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Influence Of Plant Growth Regulators On Vegetative And Phenological Characters Of Okra (Abelmoschus Esculentus L. Moench) Cv. Utkal Gourav

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Abstract

A field experiment was conducted at All India Coordinated Research Project on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar, during kharif 2021.Foliar spray of PGRs at various concentrations were given to okra crop cv. Utkal Gourav. The experiment was laid out in Randomized Block Design with three replications and eleven treatments viz., GA_3 (100 ppm) (T_1), GA_3 (150 ppm) (T_2), NAA (150ppm) (T_3), NAA (200 ppm) (T_4), Thiourea (250 ppm) (T_5), Thiourea (500 ppm) (T_6), Cycocel (200 ppm) (T_7), Cycocel (250 ppm) (T_8), Paclobutrazol (100 ppm) (T_9), Paclobutrazol (200 ppm) (T_{10}) and Control (T_{11}). The foliar sprays of growth regulators were done at 15 & 30 days after sowing. All growth regulators significantly performed better as compared to control. The results revealed that NAA performed better with respect to plant height (148.66cm), internodal length (8.66 cm) and leaf area (237.60 Cm^2) compared to control with 112.83 cm,5.45 cm & 174.69 Cm^2 respectively. Cycocel 250 ppm recorded significantly better with respect to number of nodes per plant (21.53), number of branches per plant (3.47), number of leaves (32.74), leaf chlorophyll content (1.390 mg/100 g) and days to 50 % flowering (36.50). However the untreated control plot recorded number of nodes per plant (15.08), number of branches per plant (1.66), number of leaves (21.88), leaf chlorophyll content (1.071 mg/100 g) and days to 50 % flowering (42.10).

Keywords: Vegetative growth, flowering behavior, growth promoters, growth retardants, Internodal length

1.Introduction

Okra (*Abelmoschus esculentus* L.) belongs to family Malvaceae, suitably grown in both Summer & Kharif season. Its center of origin is Ethiopia (Tanda,1985). Its a continuous flowering & fruiting crop that produces fruits in leaf axil. Flowering & fruiting are the daily phenomenon for this crop. Hence after 5 to 7 days of anthesis the tender & immature fruit is suitable for consumption (Sistrunk *et al*.,1960). After 7th day, dietary fiber converted into crude fiber & henceforth the entire pod become inedible. It is often cross-pollinated crop (5-12%) (Chadha ,2001). It is an important source of iodine which ultimately control goiter.

Plant growth regulators created a revolutionary history in both agriculture and horticulture production. They are the organic compound which stimulate different plant physiological and plant biochemical processes. They produce in one part of the plant and hence translocated to another part. Some of them enhance the growth and development so that they are called growth promoters and those who retard the growth known as retardant.
In this context GA_3, NAA & Thiourea are growth promoters, whereas cycocel and paclobutrazol are growth retardants.GA_3 helps in early seed germination, enzyme production & photosynthates mobilization. (Bewley & Black,1983). Foliar application of GA_3 synchronize flowering & fruit set (Briant,1979) enhances photosynthesis. It increases number of pods per plant and weight of the seed. NAA helps in cell elongation, cell division, cell enlargement, vascular tissue differentiation and create apical dominance. It increases supply of photosynthates and their efficient mobilization in plants leading to higher fruit length and fruit weight. In case of NAA & GA_3 more metabolic activity of plants with more meristematic activity were observed which resulted higher vegetative growth.
Cycocel and Paclobutrazol are growth retardants induce early flowering, retard vegetative growth so that there will be broader reproductive cycle as well as it reduce duration of the crop. It is a type of cytokinin which suppresses vegetative growth, reduce apical dominance and also reduce lodging effect. So it has a less demand of food material for vegetative growth. Hence after metabolic utilization of photosynthates, excess carbohydrate reserves induce early flowering and accelerate reproductive phase of the plant. which ultimately reduces plant height, increases no. of branches, reduce flower and fruit drops. Keeping pace with the influence of PGRs on growth behavior of plants, present experiment was designed to study the effect of promoters and retardants on both vegetative and phenological characters of okra cv Utkal Gourav.

