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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Effect of Plant Growth Regulators on Pigment Content in *Sechium Edule* L.

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Abstract: *Foliar application of Plant Growth Regulators was carried out to find out the pigment content on Sechium edule L. The growth promoter* GA_3*was applied at the concentrations of 50, 100, 250, 500 and 1000 µg/ml to the seedlings of the crop. In the same way the same range of concentrations of growth retardants Ethrel and CCC were made to the seedlings of S. edule grown in separate experimental plots. Pigment content was estimated by UV spectrophotometric method.* GA_3 *50µg/ml, Ethrel 500µg/ml and CCC 250 µg/ml were recorded as optimum for production of maximum pigment contents in S. edule. The experiment established that application of Plant Growth Regulators, both promoter and retardant are beneficial for regulating pigments in S. edule which can be utilized for regulation of the number of fruits per plant.*

Key Words: *CCC, Ethrel,* GA_3*, Pigment, Sechium edule L.*

INTRODUCTION

Pigments are most important component of green plants of which chlorophyll can harvest solar radiation and converted it into chemical energy. The process photosynthesis, thus, depends upon harvesting of the solar energy by these green pigments. Chlorohyll 'a' plays an important primary role in the photosynthetic process. The status of chlorophyll pigments in the leaf tissue is thus determining the overall photosynthetic efficiency of the plants. The photosynthetic efficiency directly influence on growth, development and yield of crops. The carotenoids, are organic pigments and act as passive light filters that would reduce light intercepted by chlorophyll (Williams *et al*., 2003) and the protection from reactive oxygen species (Steyn *et al*., 2002). Some carotenoids serve as precursor for vitamin A, which plays an essential role in human and animal diets and as antioxidants and also in reducing the risk of certain forms of cancer.

Scientists from different parts of the world are concentrating their field of works on higher productivity of agricultural and horticultural crops by applying Plant Growth Regulators (PGRs). PGRs are the compounds which may induce flowering and even produce flowers of desired sex in some plants. PGRs are mainly growth promoter and growth retardant. Growth promoters are types of phytohormones which promote, enhance or accelerate the overall growth, development and metabolism of plants, while growth retardants are usually the synthetic chemicals which suppress the overall growth and metabolism of plants by slowing down cell division and cell elongation without altering their gross morphology (Cathey 1964). Ali Salehi Sardoei *et al.* (2014) reported that application of plant growth regulators in higher concentration had positive effects on leaf chlorophyll content of *Ficus benjamina, Schefflera arboricola* and *Dizigotheca elegantissima* foliage plants. Bharali and Sarma (2011)

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confirmed the increase in chlorophyll content of potato treated with GA_3. It was reported by Goswami and Kashyap (2012) that GA_3 application in *Brassica campestris* at the concentration of 100 ppm increased total chlorophyll content, which is also responsible for the increase of biomass production and total yield of the crop. The chief objective of the present work was to study the effects of different plant growth regulators GA_3, Ethrel and CCC on the pigment contents of *Sechium edule* L.

MATERIALS AND METHOD

The experiment was conducted at Bongaigaon, Assam, to find out the effect of PGRs on pigment contents of Squash (*Sechium edule* L.) one of the popular Cucurbitaceous crops of northeast India. Experimental plots were well prepared by mixing organic manure before sowing of seeds. The experimental sites received free sunshine. The soil of the field is sandy loam with pH value 5.10.

The healthy seeds of squash were collected from the local market of Guwahati. The experiment was carried out in two experimental plots with six treatments of PGRs including an untreated control. The PGRs selected for experimentation were growth promoter GA_3, and growth retardant Ethrel and CCC. GA_3 prepared in five concentrations namely 50 µg/ml, 100 µg/ml, 250 µg/ml, 500 µg/ml, 1000 µg/ml and one control (distl.water treatment). The same range of concentration was prepared for Ethrel and CCC. The different concentrations of PGRs were applied to the seedlings grown in separate field by foliar spraying of the solutions. The foliar application was carried out with a hand sprayer fitted with a fine nozzle so as to facilitate uniform wetting of leaves with about 20 ml/plant. Each treatment was replicated three times. The leaves from each replication were collected and subjected to estimation of pigments by UV Spectrophotometric method.

Chlorophyll is extracted in 80% acetone and the absorbance is measured at 645 and 663 nm against the solvent blank in a spectrophotometer. The amount of chlorophyll (mg/g) is calculated out by using absorption coefficients. The concentrations of the different chlorophylls were calculated as per Parkin's method as elucidated by Nayek *et al.* (2014).

