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Influence of Plant Growth Regulators on Growth and Yield of Sponge Gourd (*Luffa aegyptiaca* Mill.) Cv. Thalaivasal Local

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ABSTRACT

A field experiment was conducted at Vegetable Yard, Department of Horticulture, Annamalai University, Chidambaram during the year 2020 with objects to influence the plant growth regulators on growth and yield of sponge gourd (*Luffa aegyptiaca* Mill.) cv. Thalaivasal local. The experiment was carried out in randomized block design with three replications and ten treatments viz., three concentration each of NAA (50, 100 and 200 ppm), Ethrel (125, 250 and 500 ppm), CCC (100, 200 and 400ppm) with control. Observations recorded on different growth and yield characters showed significant differences among different treatments. With regard to growth characters, application of NAA @ 200 ppm significantly increased the vine length, while Ethrel @ 250 ppm recorded maximum number of branches, induced earliness in flowering, more number of female flowers and reduced sex ratio, whereas highest node number of first male flower and more number of male flowers were observed in the application of CCC @ 100ppm. Ethrel @ 500 ppm evinced better performance for the fruit length and fruit weight, whereas fruit girth was found to be more in plants sprayed with CCC @ 400 ppm. The treatment Ethrel @ 500 ppm was produced heavy weight fruit. Application of Ethrel @ 250 ppm recorded more number of fruits per vine and yield per vine. The highest net return and benefit cost ratio were observed in Ethrel @ 250 ppm. Among different treatments, Ethrel @ 250 ppm was found superior to other treatments for increasing yield potential in sponge gourd.

***Key words*:** *Luffa aegyptiaca*, Growth, Yield, Ethrel, CCC, NAA

Sponge gourd (*Luffa aegyptiaca* Mill.) is one of the most important cucurbits, grown as rainy and summer season vegetable, which is grown throughout the country. Sponge gourd is an annual and monoecious cucurbit plant. Its flowers are yellow in colour and staminate flowers are raceme while, pistillate flowers are solitary with short long pedunculate. Sponge gourd fruit is easily digestible and increase the appetite when consumed, therefore, it is recommended to the patients suffering from malaria or other seasonal fevers. The nutritive value of sponge gourd (100 g of edible portion) contains as follows: Moisture (93.2g), Protein (1.2 g), Fat (0.2 g), Minerals (0.5 g), Fibre (2.0 g), Carbohydrate (5.0 g), Energy (22 K. cal.), Calcium (25.0 mg), Phosphorus (19.0 mg), Iron (1.0 mg), Vitamin A (84.0 mg), Vitamin C (7.0 mg), Thiamine (0.03 mg), Riboflavin (0.03 mg) and Nicotinic acid (0.4 mg) [1]. Tender fruits are used as vegetable or as cooked vegetables. Besides its use as vegetable, this gourd is utilized for various purposes. The fibres obtained from the mature dry fruits are used in preparation of good pot holders, table mats, bathroom mats and slipper soles. The sponge gourd has a variety of commercial purposes including personal hygiene products, household cleaning products, steam engine filters, craft items, insulation, padding for saddles, and immobilizing agents in biotechnology. The sponge gourd is used in various traditional medicines. It is quite useful in asthma, skin diseases, splenic enlargement and removal of intestinal worms. The extracts from vines are also used as ingredients in cosmetics and pharmaceutical industries. Young fruits are cool, demulcent, lower the blood sugar, blood purifier, constipation, weight loss, hypoglycemia and detoxifies the body. The seeds are emetic and cathartic.

The monoecious forms also possess a great diversity in the pistillate and staminate flowering ratio. Normally in monoecious type, the production of staminate flowers are considerably more in number than pistillate flowers. Since a direct relationship exists between the number of pistillate flowers and total yield, therefore increasing the number of pistillate flowers could increase yield. It is therefore, important to study the possibility of increasing the number of pistillate flowers by using the growth regulating chemicals. The mechanism of sex expression in most of the cucurbitaceous crops which have monoecious plants are

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considered to be controlled by genetical and environmental factors.

