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Influence of pinching and foliar application of plant growth regulators and chemicals on growth and yield of annual moringa (*Moringa oleifera* L.) cv. PKM^{-1}

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Abstract
An experiment was conducted at Department of Vegetable Science, College of horticulture, Anantharajupeta to access the effect of foliar spray of plant growth regulators on the growth attributes. Among pinching treatments, P_3 (Pinching at 90 cm) recorded highest number of primary branches, stem girth, number of flowers per panicle, number of panicles per plant, pod set percentage, yield per plant. Here, un pinched plants recorded the highest plant height. Among growth regulators and chemicals, GA_3 @ 20 ppm (G_2) recorded highest plant height, number of primary branches and stem girth. KNO3 @ 0.5% (G_4) recorded highest number of flowers per panicle, number of panicles per plant, pod set percentage and yield per plant. Among interaction effects, P_1G_2 (No pinching along with GA_3 @ 20 ppm) recorded maximum plant height. P_3G_2 (Pinching at 90 cm plant height along with GA_3 @ 20 ppm) recorded highest number of primary branches, stem girth. P_3G_4 (Pinching at 90 cm along with KNO3 @ 0.5%) recorded highest number of flowers per panicle number of panicles per plant, pod set percentage and yield per plant.

Keywords: Number of branches, stem girth, number of flowers per panicle, number of panicles per plant, pod set percentage, yield per plant

Introduction
Moringa oleifera (Moringaceae) is a medium-size agroforestry tree that originated from south Asia, but has become naturalised in many countries globally. The species is considered as a neglected and underutilised as its potential is still not well economically known and valued. With its high nutritive values, every part of the tree is suitable for either nutritional or commercial purposes. Almost all parts of the plant are used. The leaves are rich in minerals, vitamins and other essential phytochemicals. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent.

Plant growth regulators are the chemical substances which govern all the factors of development and growth within plants. Plant growth regulators are compound when added in small amount, alters the plant growth usually stimulating or modifying the natural growth system, thereby increasing the yield (Surendra *et al*., 2006) [13]. GA_3 promotes cell division and a number of plant development mechanisms and encourages numerous desirable effects such as plant height, uniform flowering, reduced time to flowering and increased flower number and size (Srivastava and Srivastava, 2007) [12]. Foliar application of NAA causes apical dominance by increased the plasticity of cell wall by loosening it and followed by hydrolyzing starch into sugars causing rapid cell elongation and cell division (Arvindkumar *et al.* 2014 and Vaishampayan, 2003) [2, 14].

Materials and Methods
The present investigation was conducted at Vegetable Science block in department of Vegetable Science, College of horticulture, Anantharajupeta in 2022 to study the effect of plant growth regulators on growth of annual moringa *cv*. PKM-1. PKM-1 seeds were collected from TNAU, Periyakulam. The spacing adopted was 3x3m in a factorial randomized block design (FRBD) with 2 factors. Factor-I includes three pinching levels P_1: Control, P_2: Pinching at 60cm plant height, P_3: Pinching at 90 cm plant height and factor- II includes G_1: No spray, G_2: GA3 @ 20 ppm, G_3: NAA @ 20 ppm, G_4: KNO3 @ 0.5%, G_5: Boric acid @ 0.2%.

Plant height was measured from the base of the plant at ground level to the tip of main stem and expressed in metres. The number of branches arising from the main stem alone was recorded. The stem girth was measured at 15 cm from the ground level and expressed in centimeters. The flower count was made in three randomly selected panicles from each tree, the mean was computed and expressed in numbers. All the panicles in the randomly selected plants were tagged and the total number of panicles per tree was summed up and expressed in numbers. Total yield of pods per plant pooled over all harvests was counted in randomly selected trees and the mean was expressed in kilograms per plant. The first five panicles appearing in the randomly selected trees under each treatment was tagged and the number of flowers per panicle and number of pods per panicle were counted and the mean was computed.