2. Materials And Methods

The research work was conducted in the AICRP on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar, during kharif 2021. The experiment was laid out in RBD with three replications and eleven treatments viz., GA_3 (100 ppm) (T_1), GA_3 (150 ppm) (T_2), NAA (150ppm) (T_3), NAA (200 ppm) (T_4), Thiourea (250 ppm) (T_5), Thiourea (500 ppm) (T_6), Cycocel (200 ppm) (T_7), Cycocel (250 ppm) (T_8), Paclobutrazol (100 ppm) (T_9), Paclobutrazol (200 ppm) (T_{10}), Control (T_{11}). Foliar spray of PGRs at various concentrations were given to okra crop cv. Utkal Gourav at 15 and 30 Days after sowing. In Control, equal quantity of water (without any PGR) was sprayed. The foliar spraying was carried out with the help of hand sprayer. The observations were recorded at peak fruiting stage of the crop.

3.Results And Discussion

a) Vegetative Parameters

Plant height (Cm): The result presented in table 1 and figure 1 revealed that during the season, the application of NAA (200 ppm), T_4 was the best increasing the plant height to maximum (144.56 cm) and is statistically at par with T_3, NAA(150 ppm) (141.21cm); T_2, (GA_3 150 ppm) (138.78 cm), T_1, GA3 (100ppm)(133.77 cm).The untreated control plot recorded plant height of 112.83 cm ,which was significantly lower than T_4 ,NAA(200 ppm) & $T_{3,}$ NAA (150 ppm). Plant growth regulators have significant influence on plant height. Generally the growth promoters increases the height and retardants decrease it. Significant increase of plant height was also recorded by Baraskar *et al*. (2018) and Gadade *et al*. (2017). The present study resulted GA_3 as a second best performer in increasing plant height. Researchers like Shahid *et al*. (2013) &Tiwari *et al*. (2017) also concluded both GA_3 and NAA having performance with respect to plant height when used either singly or in combination. However among the growth retardants T_8 (cycocel 250 ppm) was the best in lowering the plant height up to (87.10 cm) cm & also found statistically at par with T_7, cycocel (200 ppm) (91.29cm), T_{10} (paclobutrazol 200 ppm) (92.18 cm) and T_9 (paclobutrazol 100 ppm) (92.81cm). However T_8, cycocel (250 ppm) and $T_{10,}$ paclobutrazol (200 ppm) expressed significant height reduction as compared to control. The present investigation revealed lowest plant height with cycocel (250 ppm); which is also in agreement with findings of Kumar *et al*. (2018) who concluded that in okra cv. Varsha upahar , lowest plant height and internodal length recorded with cycocel (600 ppm) where growth parameters increased due to influence of cycocel which supports the present findings. The reason for reduction in height of plant might be that cycocel produced shorter stem length through inhibition of cell division. Cycocel interact with gibberellins or lower the levels of diffusible auxin and thereby suppress vegetative growth (Gowda and Gowda, 1983). These results are in conformity with that of Pateliya *et al*. (2008) with CCC and ethrel and Chutichudet *et al*. (2007) in okra with PBZ.

Number of branches per plant: Effect of growth regulators on branches also expressed significant effect with T_8 cycocel (250 ppm) and T_{10} paclobutrazol (200 ppm) with number of branches being 3.48 & 3.30 in kharif 2021 which are statistically at par as compared to control (1.66). Pateliya *et al*. (2008) reported improvement and increase in fruit yield might be due to Cycocel which reduces plant height and increases no. of branches, so that the flow of food materials are diverted for improvement of flowering and fruiting. Jyotsna *et al*. (2022) recorded highest primary branches with growth retardant paclobutrazol. The present findings also recorded more number of branches with cycocel and paclobutrazol.

