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EFFECT OF INTEGRATED NITROGEN MANAGEMENT AND SPACING ON GROWTH PARAMETERS OF KALMEGH (*ANDROGRAPHIS PANICULATA*)

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ABSTRACT

A field experiment entitled "Effect of integrated nitrogen management and spacing on growth parameters of Kalmegh (*Andrographis paniculata*)" were conducted during the kharif season of 2024-25 at AICRP on Medicinal, Aromatic Plants and Betelvine, Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in a factorial randomized block design with four nitrogen sources: 75% N through vermicompost + 25% RDN through inorganic fertilizer, 50% N through vermicompost + 50% RDN through inorganic fertilizer, 100% N through vermicompost, and 100% RDN through inorganic fertilizer, and three plant spacings (20 × 20 cm, 30 × 10 cm, and 30 × 15 cm), replicated thrice. Results indicated that application of 100% RDN through inorganic fertilizer recorded the maximum plant height (47.49 cm) and number of branches per plant (14.33), which was statistically at par with 50% N through vermicompost + 50% RDN. Among plant geometries, closer spacing (20 × 20 cm) resulted in taller plants, while wider spacing (30 × 15 cm) significantly enhanced branching. The interaction effects were non-significant. The study suggests that integrated nitrogen management combined with appropriate plant spacing can effectively improve vegetative growth of Kalmegh under rainfed conditions.

Keywords: Kalmegh, Growth,Vermicompost, Inorganic fertilizer.

Introduction

Andrographis paniculata is a valuable medicinal plant widely utilized in traditional healing systems such as Ayurveda, Unani, and Siddha, primarily due to its active compound, andrographolide. One of this group's most significant medicinal plant is Andrographis paniculata Nees, commonly known as Kalmegh .Kalmegh (Andrographis paniculata Burm.F Nees) is a bitter-taste annual herb from the Acanthaceae family, often called the "king of bitter." Improving dry matter accumulation in Kalmegh is crucial for increasing both yield and medicinal efficacy. Key agronomic practices, particularly nitrogen management and optimal plant spacing, play a significant role in influencing its growth and productivity. The adoption of integrated nitrogen management (INM), which involves the combined use of organic and inorganic nitrogen sources, has been shown to boost nutrient availability, enhance soil fertility, and support sustainable crop production (Shelke *et al*., 2024).

The proper plant spacing improves light penetration and air circulation, reduces competition, and increases dry matter yield (Shahjahan *et al*., 2013). A plant spacing of 30 cm × 15 cm significantly enhanced growth parameters, resulting in the highest number of branches (28), plant height (60 cm), and plant spread (45 cm), indicating better utilization of space and resources under optimal plant density. Likewise, a row spacing of 30 cm, when combined with suitable nitrogen levels, led to the highest seed yield herbage yield (25.43 g/plant), which was

attributed to improved radiation use efficiency and increased dry matter production. These findings collectively suggest that appropriate plant spacing and nitrogen management favors enhanced vegetative growth and biomass accumulation in Kalmegh (Singh *et al*., 2011; Patidar *et al*., 2011).

Material and Methods

The experiment entitled "Effect of integrated nitrogen management and spacing on growth parameters of Kalmegh (Andrographis paniculata)" was carried out during *kharif* season of 2024-25 at AICRP on Medicinal, Aromatic Plants and Betelvine, Nagarjun Medicinal Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola .The The site is situated in the subtropical region at 20^0 40' 35" North latitude and 76^0 59' 10" East longitude and at an altitude of 307.42 m above mean sea level with average annual precipitation was 750-950 mm. The site for experiment was clayey (52.00 % clay) in texture. The fertility status of soil was low in available N (183 kg ha^{-1}) and medium in available P_2O_5 (21 kg ha^{-1}) and K_2O (349 kg ha^{-1}). During *Kharif* 2024-25 total rainfall of 955.1 mm was received in 44 rainy days, during crop growth period which was 31% more than normal. In the beginning, less rainfall caused delay and poor germination of Kalmegh seeds. Later, heavy rains in during early growth stage slowed down seedling development due to waterlogging. As the season continued, rainfall and weather conditions became favorable, helping in good plant stand and healthy growth. Adequate moisture, along with normal temperature and humidity, supported better leaf formation, branching, and plant height. This improved photosynthesis and helped increase the dry foliage yield. Although no rain was received at the end, timely harvest just after initiation of flowering resulted in overall good crop performance. The experiment was laid out in a factorial randomized block design with four nitrogen source treatments (N_1:75% vermicompost + 25% RDN through inorganic fertilizer; N_2: 50% vermicompost + 50% RDN through inorganic fertilizer; N_3: 100% vermicompost; N_4: 100% RDN through inorganic fertilizer) and three plant spacing (S_1: 20×20 cm, S_2: 30×10 cm, S_3: 30×15 cm), replicated thrice, involving twelve treatment combinations. In the present study, the recommended dose of fertilizers (RDF) was 80:50:30 kg $N:P_2O_5:K_2O$ ha^{-1}. In treatments involving inorganic fertilizers, 50% of nitrogen along with the full dose of phosphorus and potassium was applied as a basal dose at the time of transplanting, while the remaining 50% nitrogen was top-dressed at 30 days after transplanting (DAT). The sources of fertilizers used were urea for nitrogen, single super phosphate (SSP) for phosphorus, and muriate of potash (MOP) for potassium. The seeds were sown in nursery raised on raised beds. The healthy and disease free seedlings were transplanted at 50 days after sowing (DAS) when it attains 8-10 cm height. The crop was harvested during last week of November after initiation of first flower in Kalmegh crop.