Plant growth regulators are known to have great potential to increase the productivity of vegetables. The potentialities of growth promoters and growth retardants can be used to maximize the yield of several vegetable crops. The response of plant or plant parts to growth regulators varies due to fluctuations in endogenous hormonal levels of the plant and the manner in which the natural growth regulators interact with the applied growth regulators. Exogenous application of growth regulating chemicals viz., NAA, GA_3, TIBA, MH, CCC, 2,4-D, Ethrel etc. have been reported to influence the sex expression in various cucurbits [2] in cucumber, [3] in ridge gourd. The growth regulators suppress the number of male flowers on lateral branches. Therefore, they increase the female flowers production on lateral branches and thereby ultimately increase the yield. With this background, the present investigation was aimed to find out the suitable plant growth regulators for increasing the yield potential and quality in sponge gourd with the objectives to find out the influence of plant growth regulators on growth and yield parameters in sponge gourd.

MATERIALS AND METHODS

The present study was carried out at the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar during 2019-2020. The experiment was laid out in randomized block design with three replications. Sponge gourd seeds collected from Thalaivasal area located at Salem district was used in this experiment. The experiment consists of nine treatments having three growth promoters, a growth retardant each in two concentrations and a control. Chemical used and their concentrations was listed below:

T. No	Growth regulator	Concentration (ppm)
T_1	NAA	50
T_2	NAA	100
T_3	NAA	200
T_4	Ethrel	125
T_5	Ethrel	250
T_6	Ethrel	500
T_7	CCC	100
T_8	CCC	200
T_9	CCC	400
T_{10}	Control	-

Pits were taken at a spacing of 2.0 × 1.5 m. In each pit, three seeds were sown. The cultural and management practices were adopted according to the management practices recommended by Tamil Nadu Agricultural University (TNAU), Coimbatore.

Five plants were tagged randomly in each treatment for recording the various biometric characters like vine length (cm), number of branches per vine, intermodal length (cm), days to first male flowering, days to first female flowering, node number of first male flower, node number of first female flower, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit length (cm), fruit girth (cm), number of fruits per vine, average fruit weight (g) and yield per vine (kg). Cost economics was also worked out to study the effectiveness of different treatments. The data were statistically analyzed by adopting the standard procedure of Panse and Sukhatme [4] and using AGRISTAT software.

RESULTS AND DISCUSSION

Application of plant growth regulators had significant influence on growth characters like vine length, number of branches per vine and intermodal length in sponge gourd. The present studies showed that the response of different treatments on vine length (Table 1) differed significantly. Remarkable increase in the vine length was observed with NAA @ 200 ppm and NAA @ 100 ppm. The minimum vine length was observed in CCC @ 400 ppm. There are numerous reports showing that Naphthalene Acetic Acid promotes the growth of intact plant. Increase in vine length and number of nodes thought to be due to increasing plasticity of the cell, followed by hydrolysis of starching to sugars which into lowers water potential of the cell, resulting in entry of water into the cell there by causing elongation and rapid cell division in the growing portion [5].

The significant reduction of vine length was recorded under the treatment CCC @ 400ppm (T_9), which might be due to the inhibitory action of growth retardant that regulates growth by altering transport metabolism of auxin and inhibiting gibberellins biosynthesis. Reducing in the vine length was also noted in the plant treated with Ethrel@ 250 ppm and 500 ppm (Table 1). Ethrel act as an antimitotic and thus providing an inhibitory effect on the suppression of the apical growth of the main axis an act as a gibberellins antagonist. This may be probable reason for reduction in length of vine with Ethrel treatment [6-8]. The response of different treatments on the number of branches per vine (Table 1) differed significantly. The maximum number of branches per vine (14.20) was recorded in Ethrel @ 250 ppm. It may be due to antimitotic action [9] (Greulach, 1953) and act as a gibberellin antagonist and thus providing an inhibitory effect on the suppression of the apical growth of vine and thereby increased number of branches. Increase in the number of branches was also noted in the plant treated with CCC @ 100 ppm (13.15) [10-12]. Among the NAA concentrations, maximum number of branches (14.20/vine) was recorded in NAA @ 200 ppm. This may be due to the action of NAA on cell enlargement, cell division and differentiation, which in turn resulted into promotion of growth. The response of different growth regulators treatments on the internodal length (Table 1) differed significantly. The longest internode (13.50 cm) was obtained in NAA @ 200ppm. This may be due to the action of NAA on cell enlargement, cell division and differentiation, which in turn resulted into promotion of growth. The internodal length was shorter (6.95 cm) in plant treated with Ethrel @ 500 ppm. It may be due to suppress of sub-apical meristematic activity, inhibiting stem elongation and thereby shortened the internodal distance [13].

