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Growth Regulators Impact on Yield and Alkaloid Content of Kalmegh (*Andrographis paniculata* Nees)

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ABSTRACT

A field experiment consisting of growth regulators NAA (40, 50 and 60 ppm), GA_3 (25, 50 and 100 ppm) and Paclobutrazol (100, 150 and 200 ppm) and distilled water spray as control to study the effects of plant growth regulators on yield and andrographolide content of kalmegh (Andrographis paniculata Nees). Application of paclobutrazol at 100 ppm significantly increased the fresh herb and dry herb weight, stem and their total. The foliar application of NAA at 50 ppm was very effective and recorded maximum cumulative dry herb yield, drying percentage and total andrographolide yield (3662 kg/ ha, 54.5 % and 58.89 kg/ ha respectively).

Keywords: *Andrographis paniculata, Andrographolide, Plant Growth Regulators, Whole Plant Biomass, Andrographolide yield.*

Abbreviations: *DAT : Days after transplanting, GA_3 : Gibberellic acid, NAA: Napthalene acetic acid, PGRs : Plant growth regulators, PBZ : Paclobutrazol.*

INTRODUCTION

Medicinal and aromatic plants provide important economic products, which represent significant sources of economic revenue and foreign exchange among the most important agricultural export products. In recent years, more and more people are relying upon natural supplements with herbal medicines. More than 70% of the population of India believes in a traditional system of medicine (herbal medicines) for their primary healthcare. Approximately 80% of the world population depends exclusively on plants for their health and healing[7].

Kalmegh (*Andrographis paniculata* Nees) it is a high value medicinal crop which is known as 'King of bitters' and it belongs to the family Acanthaceae. It is one among the prioritized 32 medicinal plants by the NMPB. Since time immemorial, village and ethnic communities in India have been using this herb mainly for treating fever, liver diseases, diabetes, snake bite, common cold and bronchitis and a variety of ailments[11].

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The major constituent present in the kalmegh is Andrographolide and the leaves is the source of andrographolide. Before plant bloom we can find 2 per cent andrographolide. The stem also contains small amount of Andrographolide in the range of 0.4 to 1.05[12]. Among the various medicinal plants, *Andrographis paniculata* is in pressing demand because of its anti-HIV property. High demand for andrographolide in Indian as well as in international markets has encouraged Indian farmers to start commercial cultivation of this important medicinal plant. But the biological yield and production of secondary metabolites is very low in this plant.

Plant growth regulators have great potential in increasing agricultural production and help in removing many of the barriers imposed by genetics and environment[10]. Application of plant growth regulators exogenously reported to improve the growth and yield of various crops[3,8]. For increased herbage yield and andrographolide yield in kalmegh, many experiments were conducted using different growth regulators. Hence the attempt has been made by using three different PGRs such as NAA, GA_3 and PBZ each at three different concentrations to study the influence on herb yield and andrographolide yield of kalmegh.

MATERIALS AND METHODS

The experiment was carried out on field situated at an altitude of 930 m above MSL 12° 58[1] North latitude and 77° 35[1] East longitude in the Eastern Dry Zone (zone-5) of Karnataka during *kharif* 2013-14 at College of Horticulture, University of Horticultural Sciences Campus, Gandhi Krishi Vignana Kendra, Bengaluru-65. The maximum and minimum temperatures fluctuated between 26.6-29.9^{o} C and 14.1-19.1^{o}C respectively and relative humidity varied from 39-93 percent. The total rainfall of 540 mm was received during cropping period**.** The soil of the experiment site was red sandy loam in nature with a pH of 6.7 with 3.2 per cent organic carbon and 223.4, 43.8 and 126.3 kg available NPK respectively per ha.

There were ten treatments NAA (40, 50 and 60 ppm), GA_3 (25, 50 and 100 ppm) and PBZ (100, 150 and 200 ppm) and the distilled water being the control. This study was done on the base of randomized complete block design. The treatment was replicated 3 times. The plant growth regulators were sprayed in 2 stages including 30 DAT and 30 days after harvesting of main crop. The local kamegh variety seeds were sown in raised beds. Seedlings of 45 days old were transplanted in main field. The whole plot was divided into 3 block each representing the replication. Each block was then divided into unit plot of 2.4 x 2 m size. Each block was separated from each other by 1m width bund. Seedlings were transplanted at 30 x 20 cm spacing. The experiment plot fertilized with FYM, urea, single super phosphate and muriate of potash at the rate of 25 t ha^{-1}of FYM, NPK 75 kg, 75 kg and 50 kg ha^{-1} respectively. Nitrogen was applied at two equal splits, one at the time of transplanting and another as top dressing at 30 DAT. Nitrogen at 20 kg ha^{-1} was used for top dressing of ratoon crop. All the operations done regularly during growing season. The crop was irrigated with drip system using 12 mm inline drippers with 2LPH discharge with one lateral in alternate rows of kalmegh.

After recording fresh weight of all the plants harvested from the net plot area, they were spread out in thin layer indoor in well ventilated room for drying. Their shade dry weight was recorded and expressed as kg per plot. Using dry herb yield of net plot, dry herb yield per hectare was computed and expressed as kg per hectare. Drying per centage was

estimated by dividing the shade dry herb yield by fresh herb yield.

The andrographolide content was estimated by HPLC analysis both in leaf and stem samples separately using replicated pooled samples of main crop and the same values were utilized for computing Andrographolide yield from both main as well as ratoon crops using dry leaf to stem ratio of the dry herb yield obtained.