Results and Discussion

Growth parameters

Plant height (cm)

The data on plant height at various stages of crop growth (15, 30, 45, 60, 75 DAT and at harvest) as influenced by different nitrogen sources and plant geometry are presented in Table No:1 Plant height was significantly influenced by the source of nitrogen at all growth stages. The maximum plant height at harvest was recorded under 100 % RDN through inorganic fertilizer(N_4) with 47.49 cm, which was statistically superior to all other nitrogen treatments. This was followed by 50% N through vermicompost + 50% RDN through inorganic fertilizer(N_2) with 45.98 cm, which was at par with N_4 and the next best treatment was N_1 with 43.11 cm, while the lowest plant height was observed in N_3 with 41.97 cm.

This trend was consistent throughout the crop stages, indicating that a full dose of inorganic nitrogen (N_4) provided readily available nutrients for faster vegetative growth, especially in the early stages. However, the integrated nutrient management approach in 50% N through vermicompost + 50% RDN through inorganic fertilizer(N_2) also showed a beneficial effect on plant height, likely due to the combined effect of quick nutrient release from inorganic fertilizers and slow-release, long-term nutrient supply from vermicompost. These results were in agreement with the findings of Verma *et al.* (2018) and Tiwari *et al*., (2012).

Plant geometry (spacing) also significantly influenced plant height from 30 DAT onwards. At harvest, the highest plant height was recorded in S_1 (20 × 20 cm) with 47.18 cm, which was at par with S_2 (30 × 10 cm) recording 44.32 cm the lowest plant height was observed in S_3 (30 × 15 cm) with 42.42 cm.The taller plants under S_1 could be attributed to increased intra-row competition due to closer spacing, which likely induced vertical growth in plants in search of light. In contrast, the wider spacing in S_3 may have promoted more lateral branching and less vertical elongation, resulting in slightly shorter plants. These

results were in agreement with the findings of Makwana *et al*., (2010) and Patidar *et al*., (2011)

The interaction effect between nitrogen sources and plant geometry on plant height was non-significant at all growth stages, including harvest.

Number of branches (plant^{-1})

The data on number of branches at various stages of crop growth (15, 30, 45, 60, 75 DAT and at harvest) as influenced by different nitrogen sources and plant geometries are presented in Table2.

The results revealed that there were no branches to Kalmegh crop at 15 and 30 DAT. The number of branches plant^{-1} was significantly influenced by the nitrogen source at all growth stages. At harvest, the maximum number of branches was recorded under the treatment 100 % RDN through inorganic fertilizer (N_4) with 14.33, which was statistically superior to all other treatments. This was followed by 50% N through vermicompost + 50% RDN (N_2) with 13.67 branches, which was at par with N_4 and the lowest number was recorded under N_3 (100% N through vermicompost) with 11.00 branches plant^{-1}.

The results suggest that the complete use of inorganic nitrogen (N_4) stimulated better vegetative growth and branching. However, the integrated nutrient supply through 50% N through vermicompost + 50% RDN (N_2) also proved beneficial, likely due to the combined effect of immediate and sustained nutrient availability through both organic and inorganic sources. These results were in agreement with the findings of Shrivastava *et al*., (2011) and Panwar *et al*., (2017).Plant spacing had a significant effect on the number of branches plant^{-1} at all growth stages. At harvest, the highest number of branches was recorded under S_3 (30x15 cm) with 14.08 branches, followed by S_2 (30x10 cm) recorded 12.17 branches, and lowest no. of branches was recorded in S_1 (20 x 20 cm) with 11.33 branches. The increase in the number of branches under wider spacing (S_3) can be attributed to reduced competition for light, nutrients, and space, allowing the plants to develop more lateral growth and secondary branches. These findings emphasize that wider spacing supports increased branching in Kalmegh, likely enhancing its canopy structure and possibly biomass yield per plant. These results were in agreement with the findings of Singh *et al.,* (2011) and Ram *et al*., (2008) .