The percentage of pod set was worked out using the following formula

$$\text{Pod set percentage \%} = \frac{\text{Mean number of pods per panicle}}{\text{Mean number of flowers per panicle}} \times 100$$

Results and Discussion

1) Plant height

Among pinching treatments, the highest plant height (4.32 m) was recorded under control (P_1- No pinching) which was followed by P_3 (Pinching at 90 cm plant height) (3.92 m). Lowest plant height (3.65 m) includes P_2 (Pinching at 60 cm plant height) respectively. Among growth regulators and chemicals, the highest plant height (4.33 m) was recorded in G_2 (GA_3 @20 ppm) at 180 DAS which was on par with G_3 (4.18 m) and G_4 (4.05 m). Lowest (3.46 m) was reported in control G_1 was presented in the table 1.

The interaction effect was significant among the treatments. P_1G_2 (No pinching along with GA_3 @ 20 ppm) recorded maximum plant height (5.11 m) which was on par with P_1G_3 (No pinching along with NAA @ 20 ppm) (4.88 m), P_1G_4 (No pinching along with KNO_3 @ 0.5%) (4.71 m) at 180 DAS. Lowest plant height (3.34 m) was recorded in P_2G_2 at 180 DAS.

2) Number of primary branches

Among pinching treatments, highest number of primary branches (6.07) was recorded in P_3 (Pinching at 90 cm) followed by P_2 (Pinching at 60 cm) (5.46). Lowest (4.68) was recorded under control P_1 was presented in the table 1. Among growth regulators and chemical spray, highest number of branches (5.95) were recorded in G_2 (GA_3 @ 20 ppm) which was on par with G_3 (5.67) and G_4 (5.65). Lowest (4.74) were observed in G_1 (No spray).

The interaction effect between the pinching and growth regulators and chemical spray showed significant influence on number of primary branches. Highest number of primary branches (7.25) were recorded in P_3G_2 (Pinching at 90 cm plant height along with GA_3 @ 20 ppm) P_3G_2 which was on par with P_3G_3 (6.80). Lowest (4.00) was noticed in P_1G_1.

3) Stem girth

Among pinching treatments, highest stem girth (19.60 cm) was recorded under P_3 (pinching at 90 cm plant height) followed by P_2 (pinching at 60 cm plant height) with (18.42 cm). Lowest stem girth (14.00 cm) was observed in P_1 control. Among growth regulators and chemicals, highest stem girth (19.02 cm) was noticed in G_2 (GA3 @ 20 ppm) followed by G_3 (NAA@20 ppm) (17.58 cm). Lowest (15.97 cm) was recorded in P_1 control was presented in the table 1.

Highest stem girth (22.43 cm) was recorded in P_3G_2 – (pinching at 90 cm plant height along with GA_3 @ 20 ppm) followed by P_3G_3 (19.83 cm). Lowest (1.00 cm) was observed in P_1G_1.

Table 1: Effect of pinching levels and foliar application of growth regulators and chemicals on plant height (m), number of primary branches, stem girth (cm), number of flowers per panicle in moringa cv. PKM-1.

Foliar application	Plant height (m)				Number of primary branches				Stem girth (cm)			
	Pinching levels				Pinching levels				Pinching levels			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
G_1	3.50	3.34	3.53	3.46	4.00	5.00	5.21	4.74	11.00	17.90	19.01	15.97
G_2	5.11	3.79	4.09	4.33	4.60	6.00	7.25	5.95	15.95	18.67	22.43	19.02
G_3	4.88	3.70	3.96	4.18	4.65	5.55	6.80	5.67	13.85	19.06	19.83	17.58
G_4	4.71	3.42	4.02	4.05	4.95	5.75	6.25	5.65	14.35	18.75	18.81	17.30
G_5	3.41	3.99	4.01	3.80	5.20	5.00	4.85	5.02	14.85	17.70	17.91	16.82
Mean	4.32	3.65	3.92		4.68	5.46	6.07		14.00	18.42	19.60	
Factor	P	G	P×G		P	G	P×G		P	G	P×G	
S.Em±	0.38	0.49	0.85		0.10	0.13	0.22		0.33	0.42	0.73	
CD at 5%	0.12	0.16	0.28		0.30	0.39	0.68		0.99	1.28	2.22	

P_1: Control, P2: Pinching at 60 cm plant height, P3: Pinching at 90 cm plant height
G_1: No spray, G2: GA3 @ 20 ppm, G3: NAA @ 20 ppm, G4: KNO3 @ 0.5%, G5: Boric acid @ 0.2%

4) Number of flowers per panicle

Influence of foliar application of pinching and growth regulators and chemicals on number of flowers/panicles showed highly significant effect was presented in the table 2.