Internodal length (Cm): The effect of growth promoters and growth retardants were studied on internodal distance which is presented in Table 1. During the season the internodal distance was found the highest in $T_{4,}$ NAA (200 ppm) which was statistically at par with $T_{3,}$ NAA (150 ppm). T_8 cycocel (250 ppm) was recorded the lowest internodal length (4.62 cm) which was statistically at par with $T_{7,}$ cycocel (200 ppm) 5.06 cm, $T_{9,}$ paclobutrazol (100 ppm) & $T_{10,}$ paclobutrazol (200 ppm) recording internodal length of 5.35 cm and 4.95 cm respectively. However untreated control plot recorded internodal length of 5.45 Cm. The foliar spray of cycocel also has been found to promote reduce plant height by reducing the internodal length which simultaneously induce the enhancement of reproductive phase thus giving higher yield (Shaik Moulana *et al*.,2020). NAA application might be attributed to enhance auxin activity where GA_3 foliar spray attributed to cell enlargement and internodal elongation which ultimately leads to enhanced growth & development (Jyotsna *et al*.,2022). These two concepts of growth hormone influence on internodal elongation and reduction is in agreement with the present findings. The length of internodes was decreased with increased in concentration of cycocel, the growth of internodes was short mainly due to cycocel which restricted cell division and elongation in the apical meristem, hence, length of internodes was decreased (Patil *et al*., 2008). Reduction in internodal length with increasing concentration in present study have also been similarly recorded by Nawalkar *et al*. (2007), Mandal *et al*. (2012) with respect to CCC in okra, Rai *et al*. (2006) in tomato experimenting with PBZ and Ouzounidou *et al*. (2010) while tested with ethrel in capsicum.

Number of nodes per plant: Observations on number of nodes per plant was the highest in $T_{8,}$ cycocel (250 ppm) (21.53 cm) followed by T_{10} paclobutrazol 200 ppm (20.64 cm), $T_{7,}$ cycocel (200 ppm) (20.22 cm) and $T_{9,}$ paclobutrazol (100 ppm) (19.16) which were at par and significantly higher than control (15.08) & all other growth regulators under test during the crop growth period. This result corroborated with findings of Moulana *et al*. (2020) who revealed maximum number of nodes per plant (27.21) observed with foliar spray of cycocel (400 ppm). The increased number of nodes might be due to additional availability of cycocel to the plant as foliar application. The increased number of nodes also found with increased concentration of growth retardants which confirmed the present research as revealed with increase in concentration of cycocel and paclobutrazol when the doses increase from 200 to 250 ppm and 100 to 200 ppm respectively. Maharkar *et al*. (2007) & Praveen *et al*. (2018) supported the present result. Cycocel reduced intermodal length by restricting the cell division hence, it increase the number of internodes (Tosh *et al*., 1978). The findings were closely in confirmation with the results observed by Prasad and Srihari (2008) with CCC and ethrel.

Number of leaves per plant: Data presented in table 2 represented the effect of PGRs on leaves per plant. During kharif 2021, highest number of leaves recorded in T_8 i.e., cycocel (250 ppm) (32.74) followed byT_2 GA_3 (150 ppm) (30.65). T10 paclobutrazol (200 ppm) (29.41), T_7cycocel (200 ppm) (29.59) and T_1 GA_3 (100 ppm) (29.03 cm) are statistically at par & significantly higher when compared to T_{11} control (21.88). Ayubb *et al*. (2013) & Bhagure and Tambe (2013) worked on influence of PGRs on okra also demonstrated the same result. Bhagure and Tambe (2013) reported highest number of leaves and leaf area when seeds of okra soaked with GA_3@100 ppm and foliar spray of cycocel @750 &1000 ppm sprayed at 30 &45 days respectively. These two PGRs also performed better than others when experimented with okra cv. Utkal Gourav. Ayubb *et al*. (2013) recorded increase number of leaves with application of GA_3 along with other vegetative and reproductive parameters which supports the better performance of GA_3 in the present findings. The number of leaves was increased with increased in concentration of cycocel. It might be due to cycocel effect in suppressing apical dominance, there by promoting the growth of lateral buds into new shoots (Arora and Dhankhar,1992). Similar trends of results also obtained by Mandal *et al*. (2012) with CCC in okra and Marsh *et al*. (1990) with ethrel in okra.

