SYNOPSIS

Title: Effect of Gibberellic Acid and Maleic Hydrazideon growth and yield ofOkra[*Abelmoschusesculentus* (L.) Moench]

MASTER OF SCIENCE
IN
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BY

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CERTIFICATE

Certified that this synopsis of Jyoti Verma, registration no. 11714491, entitled **"**Effect of Gibberellic Acid and Maleic Hydrazide on growth and yield of Okra [*Abelmoschus esculentus* (L.) Moench]**"** has been formulated and finalized by the student himself on the subject.

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INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] has captured a prominent position among vegetables it is choicest fruit vegetable grown extensively in the tropical, subtropical and warm area of the world like India, Africa, Turkey and other neighbouring countries. In India, okra is one of the most important vegetable crop grown for its tender green fruits during summer and rainy seasons. Okra is belonging to the family Malvaceae and a self pollinated crop, occurrence of out crossing to an extent of 0.34 – 27.30 percent is noticed with the insect assisted pollination (Kalloo, 1994). Tender green fruits are cooked in curry and soup, while crop has not adapted in India as leafy vegetable as in for East countries. It was probably domesticated in the Ethopian region but according to Murdoc it is in West Africa.

Okra is known by many local names in different parts of the world. It is called lady's finger in England, Gumbo in U.S.A. and Bhindi in India. Edible fresh and mature fruits contain 88% moisture and large number of chemical components including Vit. A 88 IU, B 63 IU and C 13 mg/100 gm. Unripe okra fruits contain 3100 calorie energy, 1.8gm. Protein, 90 mg. Calcium and 1.0 mg iron. Seed of okra (Pusa makhmali) had the highest oil content 17.3% which is a nutritious ingredient of cattle feed. It has Ayurvedic medical properties. Its leaves are used for preparing a medicament to reduce inflammation. It is an excellent source of Iodine for control of goiter (Chadha, 2001).

In India, among fresh vegetables, 60 per cent share of export goes to okra. Okra is widely cultivated in plains of the India with acreage of 518.37 thousand hectare and production 6259.19 thousand mt. In Madhya Pradesh okra is grown in 23.59 thousand hectare area and 310.00 thousand mt. production with 13.14 tonnes productivity (NHB 2011-12). It is a hardy crop and can be grow with considerable success on a wide range of soils and under variable environmental conditions. In India it is grown twice in a year for getting regular supply. In the country, a large number of okra varieties are grown, the variation occurs with regards to quantitative and qualitative traits. The plant height, number of primary branches per plant, number of fruits per plant, size of fruit i.e. length as well as weight of fruits are the yield contributing characters while, colour of fruit and fiber content determine the quality of fruit.

The foremost challenge to the existence of mankind has always been to produce adequate quantity of food form the available acreage to meet the requirements of ever expending world population. The rate of yield gain in crop improvement programme must match the rate of population growth so, as to avoid malnutrition and hunger.

The security of agricultural produce in the country can be improved if the soil, the people and the modern technology are brought in a proper relationship. The growth developments of plants are the result of the dynamic and complex processes at cellular and molecular levels. The rate of growth and pattern of development of a plant depends upon both its genetic constitution and on environmental factors. Therefore to induce any change in the behavior of the growth and development, the endogenous processes of molecular level should be altered by genetic engineering or application of growth hormones at an appropriate level. The hormonal level between different parts of the plants must clearly involve some control mechanism, such as root initiation, onset and termination of dormancy, flowering, fruit set and development, abscission, senescence and rate of growth in plants which result in final productivity. Through intensive studies, it is now known that plant growth substances play vital roles in the control of growth, not only within the plant as a whole, but also within individual organs. In many agricultural plants the process of growth can be altered by altering the endogenous hormonal levels through proper application of exogenous plant growth substances and it is quite possible that all physiological processes in plants will be economically manipulated to man's benefit. Use of growth substances for engineering the flowers and fruit set and size has become increasingly important.

