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IMPACT OF ORGANIC MANURE AND SPACING OF MORPHOLOGICAL FEATURES OF *ANDROGRAPHIS PANICULATA (BURN. F.) WALL. EX* NEES

Ram Babu Choudhary[1], Kanica Upadhyay[1], S.B.S. Pandey[2], Anju S. Vijayan [1], V.C. Prahlad[2], Anchal Sharma[3] and Arathi Chandran[1]

[1]Department of Forest Products and Utilization, College of Horticulture and Forestry, Jhalawar (Agriculture University, Kota), 326023, India.
[2]Department of Silviculture and Agroforestry, College of Horticulture and Forestry, Jhalawar (Agriculture University, Kota), 326023, India.
[3]Department of Wildlife Management, College of Horticulture and Forestry, Jhalawar (Agriculture University, Kota), 326023, India.

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ABSTRACT

Andrographis paniculata widely used in both Ayurvedic and Unani system of medicines because of its immunological, hepatoprotective and antibacterial properties. This investigation was carried out to study the influence of different spacing (30×15 cm, 30×30 cm, 30×45 cm) and application of various organic manures (vermicompost @ 15 t/ha, vermicompost @ 25t/ha, FYM @ 15 t/ha and FYM @ 25t/ha) on the morphological features of Kalmegh, variety 'cim-megha'. The field experiment was conducted at college of Horticulture and Forestry Jhalrapatan Jhalawar (Raj) during kharif season of the year 2023-24. The treatments were laid out in Factorial randomized block design (FRBD) with three replications and with 15 treatment combinations. The morphological characters such as plant height, number of branches per plant and number of leaves per plant were studies at the intervals of 30, 60, 90 and 120 days after transplanting (DAT) and also at time harvest. The highest plant height (16.30, 30.57, 33.87, 50.67, and 53.60 cm at 30, 60, 90 and 120 DAT and at harvest respectively) was obtained with the treatment of vermicompost @ 25 t/ha along with spacing of 30x15 cm and maximum number of branches (3.7, 4.66, 7, 10.4, and 13.1 at 30, 60, 90 and 120 DAT and at harvest respectively) and leaves per plant (29.3, 60.3, 86.3, 92.3, and 94 at 30, 60, 90 and 120 DAT and at harvest respectively) was recorded for the plants treated with vermicompost @ 25 t/ha and spacing 30×45 cm.

***Key words*:** Kalmegh, vermicompost, FYM, spacing.

Introduction

Andrographis paniculata (*Burn. f.*) wall. ex Nees commonly known as Kalmegh, green chiretta or king of bitters, is an annual herb belongs to family Acanthaceae and is native to India and Sri Lanka (Niranjan *et al.*, 2005). It is widely cultivated in South and East Asia, for its medicinal properties due to the presence of diterpene lactone and Andrographolide (Mishra *et al.*, 2007). In shaded areas, the plant grows as an upright herb up to a height of 30-110 cm and is composed of thin, dark green stem with longitudinal furrows in a square cross section. The lance-shaped leaves can reach 8 cm width and 2.5cm in length. The flowers are in the form of panicles or loose racemes of pink while, the fruit is a capsule that is of few millimeters in breadth and approximately 2 cm in length.

Kalmegh is well known for its medical properties as it is a blood purifier and used to curate leprosy, boils, skin eruptions, and chronic and seasonal fevers. The fresh and dried leaves of Kalmegh and herbal juice are commonly used medical drugs. The increased utilization of Kalmegh from wild resources caused sharp decline in the availability of this herb to industry. The cultivation of Kalmegh as medicinal crop with standardized agro techniques can meet the availability of the drug. However, improper nutrient management and poor returns to the farmers became the constrains for the production of

Table 1: Effect of different treatments and their interactions on Plant height (cm).

