus ha^{-1}
T_5 – (N2 P2) – 75 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}	T_{11}– (N4 P2) – 125 kg Nitrogen ha^{-1} + 75 kg Phosphorus ha^{-1}
T_6 – (N2 P3) – 75 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}	T_{12}– (N4 P3) – 125 kg Nitrogen ha^{-1} + 100 kg Phosphorus ha^{-1}
Note: Recommended dose of FYM @ 25 t and 50 kg potassium per hectare was applied equally to all the treatments.	
Factor A: Nitrogen levels	Factor B: Phosphorus levels
N1 : 50 kg ha^{-1} Nitrogen	P1 : 50 kg ha^{-1} Phosphorus
N2 : 75 kg ha^{-1} Nitrogen	P2 : 75 kg ha^{-1} Phosphorus
N3 : 100 kg ha^{-1} Nitrogen	P3 : 100 kg ha^{-1} Phosphorus
N4 : 125 kg ha^{-1} Nitrogen	

Note: Market Price in Rs per t: 50000(2019) and 52000 (2020)

Conclusion

The findings from the current study highlight that, the application of nitrogen at 125 kg ha^{-1} along with application of phosphorous at 75 kg ha^{-1} is favorable for getting higher herbage yield and net returns in Kalmegh. This outcome holds significance for cultivating Kalmegh in the northern dry zone of Karnataka, emphasizing the positive impact of this specific nutrient management approach on the plant's overall development.

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