RESULTS AND DISCUSSION

Foliar application of PGRs influenced on dry weight of plant. Higher dry weight and drying percentage was noticed in ratoon crop as compare to the main crop indicating higher dry biomass recovery in ratoon crop as compare to the main crop (Table 1). Paclobutrazol spray at 100 ppm resulted in maximum dry weight both in main and ratoon crop (3.14 and 7.74g / plant respectively) which differed significantly from all other treatments. While, NAA at 60 ppm recorded lowest plant dry weight (0.93 g / plant) in main crop. Maximum drying percentage was observed in plants fed with paclobutrazol at 150 ppm (30.13%) in main crop. However, in ratoon crop, highest drying percentage of 40.21 per cent was associated with paclobutrazol at 100 ppm which were on par with other paclobutrazol treatments (150 ppm – 37.07 % and 200 ppm – 35.25 %) and NAA at 40 (38.15 %) and 50 ppm (37.16 %) treatments. Control (27.50 %) recorded the lowest drying percentage indicating higher amount of moisture which was on par with all GA_3 treatments.

The data given in table 2 showed that growth regulators increased fresh herb yield and dry herb yield in kalmegh. Increased cumulative fresh herb yield were obtained in crop sprayed with GA_3 at 100 ppm (8105 kg per ha). NAA at 50 ppm responsible for highest cumulative dry herb yield (3662 kg per ha). The same treatment also responsible for maximum dry herb recovery (shade dry) of 54.5 per cent. This also shows the interaction of growth regulators and cropping seasons indicating differential response of crop to these growth regulators in different seasons. This can be contributed to comparatively higher drying percentage in NAA treated plants. The maximum yield were obtained by the application of growth regulators may be due to the better sink efficacy. Evans *et al*[2]., reported the involvement of growth regulating substances with sink efficiency in influencing the yield potential. It is evident from the data that control registered significantly lower yields than growth regulator sprays which indirectly manipulate the morphological, physiological and growth parameters as reported by Chennakesava *et al*[1].

Growth regulator treatments caused for higher andrographolide content in leaf and stem (Table 2). Plants applied with paclobutrazol at 100 and 150 ppm registered maximum leaf andrographolide (2.6 % w/w). Similarly, the stem andrographolide content was maximum in plants treated with paclobutrazol at 150 ppm (1.051 %). Similar results have been registered by Jaleel *et al*[5,6]., in *Catharanthus roseus,* Haque *et al*[4]., in pyrethrum and Gopi *et al*[3]., in holy basil.

NAA at 50 ppm was found to be optimum for realizing maximum (58.89) andrographolide yield per ha from the kalmegh cultivation which was significantly superior over all other treatments. The maximum yield in this treatment can be ascribed to the maximum drying percentage (54.5), cumulative dry herb yield (3662 kg/ha) coupled with fairly higher andrographolide content due to NAA application at 50 ppm. This result was in accordance with Menaria and Maliwal[9] in fennel.

Table 1: Dry matter accumulation (g/plant) and drying percentage in kalmegh as influenced by growth regulators

Treatments	Main crop		Ratoon crop	
	Total dry weight	Drying percentage	Total dry weight	Drying percentage
Control	1.73	25.60	4.07	27.50
NAA 40 ppm	1.82	24.88	5.25	38.15
NAA 50 ppm	2.71	27.09	5.01	37.16
NAA 60 ppm	0.93	17.32	3.44	31.27
GA_3 25 ppm	1.82	17.71	4.36	33.69
GA_3 50 ppm	1.09	12.79	3.39	29.98
GA_3 100 ppm	2.03	22.63	5.02	33.60
Paclobutrazol 100 ppm	3.14	26.49	7.74	40.21
Paclobutrazol 150 ppm	2.51	30.13	4.58	37.07
Paclobutrazol 200 ppm	1.88	24.45	5.35	35.25
Mean	1.97	22.91	4.82	34.39
S.Em ±	0.11	3.30	0.37	2.17
CD at 5%	0.33	9.88	1.11	6.49

Table 2: The effect of PGRs on yield parameters of kalmegh (*Andrographis paniculata* Nees.)

Treatments	Cumulative fresh herb yield(kg/ha)	Cumulative dry herb yield (kg/ha)	Drying percentage (on shade dry basis)	*Leaf Andrographolide content	*Stem andrographolide content	Total andrographolide yield(kg/ha) in one cropping season (M+R)
Control	4924	2171	44.1	2.5	0.895	43.89
NAA 40 ppm	5760	2824	49.1	2.4	0.565	47.28
NAA 50 ppm	6728	3662	54.5	2.3	0.588	58.89
NAA 60 ppm	5592	2081	37.2	2.4	0.583	36.29
GA_3 25 ppm	6285	2487	39.5	2.2	0.473	41.32
GA_3 50 ppm	5673	1890	33.4	1.8	0.414	23.24
GA_3 100 ppm	8105	3248	40.1	1.8	0.585	40.99
Paclobutrazol 100 ppm	6391	2529	39.7	2.6	0.453	46.87
Paclobutrazol 150 ppm	5277	2496	47.4	2.6	1.051	49.23
Paclobutrazol 200 ppm	5262	2569	48.8	2.5	0.757	45.77
Mean	5999	2596	43.4	2.3	0.636	43.38
S.Em ±	120	83	1.6	-	-	2.37
CD at 5%	361	248	5.0	-	-	7.09

M+ R- Main + Ratoon crop * Replicated pooled samples and hence statistically not analysed

CONCLUSION

The result obtained from the present investigation showed that kalmegh positively responded to NAA application. Among other growth regulators spraying the kalmegh crop with NAA at 50 ppm after 30 days after transplanting or harvesting of main crop had incresing effect on alkaloid yield per hectare.

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