Leaf area (Cm^2): Effect of PGRs demonstrated significantly increase in leaf area with spray of all growth promoters being highest in T_4 NAA (200 ppm) (237.60 Cm^2) closely followed by $T_{2,}$ GA_3 (150 ppm) (233.76 Cm^2) and T_3NAA (150ppm) (228.29 Cm^2)which were statistically at par in experiment compared to T_{11} control

(174.69 Cm^2).T_8 cycocel (250 ppm) was recorded the lowest leaf area (180.51 Cm^2) which were statistically at par with T_7, cycocel (200 ppm)(183.22 $Cm^{2)}$ & T_9, paclobutrazol (100 ppm) (196.72 Cm^2) and T_{10}, paclobutrazol (200 ppm)(189.37 $Cm^{2)}$ which is being supported by result of Barskar *et al*. (2018) Ravat & Makani (2014). Under the influence of plant growth regulators like GA_3, NAA, chitosan and salicylic acid, elongation and multiplication of cell takes place and it may have resulted in large and broader blade size of leaf. It is observed fact, that GA_3 act in cell elongation or cell enlargement resulting in increased in size of leaves. Similar result was also reported by Kokare *et al*. (2006) and Elumalai *et al*. (2013) in okra.

Leaf Chlorophyll content (mg/100g): Data presented in table 2 revealed that the maximum chlorophyll content (1.39 mg/100g) with cycocel (250 ppm) foliar spray closely followed by GA_3 (150 ppm) (1.387 mg/100 g) compared to control (1.071mg/100g).Kokare *et al*.(2006) also reported Cycocel (400 ppm) to increase total chlorophyll content in both leaf and fruit and also decrease the days to 50% flowering. It might be due to CCC which have the ability to delay senescence of leaf, arresting the chlorophyll degradation and promoting the synthesis of soluble protein and enzyme (Srivastava and Goswami, 1988). Similar findings were also recorded by Joshi (2001) applying CCC in capsicum, Faten (2003) in okra with PBZ and Deepak *et al*. (2007) experimenting with ethrel in okra.

Days to 50% flowering: The PGRs effect on various phenological parameters were also studied and data represented in table 2 and fig 2 is that the superiority of all growth regulators in reducing days to 50% flowering. Days to 50% flowering is one of the important phenological character which expressed early ness in flowering with cycocel (250 ppm) (36.50days) and paclobutrazol (200 ppm) (36.92days). Earlier the researchers also reported earliness in flowering due to spray of growth retardants like cycocel & paclobutrazol. Shaik Moulana *et al*. (2020), Kokare *et al*. (2016) and Pateliya *et al*. (2008) reported that cycocel (300 ppm) influence early flowering (37.26 days) with a lengthy reproductive phase (67.20 days). The excessive carbohydrate reserve might have induced early flowering and accelerated reproductive phase of the plant. This result is similar to findings of present research where cycocel (250 ppm) is the best performer with respect to early flowering and fruit yield.