The response of different treatments on days required for appearance of the first female flower (Table 2) and node numbers of first female flowering (Table 2) differed significantly. In case of days required for the appearance of first pistillate flower (Table 2) was significantly lowered by Ethrel application. Among all the treatments, Ethrel @ 250 ppm was found to be most effective in reduced number of days (57.96) to appearance of first female flower which was on par with Ethrel @ 125 ppm (58.83). Ethrel treatment brought down the number of days for the appearance of

female flower and delayed the appearance of male flowers. The foliar spray of Ethrel shifted sex expression towards femaleness. Such effects could be attributing to the fact that at lower concentration of Ethrel slightly inhibited vegetative growth, increased lateral development, reduced respiration, thus increasing the source, sink relationship, and helped in the early accumulation of photosynthates necessary for early pistillate flowers [14]. The studies indicated that the node number to first female flower appearance was significantly lowered by NAA application. Among the treatments, NAA @ 200 ppm was most effective in reducing the node numbers (15.98) for the appearance of first female flower. This may be probably due to the application of growth regulators seemed to have built up the auxins needed for flower-bud differentiation and thereby early appearance of pistillate flower at lower node [15].

Table 1 Influence of different plant growth regulators on growth attributes in sponge gourd

Treatments	Vine length (cm)	Number of branches vine^{-1}	Internodal length (cm)
T_1: NAA @ 50 ppm	486.52	9.85	10.90
T_2: NAA @ 100 ppm	491.00	10.30	11.85
T_3: NAA @ 200 ppm	510.25	12.45	13.50
T_4: Ethrel @ 125 ppm	451.50	13.00	9.75
T_5: Ethrel @ 250 ppm	430.25	14.20	9.54
T_6: Ethrel @ 500 ppm	406.00	12.10	6.95
T_7: CCC @ 100 ppm	448.25	13.15	10.80
T_8: CCC @ 200 ppm	423.50	11.95	8.98
T_9: CCC @ 400 ppm	363.00	8.10	7.62
T_{10}: Control	472.25	8.35	12.45
S. Ed.	8.31	0.39	0.45
CD (p = 0.05)	17.12	0.86	0.92

Table 2 Influence of different plant growth regulators on flowering attributes in sponge gourd

Treatments	Days to first male flowering	Days to first female flowering	Node number of first male flower	Node number of first female flower	Number of male flowers vine^{-1}	Number of female flowers vine^{-1}	Sex ratio
T_1: NAA @ 50 ppm	55.23	65.16	16.45	23.56	258.95	19.23	13.47
T_2: NAA @ 100 ppm	53.10	63.52	14.63	19.45	291.77	22.36	13.05
T_3: NAA @ 200 ppm	53.79	60.78	13.97	15.98	315.42	29.74	10.61
T_4: Ethrel @ 125 ppm	53.84	58.83	13.70	18.11	283.56	29.32	9.67
T_5: Ethrel @ 250 ppm	54.75	57.96	14.12	17.26	304.68	40.15	7.59
T_6: Ethrel @ 500 ppm	54.33	60.14	15.36	23.02	280.84	28.60	9.82
T_7: CCC @ 100 ppm	52.04	62.20	13.58	16.32	352.70	32.81	10.75
T_8: CCC @ 200 ppm	57.62	64.66	13.12	20.48	334.85	24.74	13.52
T_9: CCC @ 400 ppm	55.56	66.53	15.25	23.64	276.92	20.92	13.23
T_{10}: Control	57.90	71.03	14.56	24.72	326.63	16.89	19.44
S. Ed.	_	0.67	_	0.57	5.65	1.35	0.77
CD (p = 0.05)	N.S.	1.45	N.S.	1.20	11.76	2.84	1.62