Modern technology of agricultural science to improve plant and yield has brought into plant nutrition, use of plant protection measures and recently the use of plant growth regulators. Plant growth regulators are known to change the growth and development pattern of crop plants by altering many physiological and biochemical processes and thereby increasing the yield of crops. The growth regulators and their uses are considered to be most technical and scientific in crop production. The selection of right hormones, their appropriate concentration and their time and method of application are most essential. Even the same growth regulators in different concentrations bring about the different results.

In view of the above facts, the present studies in okra entitled “Effect of gibberellic acid and maleic hydrazide on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench)” has been carried out with the following objectives:

Objectives:

1. To study the effect of GA3 and MH application on morphological parameters of okra.

2. To ascertain the suitable concentration of GA3 and MH for improving the growth, yield and quality of okra.

3. To work out economics of the various treatments and select out viable and feasible combination of the treatments.

REVIEW OF LITERATURE

Effect of plant growth regulators on seed germination

Srivastava and Singh (1968) reported the effect of GA3 on germination of okra seeds. The okra seeds were allowed to soak at different concentrations of GA3 for six hours before seed sowing. The GA3 at 10 ppm resulted in the highest germination percentage.

Bhat and Singh (1996) reported that seed treatment with GA3 (100, 200, 300 ppm) improved its germination. They attributed this to be due to its effects on various metabolic activities, as it stimulates synthesis of hydrolytic enzyme, which are secreted and act on starchy endosperm in turn affecting physiology of seed germination and establishment of seedling but not significantly superior over control.

Srivastava and Sachan (1985) are that the effect of GA3 treatments (50 and 75 ppm) were more pronounced and give higher germination percentage whereas Suryanarayan and Arifuddin (1980) indicated non-significant response of GA3 treatment on seed. However Srivastava and Sahan (1965) reported improved seedling vigor at 100 ppm GA3 seed treatment which could be attributed to active physiological processes leading to build up of sufficient food reserve and resulting into better growth and development of plants.

Effect of plant growth regulators on vegetative characters

In okra, use of GA3 at 50 ppm exhibited maximum plant height (99.43 cm) as compared to 0, 25, 100 ppm and control (Maurya et al. 1987). A similar study at Varanasi of India in summer season of 1983 on use of GA3 revealed that use of GA3 @ 50 ppm spray increased plant height (55.42 q/ha) as compared to control (48.32 cm) (Maurya et al., 1985). All GA3 treatments, either alone or in combination with urea and Agromin (nutrient mixture), significantly increased the plant height over control (Surya narayana & Subba Rao, 1981). GA3 plus Agromin exhibited the maximum plant height (91.16 cm). Naphthalene Acetic Acid treatments also increased the plant height considerably (73.40 cm). The plants receiving cycocel (CCC) treatments were significantly shorter (28.40 cm) than untreated plants (62.25 cm). The inhibitory effect of CCC on plant growth was counteracted to some extent by urea and Agromin.

At initial stage of growth all the plants were almost similar in respect of plant height and number of branches, when okra (cv. Pusa Sawani) seeds were treated with 100, 200, 400 and, 800 ppm Ethrel (2-Chloroethyl phosphonic acid), but at the time of final observation these characters varied markedly due to treatments. Plants treated with 800-ppm ethrel were as tall as 60.23 cm but at control the plant height was 64.13 cm. More number of branches per plant (4.58) was recorded in both 200 ppm and 400 ppm; however, 4.0 branches were recorded in control. Statistically less number of branches was recorded in higher concentration of Ethrel (Chhonker *et al.,* 1977).

A study conducted by Surya narayana and Rao (1981) to study the effect of growth regulators on yield of okra by spraying GA3, CCC, and Maleic hydrazide (MH) twice at 15 and 30 day after sowing at concentration of 25, 50, 200, and 1000 ppm revealed that except CCC (28.4cm) all treatments increased plant height, GA3 showing the highest (85.76 cm).