Table:-1 Effect of foliar spray of plant growth regulators on plant height, no. of branches, no. of nodes and internodal length per plant grown in *kharif* 2021 at peak fruiting stage in cv. Utkal Gourav

Treatments		**Plant height (cm)**	**No. of branches**	**No. of nodes**	**Internodal length (cm)**
T_1	GA_3 (100 PPM)	138.59	2.96	17.66	6.63
T_2	GA_3 (150 ppm)	142.36	3.00	18.68	6.74
T_3	NAA (150 ppm)	144.55	2.56	16.92	8.01
T_4	NAA (200 ppm)	148.66	2.96	17.89	8.66
T_5	Thio urea (250ppm)	127.11	2.37	16.50	7.78
T_6	Thiourea (500 ppm)	130.59	2.43	16.12	7.62
T_7	Cycocel (200 ppm)	95.81	2.73	20.22	5.06
T_8	Cycocel (250 ppm)	93.22	3.47	21.53	4.62
T_9	Paclobutrazol (100 ppm)	97.61	2.53	19.16	5.35
T_{10}	Paclobutrazol (200 ppm)	95.14	3.12	20.64	4.95
T_{11}	Control	112.83	1.66	15.08	5.45
	Grand mean	120.59	2.71	18.21	6.44
	S.E.m (±)	5.67	0.15	0.797	0.25
	CD (5%)	16.72	0.45	2.351	0.75

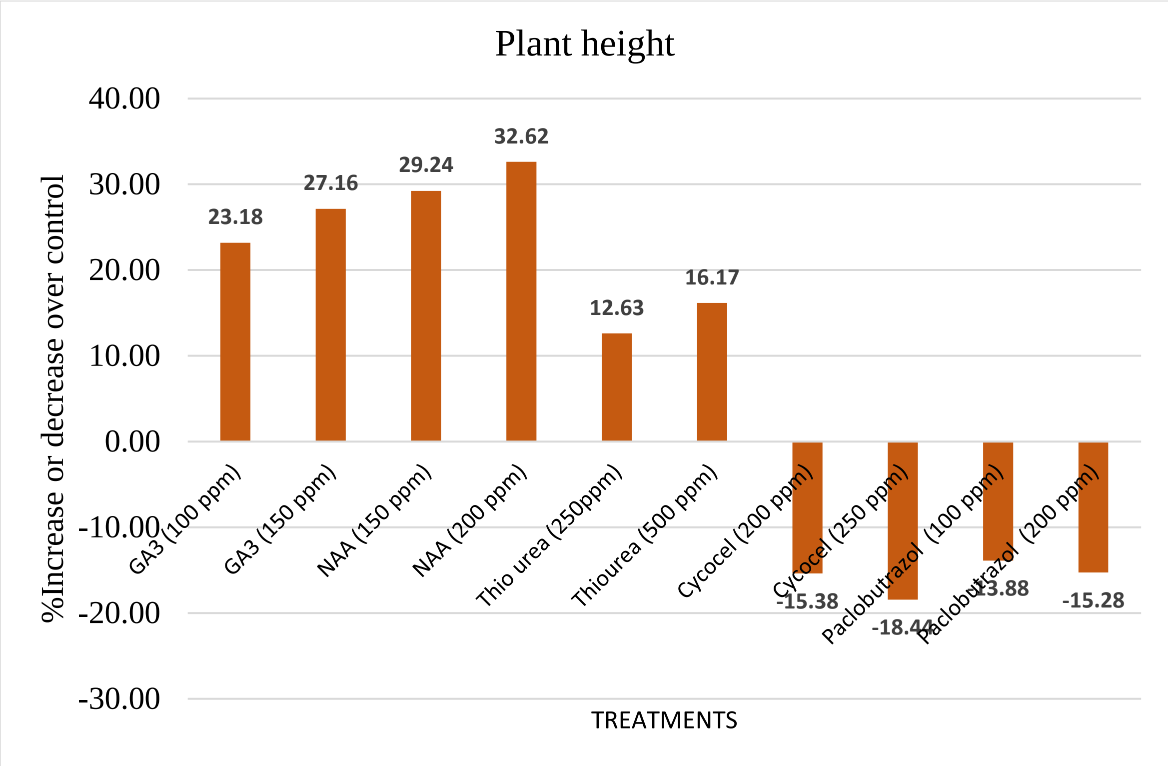

Figure 1:- Percent increase over control in Plant height in seed crop of okra cv. Utkal Gourav as influenced by foliar application of growth regulators