	Plant Height (30 days)				Plant Height (60 days)				Plant Height (90 days)				Plant Height (120 days)				Plant Height (At harvest)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_0	14.47	12.83	11.13	12.81	26.67	25.47	24.77	25.63	31.87	29.57	27.67	29.70	48.63	46.77	45.67	47.02	50.07	49.07	47.43	48.86
M_1	15.03	13.67	12.80	13.83	28.53	27.27	25.60	27.13	32.33	30.00	29.87	30.73	49.17	48.17	47.73	48.36	52.97	50.83	50.57	51.46
M_2	16.30	15.39	13.13	14.94	30.57	28.20	28.50	29.09	33.87	31.80	31.00	32.22	50.67	50.10	48.20	49.66	53.60	52.73	51.77	52.70
M_3	15.40	13.83	11.90	13.71	28.67	27.67	25.83	27.39	32.23	30.40	28.67	30.43	49.63	48.30	47.27	48.40	52.53	51.47	49.83	51.28
M_4	16.30	15.27	13.23	14.93	30.23	28.20	28.73	29.06	33.80	31.90	30.63	32.11	50.53	49.63	48.73	49.63	53.00	52.50	51.20	52.23
Mean	15.50	14.20	12.44		28.93	27.36	26.69		32.82	30.73	29.57		49.73	45.67	47.52		52.43	51.32	50.16	
	SE	$CD_{0.05}$			**SE**	$CD_{0.05}$		**SE**	$CD_{0.05}$			**SE**	$CD_{0.05}$			**SE**	$CD_{0.05}$			
Spacing	0.25	0.52			0.25	0.52		0.35	0.73			0.21	0.43			0.17	0.34			
Manure	0.33	0.67			0.33	0.67		0.46	0.94			0.27	0.56			0.21	0.44			
S×M	NS	NS			NS	NS		NS	NS			NS	NS			NS	NS			

M_0: M_0 (control); **M_1:** M_1(Vermicompost @ 15 t ha^{-1}); **M_2:** M_2(Vermicompost @ 25 t ha^{-1}); **M_3:** M_3 (FYM @ 15 t ha^{-1}); **M_4:** M_4 (FYM @ 25 t ha^{-1}); **S_1:** (30×15); **S_2:** (30×30); **S_3:** (30×45); **S×M:** Interaction between 2 factors

Kalmegh (Swetha *et al*., 2021). Planting of crops with proper spacing and nutrient management can promote the growth and yield of Kalmegh (Chandana *et al*., 2018). Use of organic manure provides several benefits to the growers. It reduces production costs and it is an environmentally friendly method of cultivation. Soil fertility and biological properties also improved with the application of organic sources, particularly FYM and Vermicompost. Spacing is an important factor for better growth and yield of the plant. Optimum number of plants is required per unit area to utilize efficiently the available production factors such as water, nutrient, light and CO_2. Thus, keeping in view the potentialities of pant spacing and organic manures for enhanced growth in Kalmegh, the present investigation was undertaken with the objective to study the effect of organic manure and plant spacing on the morphological characteristics of Kalmegh.

Material and Methods

Plant material

Kalmegh seed of the variety 'cim-megha' was collected from CIMAP-Lucknow, Uttar Pradesh for the sowing purpose in this field experiment.

Experimental site

The field experiment was conducted at college of Horticulture and Forestry Jhalrapatan Jhalawar (Raj) during kharif season of the year 2023-24 to study the effect of organic manure and spacing of morphological features of Kalmegh. The institute is situated in the south-Eastern part of Rajasthan at North latitude of 23° 45' to 24° 52' and 75° 29' to 76° 56' East longitudes and an altitude of 131.14 meters above mean sea level. The soil of the experimental site was black cotton soil having pH 7.33, EC 0.31 dsm^{-1}, high available nitrogen (287.25kg/ha), high available phosphorus (28.87kg/ha) and high available potassium (232.73kg/ha).

Experimental Design and Details of treatments

The experiment was laid out in Factorial randomized block design (FRBD) in three replications with 15 treatment combinations comprised of five levels of organic treatments M_0 -Control, M_1- Vermicompost @ 15 t/ha, M_2 - Vermicompost @ 25t/ha, M_3-FYM @ 15t/ha, M_4-FYM @ 25t/ha three levels of spacing S_1-30×15 cm, S_2-30×30 cm, S_3-30×45 cm. The treatment combinations include M_0S_1 (Control with Spacing 30×15cm), M_0S_2 (Control With Spacing 30×30cm), M_0S_3 (Control with Spacing 30×45 cm), M_1S_1 (Vermicompost @ 15 t with Spacing 30×15cm), M_1S_2 (Vermicompost @ 15 t with Spacing 30×30 cm), M_1S_3 (Vermicompost @15 t with Spacing 30×45 cm) , M_2S_1(Vermicompost @ 25 t with Spacing 30×15 cm) , M_1S_2 (Vermicompost @ 25 t

Table 2: Effect of different treatments and their interactions on number of branches (plant^{-1}).