Among the pinching treatments, highest number of flowers per panicle (57.38) was recorded in P_3 followed by P_2 (54.44) and the lowest (51.47) was observed in control (P_1).

Among growth regulators and chemicals applied, highest number of flowers per panicle (59.36) was recorded in G_4 which was on par with G_3 (57.36) and lowest (46.90) was noticed in G_1 respectively.

The combined effect of pinching and growth regulator, chemical spray on number of flowers per panicle showed significant difference. P_3G_4 (Pinching at 90 cm along with KNO3 @ 0.5%) recorded highest number of flowers per panicle with (62.57) which was on par with P_3G_5 (60.19), P_2G_4 (60.18), P_3G_3 (59.79) and the lowest (41.19) was recorded in P_1G_1 respectively.

Number of flowers per panicle were registered highest with KNO_3 spray. This might be due the induction of bud

formation and onset of flowering. Number of flowers and inflorescences increased when plants were treated with potassium nitrate, Khayat *et al*. (2010) [5] reported similar results for 'Selva' strawberries, and also our findings were in accordance with previous works (Rahemi and Asghari, 2004) [7]. The element K has important regulatory roles inside and outside of plant cells, so it can be expected that plant access to an available K source should optimize plant growth and consequently this enables plants to flower more frequently. Highest flowering might be due to KNO_3 spray, it promoted translocation of assimilates into the sink threshold thereby synchronizing bud break from apices with existing floral stimulus.

5) Number of panicles per plant

Among the pinching treatments, highest number of panicles per tree (42.23) were observed in P_3 (pinching at 90 cm plant height) followed by P_2 (pinching at 60 cm plant height) with (38.53) and lowest (35.58) was observed in control P_1. Among growth regulators and chemicals applied, highest number of panicles per plant (44.18) were noticed in G_4 (KNO_3 @ 0.5% spray) which was on par with G_3 (NAA @ 20 ppm spray) with (42.52) and lowest was reported in G_1 (No spray) with (32.35) respectively was presented in the table 2.

Significant difference was noticed on number of panicles per tree under the interaction of pinching and growth regulators and chemicals involved in the present investigation. The highest number of panicles were observed in P_3G_4 (50.35) which was on par with P_3G_3 (47.80) and P_2G_4 (46.80) and the lowest was noticed in P_1G_1 (28.70) respectively.

Among the pinching treatments, pinching at 60 cm plant height recorded the highest number of panicles as compared to control. As discussed earlier, pinching treatment resulted in higher number of primary branches, stem girth, canopy spread, the cumulative effects of which might have made a positive contribution to the highest number of panicles per tree. Similar results were reported by Vijayakumar (2001) [15] in annual moringa.

Potassium nitrate (KNO_3) has been shown to stimulate early flowering and to increase number of panicles in trees growing in tropical and subtropical regions, thus ensuring increased and regular production (Adam *et al*., 1986) [1]. The plants could have accumulated sufficient carbohydrates and synthesized proteins during early stages for the production of higher number of flowers (Guruswathi, 2002) [4]. The photosynthates might have been utilized efficiently for increasing the number of flowers. Similar results were obtained by Savitha *et al*. (2004) [10] in okra and Saraswathi and Vadivel (2009) [9] in marigold.

6) Pod set percentage (%)

Among the pinching treatments, P_3 (2.77) found to be significantly superior with high pod set percentage as compared with P_2 (2.42) and least pod set percentage was noticed in control P_1 (1.76). Among growth regulators and chemicals applied, highest pod set percentage was recorded in G_4 (2.78) followed by G_3 (2.49) and lowest was noticed in G_1 (2.04) was presented in the table 2.