Table:-2 Effect of foliar spray of plant growth regulators on no. of leaves, leaf area, leaf chlorophyll content and days to 50% flowering grown in *kharif* season at peak fruiting stage in okra cv. Utkal Gourav

Treatments		**No. of leaves**	**Leaf area (Cm^2)**	**Chlorophyll content (mg/100g)**	**Days to 50% flowering**
T_1	GA_3 (100 PPM)	29.03	221.91	1.190	41.80
T_2	GA_3 (150 ppm)	30.65	233.76	1.387	41.37
T_3	NAA (150 ppm)	27.26	228.29	1.263	39.43
T_4	NAA (200 ppm)	27.57	237.60	1.311	39.23
T_5	Thio urea (250ppm)	26.98	213.11	1.181	38.00
T_6	Thiourea (500 ppm)	25.46	210.58	1.277	38.24
T_7	Cycocel (200 ppm)	29.59	183.22	1.384	37.39
T_8	Cycocel (250 ppm)	32.74	180.51	1.390	36.50
T_9	Paclobutrazol (100 ppm)	28.02	196.72	1.239	38.54
T_{10}	Paclobutrazol (200 ppm)	29.41	189.37	1.276	36.92
T_{11}	Control	21.88	174.69	1.071	42.10
	Grand mean	27.98	206.34	1.270	39.05
	S.E.m (±)	1.59	5.16	0.004	1.26
	CD (5%)	4.69	15.23	0.012	3.71 (s)

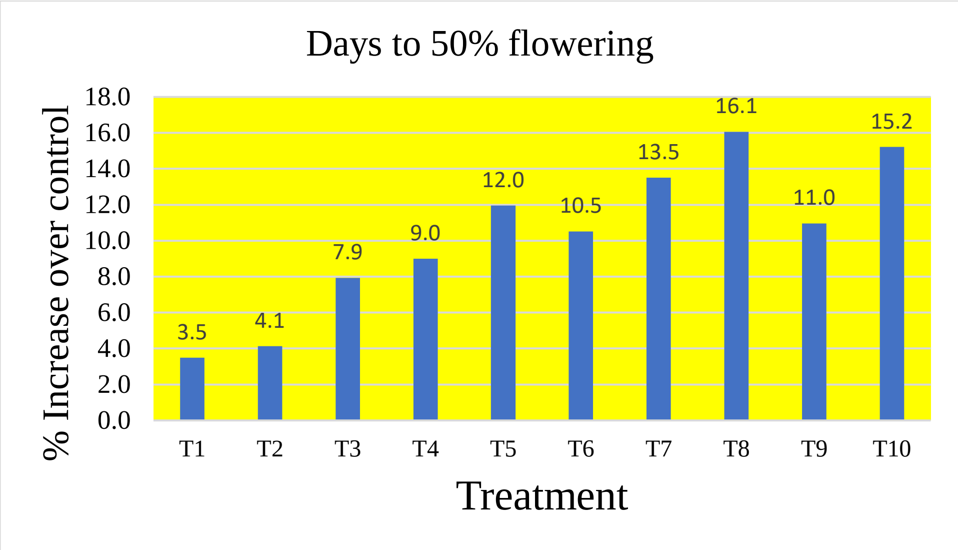

Figure 2:- Percent increase over control in Days to 50% flowering in seed crop of okra cv. Utkal Gourav as influenced by foliar application of growth regulators

4.Conclusion

The results obtained during the present investigation reveals that the effective concentration of plant growth regulators can be used to improve the growth and yield parameters of okra especially treatment with foliar application of Cycocel &NAA. So it can be concluded that foliar application of Cycocel (250 ppm) and NAA (200ppm) were most effective in enhancing the vegetative as well as phenological parameters of okra. The yield attributing characters like leaf chlorophyll content, number of leaves and days to 50% flowering is earlier in T_8 (Cycocel 250 ppm) than other plant growth regulators under test.

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