	No. of branches (30 days)				No. of branches (60 days)				No. of branches (90 days)				No. of branches (120 days)				No. of branches (At harvest)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_0	1.0	2.3	3.0	2.1	2.66	2.96	3.33	2.98	3	4	5	4	6.43	7.36	8.56	7.45	8.33	9.66	10.3	9.44
M_1	1.7	2.7	3.3	2.6	3	3.36	4	3.45	4.33	4.33	6	4.88	7.2	9.03	9	8.41	8.66	10.3	11.3	10.1
M_2	2.0	3.0	3.7	2.9	3.56	3.83	4.66	4.02	5	5.33	7	5.77	8.53	8.83	10.3	9.24	10	11.8	13	11.6
M_3	1.7	2.7	3.3	2.6	2.66	3.43	4	3.36	4.76	4.6	5.66	5.01	7.16	9.26	9.23	8.55	9	10.3	11.8	10.3
M_4	2.3	3.0	3.7	3.0	3.73	3.9	4.66	4.1	5.3	5.5	7	5.93	8.63	8.93	10.4	9.34	9.66	11.3	13.1	11.3
Mean	1.7	2.7	3.4		3.12	3.5	4.13		4.48	4.75	6.13		7.59	8.68	9.52		9.13	10.67	11.9	
	SE	$CD_{0.05}$			**SE**	$CD_{0.05}$			**SE**	$CD_{0.05}$			**SE**	$CD_{0.05}$			**SE**	$CD_{0.05}$		
Spacing	0.31	0.64			0.21	0.43		0.37	0.77			0.12	0.25			0.27	0.57			
Manure	NS	NS			0.27	0.56		0.48	0.99			0.16	0.33			0.36	0.74			
S×M	NS	NS			NS	NS		NS	NS			0.27	0.57			NS	NS			

M_0: M_0 (control); **M_1:** M_1(Vermicompost @ 15 t ha^{-1}); **M_2:** M_2(Vermicompost @ 25 t ha^{-1}); **M_3:** M_3 (FYM @ 15 t ha^{-1}); **M_4:** M_4 (FYM @ 25 t ha^{-1}); **S_1:** (30×15); **S_2:** (30×30); **S_3:** (30×45); **S×M:** Interaction between 2 factors

with Spacing 30×30 cm), M_2S_3 (Vermicompost @ 25 t with Spacing 30×45 cm), M_3S_1(FYM @ 15 t with Spacing 30×15 cm), M_3S_2(FYM @ 15 t with Spacing 30×30 cm), M_3S_3(FYM @ 15 t with Spacing 30×45 cm), M_4S_1(FYM @ 25 t with Spacing 30×15 cm), M_4S_2 (FYM @ 25 t with Spacing 30×30 cm) and M_4S_3 (FYM @ 25 t with Spacing 30×45 cm).

Observations

The morphological characters such as plant height (cm), number of branches per plant, number of leaves per plant at an interval of 30, 60, 90 and 120 days after transplanting (DAT) and also at harvest were recorded. The plant height of five plants were selected randomly from each plot and were measured. The height was measured from the ground level to the tip of the main shoot with the help of metre scale. The average was calculated and expressed in cm. For measuring Number of leaves and branches per plant, a total number of fully developed and functional leaves and primary & secondary branches bearing pairs of fully developed leaves of five randomly selected plants each plot were counted and mean value was calculated for individual plant.

Result and Discussion

The results indicated a significant impact of organic manure application and spacing on plant height throughout different growth stages (Table 1 & Fig. 1). Maximum plant heights (14.94, 29.09, 32.22, 49.66, and 52.70 cm) were achieved in the M_2 treatment with vermicompost applied at 25 t ha^{-1}. In contrast, minimum plant heights (12.81, 25.63, 29.70, 47.02, and 48.86 cm) were recorded in the control treatment (M_0) at 30, 60, 90, 120 days after transplanting (DAT), and at harvest, respectively. Regarding spacing, the closest spacing of S_1 (30 × 15 cm) produced the highest plant heights (15.50, 28.93, 32.82, 49.73, and 52.43 cm), while the widest spacing of S3 (30 × 45 cm) yielded the lowest heights (12.44, 27.37, 29.81, 47.65, and 50.16 cm). For combined treatments, the M_2S_3 combination (vermicompost at 25 t ha^{-1} with 30