To determine the carotenoids 100 mg leaf tissue is extracted in 80% acetone and the absorbance is measured at 480 nm in UV spectrophotometer.

The concentrations of the carotenoids were calculated as follows:

Amount of carotenoids in 100 mg plant tissue

$$= 4 \times \text{OD value} \times \frac{\textit{Total volume of sample}}{\textit{weight of fresh plant tissue}}$$

The data recorded was statistically analysed and presented in a tabular form.

RESULTS AND DISCUSSION

The foliar application of Plant Growth Regulators on *Sechium edule* L. exhibited considerable variation in different concentrations. GA_3 at the concentration of 50µg/ml emerged as optimum concentration in squash for production of Chlorophyll 'a', Chlorophyll 'b' and total chlorophyll pigments, estimated as 39.68 mg/g, 34.85 mg/g and 53.82 mg/g, respectively, against the control recorded as 35.84 mg/g, 34.76 mg/g and 50.37 mg/g, respectively. Total carotenoid was estimated as 9.48 mg/g at the concentration of 250µg/ml of GA_3 which was recorded as the maximum value. Chlorophyll 'a' was higher than chlorophyll 'b' in all the concentrations of PGR applied. However, statistical analysis revealed that the PGRs tested in the experiment had insignificant impact on synthesis of chlorophyll a, while, significantly influenced chlorophyll b, total chlorophyll and carotenoid contents in squash. In chlorophyll a-b ratio GA_3 and Ethrel had at par and higher result than that of CCC. Similar trend was also exhibited in total carotenoid content (Table 1).

Amongst the concentrations of PGRs tested (0 to 1000 µg/ml) had no significantly different result in case of chlorophyll a. However, the application of GA_3, CCC and Ethrel had reduced the chlorophyll b content in this crop in such a way that the chlorophyll a-b ratio became higher than that of the control. Total chlorophyll content was also significantly reduced comparing to zero PGR application. In contrary, carotenoid content was significantly increased due to application of PGR over the control to the extent of 55.5% at PGR concentration 1000 µg/ml (Table 1) and Figure 1.

The interaction effect between different concentrations of PGRs had shown significant differences in chlorophyll b, total chlorophyll, carotenoid and chlorophyll a-b ratio, but was no significant in chlorophyll a content (Table 2 & 3). Ethrel showed uniform declination of chlorophyll b with increase of concentration. CCC at 100 µg/ml had insignificant chlorophyll b content with zero concentration. While, in GA_3 the lowest chlorophyll b and total chlorophyll were recorded at the concentration 250 µg/ml, that was 1000 µg/ml in case of CCC. On the other hand, concentration from 50 to 1000 µg/ml of GA_3 and CCC had insignificant difference of chlorophyll a-b ratio, while the values were significantly higher than zero concentration. In contrary, Ethrel had almost uniform increase of chlorophyll a-b ratio from lower to higher concentrations.

GA_3 concentrations 50 and 250 µg/ml resulted the least content of carotenoid and the rest of its concentrations had higher but at par results. CCC concentration 50 µg/ml had the highest carotenoid content which was at par with 100 µg/ml. In case of Ethral, concentration 100 and 250 µg/ml had the least carotenoid content followed by 50 µg/ml; the highest content of carotenoid was produced at concentration 1000 µg/ml which was at par with 500 µg/ml.

Manipulation of growth and development of plants for agricultural and horticultural purposes is an absorbing interest to the plant physiologists. The important tools, being used in recent days, for achieving plant types for enhanced productivity of crop plants are some growth promoters and growth retardants (Lama, 2000). GA_3 is a growth promoting hormone and it has physiological as well as morphological effects on plants. It is found in the form of crystalline solid, crystalline potassium salt, compressed tablets of acid plus buffering products and as isopropyl alcohol solution. It is soluble in methanol, ethanol, acetone and dilute alkali, moderately soluble in ethyl acetate, slightly soluble in water and ether (Anon, 1967). Gibberellins are known to increase fruit set, expand leaf area, remove hyponasty of leaves and increase maleness in cucurbits and femaleness in maize and castor bean was reported by Nath (1996). Suryanarayanan (1981) worked on mango plant and studied the influence of growth retardants on respiration, chlorophyll and carotenoid pigments in mango leaves in relation to flowering. The retardants improved the flowering potential of mango trees by providing a more efficient photosynthetic apparatus and by moderating the respiratory catabolism.