The interaction effect between the pinching and growth regulators and chemical spray showed highly significant influence on pod set percentage. P_3G_4 (Pinching at 90 cm along with KNO_3 @ 0.5%) recorded the highest pod set percentage (3.71) which was on par with P_3G_3 (3.37). Lowest pod set percentage (1.60) was observed in P_1G_1.

KNO3 treatment effect on time to flowering, percentage flowering, number of panicles and fruit set was observed in both mango varieties regardless of the production location. KNO3 at 4% induced early flowering in treated trees compared to control trees. This effect could be in part attributed to additional nitrogen from KNO_3. Increased nitrogen fertilization through the soil has been found to increase fruit retention and yield in mango (Smith *et al*., 1994 and Yeshitela *et al*., 2004) [11, 16]. According to Kulkarni (2014) [6], the floral stimulus is present in stems when buds are forced in response to KNO_3 and that KNO_3 may sensitize buds to the floral stimulus. And also, the effect of NAA 20 ppm prevents the flower abscission and improved the pod set as reported by Vijayakumar *et al*. (2001) [15].

Table 2: Effect of pinching levels and foliar application of growth regulators and chemicals on number of flowers per panicle, number of panicles per plant, pod set percentage (%), yield per plant (kg) in moringa cv. PKM-1.

Foliar application	Number of flowers per panicle				Number of panicles per plant				Pod set percentage (%)				Yield per plant (kg)			
	Pinching levels				Pinching levels				Pinching levels				Pinching levels			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
G_1	41.19	50.15	49.36	46.90	28.70	30.95	37.40	32.35	1.60	2.04	2.48	2.04	4.80	7.59	9.23	7.21
G_2	53.26	47.98	55.00	52.08	39.00	29.85	32.85	33.90	1.95	2.58	1.99	2.17	7.60	11.92	10.00	9.84
G_3	54.25	58.05	59.79	57.36	36.70	43.05	47.80	42.52	1.70	2.39	3.37	2.49	6.50	13.49	24.71	14.90
G_4	55.33	60.18	62.57	59.36	35.40	46.80	50.35	44.18	1.90	2.74	3.71	2.78	9.15	16.30	24.94	16.80
G_5	53.33	55.84	60.19	56.46	38.10	42.00	42.75	40.95	1.64	2.34	2.29	2.09	9.36	9.96	12.58	10.63
Mean	51.47	54.44	57.38		35.58	38.53	42.23		1.76	2.42	2.77		7.48	11.85	16.38	
Factor	P	G	P×G		P	G	P×G		P	G	P×G		P	G	P×G	
S.Em±	0.58	0.75	1.29		0.54	0.69	1.20		0.06	0.08	0.13		0.40	0.52	0.90	
CD at 5%	1.75	2.26	3.92		1.63	2.01	3.63		0.18	0.23	0.40		1.22	1.57	2.72	

P_1: Control, P2: Pinching at 60 cm plant height, P3: Pinching at 90 cm plant height

G_1: No spray, G2: GA3 @ 20 ppm, G3: NAA @ 20 ppm, G4: KNO3 @ 0.5%, G5: Boric acid @ 0.2%

7) Yield per plant (kg)

Influence of foliar application of pinching and growth regulators and chemicals on yield/ plant showed highly significant effect. Among the pinching treatments, P_3 (16.38 kg/plant) found to be significantly superior on yield followed by P_2 (11.85 kg/plant) and least was noticed in control P_1 (7.48 kg/plant). Among growth regulators and chemicals applied, highest yield was recorded in G_4 (16.80 kg/plant) followed by G_3 (14.90 kg/plant) and lowest yield was recorded in G1 (7.21 kg/plant) was presented in the table 2.

The combined effect of pinching and growth regulator, chemical spray on yield per plant showed highly significant difference among the treatments. P_3G_4 (Pinching at 90 cm along with KNO_3 @ 0.5%) (24.94 kg/plant) recorded highest

yield per plant which in turn-maintained parity with P_3G_3 (24.71 kg/plant) and lowest yield was noticed in control P_1G_1 (4.80 kg/plant).