It was also observed that application of CCC @ 100 ppm also reduced the node numbers (16.32) to appear the first female flower. The response of different treatments on number of male flowers (Table 2) differed significantly. All the treatments were found significantly superior in reducing the number of male flowers than control. As regard, the number of male flowers, it was observed that treatment CCC @ 100 and 200 ppm produced maximum number of male flowers (352.7 and 334.85), respectively. This may be probably due to retardation of starch digestion, as well as respiration in plant tissues after treatments with CCC and thereby considerable starch remain for the long period. This means that CCC reduces ongoing catabolic activities in plants and probably acts in the same way as that of low temperature and short days and thereby finally reduced the number of male flowers [16].

In case of female flowers, all treatments were found superior in producing more number of female flowers over the control (Table 2). It was observed that treatment Ethrel @ 250 ppm produced significantly maximum number of female flowers (40.15). Ethrel treatment brought down the number of days for the appearance of female flower and delayed the appearance of male flowers. The foliar application of Ethrel shifted sex expression towards femaleness. Application of Ethrel @ 250 ppm reduced level of endogenous gibberellins and increased level of auxin after Ethrel spray may be probable reason for increased number of female flowers, decreased number of male flowers and thereby lowered sex ratio [16].

Among the NAA concentrations maximum number of female flowers (29.74 per vine) was observed in NAA @ 200 ppm. It may be due to the fact that the exogenous application of NAA possibly buildup the required auxins level in flower primordia and thereby favour for female flower production. The auxins are to be involved in the evolution of ethylene. Thus, NAA seems to have indirectly raised the level of ethylene in plants, which increased the tendency to produce pistillate flower. This may also be a probable reason for production of more female flowers by NAA treatment [17].

The present studies indicated that the response of different treatments to male: female sex ratio differed significantly lowered the male: female sex ratio over control (Table 2). Among all the treatments Ethrel @ 250 ppm and 125ppm was found to be most effective in lowering the male: female sex ratio (7.59 and 9.67, respectively). The

sexual differentiation is controlled by endogenous levels of auxins, which developed flowering primordial during flowering act as antigibberellin substance. This antigibberellin cause suppressed staminate flowers and promotes more number of pistillate flowers [18-19]. The treatment NAA @ 200 ppm also produced low male: female sex ratio (10.61), whereas in the control it was higher ratio (19.44). Probably, it could be attributed to the suppression in number of staminate flowers and promoted in more number of pistillate flowers [20]. The present studies showed that various fruit characters of sponge gourd viz., length (cm) and girth (cm) of fruit differed significantly. All the treatments were significantly superior in recording more length of fruit as compared to the control (Table 3). It was observed that among all the treatments Ethrel @ 500 ppm produced the longest fruit (28.96 cm). The beneficial effects may be explained that the sole function of fertilized ovules or seeds in relation to growth of fruit is to synthesize one or more hormones which initiate and maintain a metabolic gradient along with food can be translocated from parts of plants towards the fruits [15].

In the present investigation, NAA @ 200 ppm also increased the length of fruit (26.84 cm). These may be probably due to cell division, enlargement of cell and increasing the metabolic activity in fruit NAA in treated plants. The probable reason for increase in fruit length was due to respiration and photosynthesis of treated plant remains higher than the control. The possible reason may be synthesis of one or more hormones which initiate the maintain a metabolic gradient along which foods can be translocated from the parts of the plants towards the fruits [15]. All the concentrations of CCC increased the girth of fruit. It was observed that among all the treatments, CCC @ 400 ppm, 200 ppm and 100 ppm recorded the maximum girth of fruit (15.42 cm, 15.06 cm and 14.70 cm respectively). It may be due to suppression of the fruit elongation and simultaneous accumulation of carbohydrate in horizontal way. This confirms the finding of the present study [21-24].