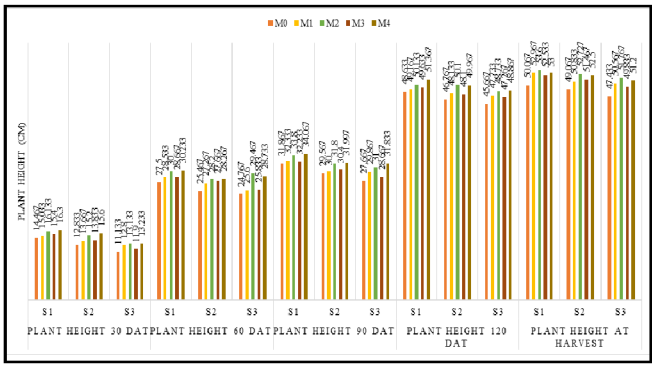

Fig.1: Plant height (cm) at different treatments and their interactions.

Table 3: Effect of different treatments and their interactions on Number of leaves (plant^{-1}).

	No. of leaves (30 days)				No. of leaves (60 days)				No. of leaves (90 days)				No. of leaves (120 days)				No. of leaves (At harvest)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
M_0	11.6	22.6	18	17.4	32	38	49.3	39.7	60.6	67	70.3	66	68	70.6	75.3	71.3	70.3	72.6	77	73.3
M_1	12.6	21.3	24	19.3	36	39	55.3	43.4	70.3	74	76.3	73.5	74.6	78	84	78.8	76	80.3	86	80.7
M_2	18	22.3	29.3	23.2	40.6	40.3	60.3	47.1	75	82.6	86.3	81.3	78.3	87.3	92.3	86	80	88.6	94	87.5
M_3	16.3	21	26	21.1	46.6	46	58	50.2	68.3	80	82.3	76.8	77	84.3	86.3	82.5	79.3	84.3	87.6	83.7
M_4	17	18.6	24	19.8	42	45.3	58	48.4	74.3	81.3	85	80.2	75.6	86	91.3	84.3	78.3	87	92.6	86
Mean	15.1	21.2	24.2		39.4	41.7	56.2		69.7	77	80.0		74.7	81.2	85.8		76.8	82.6	87.4	
	SE	**$CD_{0.05}$**			**SE**	**$CD_{0.05}$**			**SE**	**$CD_{0.05}$**			**SE**	**$CD_{0.05}$**			**SE**	**$CD_{0.05}$**		
Spacing	0.67	1.37			0.80	1.65			0.91	1.66			1.15	1.87			2.36			
Manure	0.86	1.77			1.04	2.13			1.18	2.15			1.48	2.42			3.04			
S×M	1.49	3.07			1.80	3.69			NS	NS			NS	NS			NS	NS		

M_0: M_0 (control); **M_1:** M_1(Vermicompost @ 15 t ha^{-1}); **M_2:** M_2(Vermicompost @ 25 t ha^{-1}); **M_3:** M_3 (FYM @ 15 t ha^{-1}); **M_4:** M_4 (FYM @ 25 t ha^{-1}); **S_1:** (30×15); **S_2:** (30×30); **S_3:** (30×45); **S×M:** Interaction between 2 factors

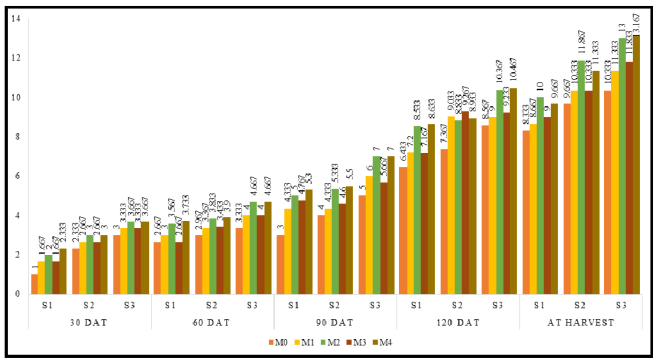

Fig. 2: Number of branches (plant^{-1}) at different treatments and their interactions.

× 15 cm spacing) recorded the highest plant heights (16.30, 30.57, 33.87, 50.67, and 53.60 cm), whereas the M_0S_1 combination (control with 30 × 15 cm spacing) had the lowest (11.13, 24.77, 27.67, 45.67, and 47.43 cm) at 30, 60, 90, 120 DAT, and at harvest, respectively. Organic manures and varied plant spacing improved soil porosity, water retention, and nutrient availability, promoting plant height and supporting apical growth with closer spacing (Sultan, 1997). Sivasankar *et al*., (2024) also reported that the use of vermicompost in combination with 30 × 45 cm spacing positively influenced plant height, consistent with findings by Shahjahan *et al*., (2013).