Several workers have reported that Plant Growth Regulators imparts a favourable effect on chlorophyll content. Cycocel at 250 and 500 ppm significantly improved the chlorophyll contents in leaves of *Brassica napus* (Grewal *et al.*, 1993). Effects of Cycocel on chlorophyll content have also been reported in mungbeen (Shah and Prathapasenan, 1991), green gram (Mandal *et al.*, 1997), Sesamum (Bashist, 1990), Soyabean (Abo-El-Kheir *et al.*, 1994), Onion (Miroshnichenk and Manakov, 1992), Wheat (Sairam *et al.*, 1991), Safflower (Kar *et al.*, 1989), *Brassica juncea* (Lone 2001) and Cotton (Kumar *et al.*, 2005).

The chlorophyll content was significantly increased in response to GA, CCC, methionine and cysteine applications (Lokhande, 2014). Application of CCC in *Lolium temulentum* recorded increase in chlorophyll content (Stoddert, 1965). It was reported by Yadav *et al.* (1978), foliar application of CCC enhanced carotenoid in leaves of *Trifolium alaxandrum* (Berseem) plants. Increased chlorophyll content of leaves of GA_3 treated plants may be indication of increased rate of photosynthesis (Kanjilal, 1998).The findings of present experiment is in support with Gomathinayagam *et. al* (2009) who achieved increased level of Chlorophyll 'a' and chlorophyll 'b' in *Andrographis paniculata* after GA_3 treatments. Kojo (2004) observed increase in carotenoid content of Onion leaves by foliar application of growth regulators. He reported that increased level of carotenoid content might play an important role in the protection against oxidative stress as well as protect the chlorophylls and maintain better growth and productivity of onion bulb.

A number of workers studied the effect of Ethrel (2-chloroethyl phophonic acid) and CCC (2-chloroethyl trimethyl ammonium chloride) on reversal of sex in different plants. Ethrel caused increased femaleness in cucurbits (Ito and Saito 1956, Pandey *et al*., 1976). The effect of ethrel on *Cucurbita pepo* cv.Amcobella were studied by GAD *et al*. (1993). They reported that ethrel at 225 ppm and 300 ppm markedly reduced the number of male flowers and increased the number of female flowers within the first 15-20 days from anthesis and increased early and total yield, number of fruits/

Table 1
Effect of plant growth regulators on pigment content (mg/g) in *Sechium edule*

	Chlorophyll a	*Chlorophyll b*	*total chlorophyll*	*Carotenoids*	*Chlorophyll a:b*
Plant Growth Regulator					
GA_3	36.09	25.26	40.65	6.71	1.69
CCC	35.42	28.78	44.08	5.14	1.29
Ethral	35.78	24.11	38.74	6.67	1.68
S.Ed (±)	0.31	0.17	0.04	0.10	0.05
CD 5%	NS	1.00	0.25	0.61	0.31
Concentration (μg/ml)					
0	35.84	34.76	50.37	3.30	1.02
50	36.90	28.72	44.72	6.46	1.31
100	34.41	28.95	43.58	6.00	1.20
250	34.46	21.02	35.13	7.31	2.05
500	35.94	23.93	39.40	6.55	1.67
1000	37.04	18.55	33.74	7.42	2.07
S.Ed (±)	0.63	0.33	0.08	0.02	0.10
CD 5%	NS	1.41	0.35	1.00	0.44
PGR x Conc.	NS	S	S	S	S

Table 2
Interaction effect of plant growth regulators and concentrations on chlorophyll b and total chlorophyll in *Sechium edule*

	Chllrophyll b						*Total chlorphyll*					
	0	*50*	*100*	*250*	*500*	*1000*	*0*	*50*	*100*	*250*	*500*	*1000*
GA_3	34.76	34.85	25.39	11.08	23.71	21.75	50.37	53.82	39.65	25.05	37.78	37.20
CCC		23.15	32.09	29.83	33.12	19.71		37.71	47.78	43.69	50.57	34.38
Ethrel		28.17	29.38	22.15	14.96	14.18		42.63	43.30	36.64	29.85	29.63
S. Ed (±)			0.98						0.25			
CD 5%			2.45						0.61			

Table 3
Interaction effect of plant growth regulators and concentrations on chlorophyll a-b ratio and total carotenoids in *Sechium edule*