In the present studies, all the treatments showed a significant increase in the average weight of fruit than the control (Table 3). Among the treatments, Ethrel @ 500 ppm, 250 ppm and 125 ppm recorded significantly maximum weight of fruit (182.76 g, 171.80 g and 168.35 g respectively), whereas the fruit weight was minimum in control (104.37 g). The increase in fruit weight with Ethrel might be due to attributed to the reason that the plants remained physiologically more active in building up sufficient food stock for developing fruits. The heaviest fruit formed due to an increase in cell division and cell elongation as well as enhanced metabolic activity under the influence of Ethrel [25-26].

Table 3 Influence of different plant growth regulators on yield attributes in sponge gourd

Treatments	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	Number of fruits vine^{-1}	Yield vine^{-1} (g)
T_1: NAA @ 50 ppm	22.72	13.56	155.98	13.92	2.28
T_2: NAA @ 100 ppm	24.36	12,73	167.21	18.64	2.86
T_3: NAA @ 200 ppm	26.84	11.92	147.34	19.44	2.41
T_4: Ethrel @ 125 ppm	24.60	11.85	168.35	18.75	3.07
T_5: Ethrel @ 250 ppm	25.74	13.12	171.80	23.48	3.98
T_6: Ethrel @ 500 ppm	28.96	14.53	182.76	19.56	3.62
T_7: CCC @ 100 ppm	21.55	14.70	139.85	19.02	2.58
T_8: CCC @ 200 ppm	20.49	15.05	151.62	17.85	2.73
T_9: CCC @ 400 ppm	18.93	15.42	125.58	16.62	2.71
T_{10}: Control	19.29	13.94	104.37	12.60	1.72
S. Ed.	0.92	0.30	4.83	0.69	0.15
CD (p = 0.05)	2.10	0.68	10.13	1.48	0.32

All the treatments produced significantly higher number of fruits per vine when compare to control (Table 3). Among all the treatments, Ethrel@ 250 ppm recorded significantly maximum number of fruits (23.48) per vine followed by Ethrel @ 500 ppm (19.56). This may be due to the fact that Ethrel suppressed the number of male flowers and promoted number of female flowers thereby increased number of fruits [15].

The fruit yield depends on the accumulation of photo assimilates and partitioning in different plant parts. The yield was found to be strongly influenced by the application of different growth regulators, thus indicating the importance of these compounds in increasing the yield potential. All the plant growth regulator treatments ex significantly increased the yield in comparison to the control (Table 3). In the present studies, the plants treated with Ethrel @ 250 ppm produced the maximum yield per vine (3.98 kg), while the control produced the lowest yield per vine (1.72 kg). Next effective treatment was Ethrel @ 500 ppm (3.62 kg). An increase in fruit yield in Ethrel treated plants may be attributed to the reason that plants remain physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to the higher yield. The increase in fruit yield per vine with Ethrel application was owing to the efficiency of Ethrel to build up high levels of ethylene in plants, which increased yield components such as pistillate flowers and the number, size and weight of the fruits [15]. Among different treatments, Ethrel @ 250 ppm was found superior to other treatments for increasing the yield potential of sponge gourd. The economics of crop production worked out for each treatment separately. The highest net return (49083 Rs./ha) was obtained with Ethrel @ 250 ppm, which was followed by Ethrel @ 500 ppm (43,104 Rs./ha).

CONCLUSION

All the growth regulators increased the net returns over control. The production and net returns from Ethrel treatments were higher due to maximum fruit numbers per vine and low cost of growth regulators. Lowest net return (12051 Rs./ha) was obtained from control.

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