The interaction effect between nitrogen sources and spacing on the number of branches plant^{-1} was non-significant across all growth stages and at harvest.

Table 1 : Plant Height as influenced by nitrogen sources and plant geometry in Kalmegh

Treatments	Plant Height (cm)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	At harvest
Factor A: Sources of N applications						
N1: 75 N through vermicompost + 25% RDN through inorganic fertilizer	11.44	16.30	32.62	40.29	41.26	43.11
N2: 50% N through vermicompost + 50% RDN through inorganic fertilizer	12.33	18.31	33.89	42.67	43.72	45.98
N3: 100% N through vermicompost	11.11	15.00	30.12	37.02	39.72	41.97
N4: 100 % RDN through inorganic fertilizer	12.99	19.33	34.99	44.11	45.44	47.49
SE (m) ±	**0.38**	**0.56**	**0.89**	**1.45**	**1.05**	**1.16**
CD at 5 %	**1.10**	**1.65**	**2.61**	**4.26**	**3.09**	**3.39**
Factor B : Spacing						
S1: 20x20 cm	12.55	18.42	34.33	43.47	44.38	47.18
S2: 30x10 cm	11.85	16.83	33.00	41.28	42.94	44.32
S3: 30x15 cm	11.51	16.46	31.39	38.32	40.29	42.42
SE (m) ±	**0.33**	**0.49**	**0.77**	**1.26**	**0.91**	**1.00**
CD at 5 %	**NS**	**1.43**	**2.26**	**3.69**	**2.68**	**2.93**
Int. (N X S)						
SE (m) ±	**0.65**	**0.97**	**1.54**	**2.52**	**1.83**	**2.00**
CD at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV %	**9.42**	**9.78**	**8.10**	**10.63**	**7.44**	**7.76**
GM	**11.97**	**17.24**	**32.91**	**41.02**	**42.54**	**44.64**

Table 2: Number of Branches per plant as influenced by nitrogen sources and plant geometry in Kalmegh

Treatments	No. of branches plant^{-1}			
	45 DAT	60 DAT	75 DAT	At harvest
Factor A : Sources of N applications				
N1: 75% N through vermicompost + 25% RDN through inorganic fertilizer	5.00	8.56	10.78	11.11
N2**:** 50% N through vermicompost + 50% RDN through inorganic fertilizer	5.33	9.22	12.67	13.67
N3**:** 100% N through vermicompost	3.33	8.00	10.33	11.00
N4**:** 100 % RDN through inorganic fertilizer	6.33	10.44	13.56	14.33
SE (m) ±	**0.20**	**0.35**	**0.34**	**0.48**
CD at 5 %	**0.58**	**1.03**	**1.01**	**1.41**
Factor B: Spacing				
S1: 20x20 cm	4.58	7.92	10.58	11.33
S2: 30x10 cm	5.00	8.75	11.58	12.17
S3: 30x15 cm	5.42	10.50	13.33	14.08
SE (m) ±	**0.17**	**0.30**	**0.30**	**0.42**
CD at 5 %	**0.50**	**0.89**	**0.88**	**1.22**
Int. (N X S)				
SE (m) ±	**0.34**	**0.61**	**0.60**	**0.83**
CD at 5 %	**NS**	**NS**	**NS**	**NS**
CV %	**11.89**	**11.60**	**8.73**	**11.51**
GM	**5.00**	**9.06**	**11.83**	**12.53**

Conclusion

The results of present investigation revealed that both nitrogen management and plant geometry significantly influenced the growth parameters (plant height and Number of branches) of Kalmegh (Andrographis paniculata). Application of 100% recommended nitrogen through inorganic fertilizer recorded the highest plant height and number of branches, while integrated nutrient management with 50% nitrogen through vermicompost and 50% RDN performed comparably, indicating a beneficial synergy between readily available and sustained nitrogen supply. Plant spacing significantly affected plant architecture, with wider spacing (30 × 15 cm) promoting greater branching due to reduced competition, whereas closer spacing (20 × 20 cm) resulted in taller plants because of increased intra-plant competition. The interaction between nitrogen sources and spacing was non-significant, suggesting their independent influence on crop growth

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