The number of primary branches was unaffected by organic manures and spacing at the early stage (30 DAT), but these factors significantly influenced branch development at 60, 90, 120 DAT, and at harvest. Results showed that (Table 2 & Fig. 2) the highest number of primary branches (3.0, 4.1, 5.93, 9.34, and 11.6) was observed in the M_2 treatment (vermicompost at 25 t ha^{-1}), while the lowest numbers (2.1, 2.98, 6.43, 8.33, and 9.44) occurred in the control (M_0) treatment. Among spacing treatments, S_3 (30 × 45 cm) promoted a greater number of branches (3.4, 4.13, 6.13, 9.52, and 11.93), whereas S_1 (30 × 15 cm) resulted in fewer branches (1.7, 3.12, 4.48, 7.59, and 9.13). In combined treatments, the M_2S_3 treatment (vermicompost at 25 t ha^{-1} with 30 × 45 cm spacing) had the maximum number of primary branches (3.7, 4.66, 7, 10.4, and 13.1), while the M_0S_1 treatment

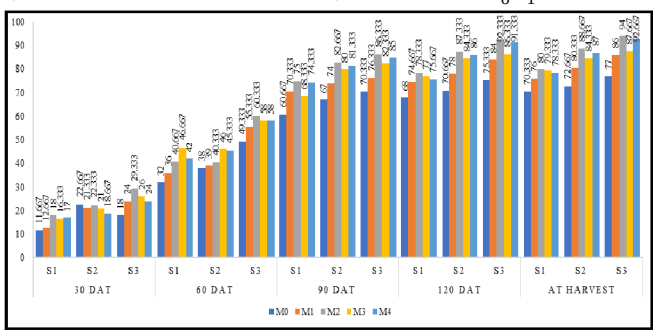

Fig. 3: Number of Number of leaves (plant^{-1}) at different treatments and their interactions.

(control with 30 × 15 cm spacing) recorded the minimum (1.0, 2.6, 3.0, 6.43, and 8.33) at 30, 60, 90, 120 DAT, and harvest, respectively. The wider spacing likely improved the availability of sunlight, nutrients, and water, reducing interplant competition and promoting lateral growth, which increased branch formation. Verma *et al*., (2018) and Semwal *et al*., (2016) reported similar effects on growth parameters in Kalmegh.

The number of leaves was significantly influenced by different organic manure applications and spacing at 60, 90, 120 DAT, and at harvest (Table 3 & Fig. 3). Results showed that the highest leaf count (23.2, 50.2, 81.3, 86, and 87.5) was observed in the M_2 treatment (vermicompost at 25 t ha^{-1}), while the lowest (17.4, 39.7, 66, 71.3, and 73.3) was found in the control (M_o) treatment. Among spacing treatments, S_3 (30 × 45 cm) spacing produced the most leaves (24.2, 56.2, 80, 85.8, and 87.4), whereas S_1 (30 × 15 cm) spacing resulted in the fewest (15.1, 39.4, 69.7, 74.7, and 76.8). For combined treatments, M_2S_3 (vermicompost at 25 t ha^{-1} with 30 × 45 cm spacing) yielded the highest leaf numbers (29.3, 60.3, 86.3, 92.3, and 94), while M_oS_1 (control with 30 × 15 cm spacing) had the lowest (11.6, 32, 60.6, 68, and 70.3) at 30, 60, 90, 120 DAT, and at harvest, respectively. The application of vermicompost with wider spacing promoted leaf development, likely due to improved spatial access and reduced interplant competition, which led to healthier leaves compared to closer spacing without manure. Wider spacing also maximized sunlight exposure, enhancing photosynthesis and foliage development (Ram *et al*., 2008). Additionally, vermicompost provides essential macro and micronutrients, further boosting leaf production. Chandana *et al*., (2021) reported similar findings.

Conclusion

It can be concluded that growing of Kalmegh with the combined use of organic manure and spacing was found effective in promoting morphological parameters such as plant height, number of branches per plant and number of leaves per plant. The highest plant height could be obtained with the application of Vermicompost @ 25 t/ha along with the spacing of 30×15 cm. But maximum number of branches and leaves per plant was recorded when the plants treated with Vermicompost @ 25 t/ha with spacing 30×45 cm

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