	Chlorophyll a:b						*Carotenoids*					
	0	*50*	*100*	*250*	*500*	*1000*	*0*	*50*	*100*	*250*	*500*	*1000*
GA_3	1.03	1.31	1.38	2.04	1.45	1.75	3.30	4.10	9.48	6.53	7.99	8.87
CCC		1.54	1.07	1.14	1.12	1.82		7.42	6.64	4.81	1.69	5.04
Ethrel		1.26	1.17	1.60	2.43	2.65		7.86	5.80	6.67	8.04	8.36
S. Ed (±)			0.31						0.60			
CD 5%			0.76						1.50			

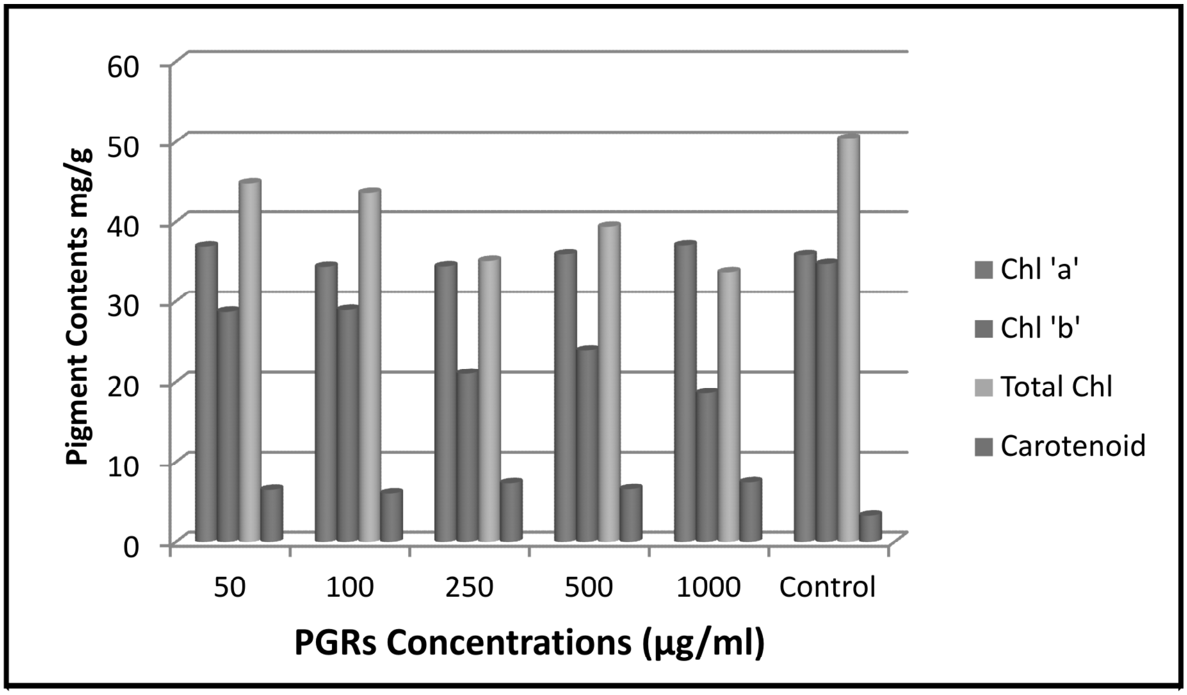

Figure 1: Effect of PGRs Concentrations on Pigment content in *Sechium edule* L.

plant and fruit weight compared with unsprayed controls. It was confirmed by (Baruah and Sarma, 2013) that PGRs shows a tremendous effect in increasing femaleness in squash. It is evident that growth retardants help in the yield of fruits/plant. This is in conformity with the present study that growth retardants and growth promoter also enhanced the level of pigments in *S.edule*, which is correlated with the photosynthetic efficiency of the plant. Higher level of Pigments means higher photosynthetic efficiency which ultimately helps in the yields of fruits of the crop in greater quantity.

COCLUSION

From the present study it is evident that Plant Growth Regulators have an immense influence in the enhancement of pigment contents in Squash. Higher level of pigments is directly correlated with the production of the crop. The PGRs, both promoter and retardant are beneficial for regulating pigments in squash which can be utilized for regulation of the number of fruits per plant.

Acknowledgement

The authors are thankful to the Bio-Tech Hub, Birjhora Mahavidyalaya, Bongaigaon for providing the lab facility to carry out the biochemical analysis. The authors are obliged to Mr. Jayanta Kumar Roy, Asstt. Executive Engineer, PWD, Assam for his constant support, help and encouragement.

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