Among the pinching treatments, the highest pod yield was recorded by pinching at 90 cm as compared to control. Similar result was obtained by Vijayakumar (2001) [15], who noticed that pinching on 60th day after pinching on significantly increased the pod yield in annual moringa compared to pinched trees. Raman (1973) [8] also observed that pinching of shoots resulted in higher yields up to 40 per cent over control in jasmine.

The photosynthates might have been utilized efficiently for increasing the number of flowers and yield. KNO3 increased yield due to the increase in number of pods per panicle, pod weight, number of panicles per tree, number of flowers per panicle, pod set percentage. Golcz *et al*. (2012) [3] have reported that the total yield, marketable yield, commercial fruit yield and total average yield per plant were increased by increasing application rates of potassium (K) fertilizers on pepper plant.

Reference

1. Adam CS. Off-season flowering response of mango cultivars to potassium nitrate. Acta Horticulturae. 1986;175:277-280.
2. Arvindkumar PR, Vasudevan SN, Patil MG. Effect of foliar sprays of NAA, triacontanol and boron on growth and seed quality in bitter gourd (*Momordica charantia* L.) cv. Pusa Visesh. J Horticultural Science. 2014;9(2):148-152.
3. Golcz A, Kujawski P, Markiewicz B. Yielding of red pepper (*Capsicum annuum* L.) under the influence of varied potassium fertilization. Acta Scientiarum Polonorum-Hortorum Cultus. 2012;11(4):3-15.
4. Guruswathi M. Studies on the effect of Boom flower N-A flowering stimulant on Jasminum sambac Ait. Cv. Gundumalli. M.Sc. (Hort.) Thesis, AC& RI, TNAU, Madurai; 2002.
5. Khayat M, Rajaee S, Shayesteh M, Sajadinia A, Moradinezhad F. Effect of potassium nitrate on breaking and dormancy in strawberry plants. Journal of plant nutrition. 2010;33(11):1605-1611.
6. Kulkarni VJ. The tri-factor hypothesis of flowering in mango. Acta Horticulturae. 2004;645:61-70.
7. Rahemi M, Asghari H. Effect of hydrogen cyanamide, volk oil and potassium nitrate on bud break, yield and nut characteristics of pistachio. Journal of Horticultural Science and Biotechnology. 2004;79(5):823-827.
8. Raman KR. Studies on jasmine with particular reference to flowering. Ph.D. thesis submitted to Tamil Nadu Agricultural University, Dept. of Horticulture, Coimbatore, 1973.
9. Saraswathi T, Vadivel E. Effect of Panchagavya, Nitrobenzene and Salicylic acid in increasing yield of marigold (*Tagetes erecta* L.). Ad. Plant Sel. 2009;22(1):119-121.
10. Savitha H. Determination of phytotonicity, phytotoxity, safety and residue of nitrobenzene in okra. M.Sc. (Hort.) Thesis, TNAU, Coimbatore; 2004.
11. Smith JD. Nitrogen fertilization of cranberries: What type should I use, how should I apply it, and where is my nitrogen from last season? Wisconsin Cranberry School Proceedings. 1994;5:23-30.
12. Srivastava NK, Srivastava AK. Influence of gibberellic acid on CO_2 metabolism, growth, and production of alkaloids in *Catharanthus roseus*. Photosynthetic. 2007;45:156-60.
13. Surendra P, Nawalagatti CM, Chetti MB, Hiremath SM. Effect of plant growth regulators and micronutrients on yield and yield component of okra. Karnataka Journal of Agricultural Sciences. 2006;19(2):264-267.
14. Vaishampayan DC. Studies on effect of fertilizers, growth regulators and pruning on growth, yield and quality of drumstick (*Moringa oleifera* Lam.) Var. PKM 1. Ph.D. Thesis. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. India, 2003.
15. Vijayakumar RM. Studies on influence of months of sowing and growth regulation on annual moringa (*Moringa pterygosperma* Gaertn) Ph.D. Thesis, TNAU, India, 2001.
16. Yeshitela T, Robbertse PJ, Stassen PJC. Effects of various inductive periods and chemicals on flowering and vegetative growth of 'Tommy Atkins' and 'Keitt' mango (*Mangifera indica*) cultivars. New Zealand Journal of Crop and Horticultural Science. 2004;32:209-21.