Effect of plant growth regulators on reproductive characters

Different combinations of GA3 and Indole acetic acid (IAA) concentrations were compared as seed treatment and/or whole plant spray on the cv. Pusa Sawani. Significant effects were observed in respect of number of days to flower. Seed soaking with 10 ppm GA3 and plant spray with 300 ppm of GA3 (30 days after sowing) advanced flowering by 6.33 days when compared with 50-ppm IAA seed treatment plus 100 ppm of same plant spray (Rattan et al., 1987).

Soaking of okra seeds (cv. Pusa Sawani) in 100-ppm solution of cycocel for 24 h significantly reduced the number of days to 50% flowering while maximum number of days were taken in control. Significant difference in the number of days to 50% flowering was recorded due to seed soaking in 100 ppm cycocel followed by foliar spray of same regulators, which took 38 days to 50% flowering whereas control and water soaking of seeds delayed it (48 days) (Arora and Dhankar, 1992).

Pandita's study on Pusa Sawani with seed soaking and foliar spray in both summer and rainy season crop with mixtalol and Vipul showed that the difference in the number of days to flowering 50% of the plants due to the treatments was not significant in rainy season. Seed soaking in Vipul at 2 ppm for 3 hrs + single spray of this solution resulted in significantly earlier flowering of plants while Mixtalol at 4 ppm when sprayed twice and Vipul 2.5 ppm when sprayed three times significantly delayed the flowering in summer season crop (Pandita *et al.,* 1991).

Effect on quality

Munda *et al*. (2000) reported that the applications of different concentration of growth hormones viz, GA and NAA on different parameter of Okra seeds revealed that GA 100 ppm as seed treatment was found to be most effective where, seeds per pod, weight per pod, weight of seed per plant, size of seed, 100-seed weight and seed yield per ha was significantly superior over rest of the treatment.

Patil *et al*. (2008) reported that the reproductive and quality parameter viz., length of dried pod, weight of seeds per pod, yield per plant and yield per plot and weight of 100 seeds, the treatment GA at 50 ppm showed significantly superior performance over remaining all other treatments.

Pateliya *et al*. (2008) showed that the foliar application of CCC at 300 ppm at 25 and 50 DAS. The fruit quality, i.e. crude fiber content, was found non-significant.

Effect of gibberellic acid and maleic hydrazide on growth and yield

Singh *et al.* (1998) reported that the urea and gibberellic acid application enhanced the growth and fruit yield of okra significantly. The interaction of urea and GA3 also had a favorable effect on growth and yield. The double spray of 2% urea and 150 ppm gibberellic acid (N2 GA3 S2) gave the highest fruit yield 226.80 q ha-1. For days taken to 50 per cent flowering the best treatment combination was double spray of 1% urea and 150 ppm GA3 (N1 GA3 S2). This application of urea and gibberellic acid can be beneficial to maximize the yield of okra.

Paliwal *et al*. (1999) reported that the foliar application of gibberellic acid (GA3) and naphthalene acetic acid (NAA) on growth and yield of okra (Abelmoschus esculentus) cv. PusaSawani was carried out in kharif 1996 in Rajasthan, India. The treatments comprised of 25, 50 and 75 ppm GA3 and 25, 50 and 75 ppm NAA and a single over all control treatments. These ten treatment combinations were replicated four times in the randomized block design. Application of both growth regulators enhanced the growth and fruit yield of okra significantly. A combined spray of GA3 and NAA (75 ppm GA3 and 75 ppm NAA) gave the highest fruit yield (215.55 q ha-1.) Foliar spray with 75 ppm concentration of GA3 and NAA gave the highest fruit yield i.e., 180.79 and 197.51 q ha-1, respectively.

Singh *et al*. (1999) reported that the foliar application of the plant growth regulators GA (gibberellic acid; 20, 30 and 40 ppm) and NAA (50, 75 and 100 ppm) along with green fruit picking encouraged vegetative growth, fruit characters and ultimate seed yield per plant in okra. Such plants exhibited increased plant height, number of dry fruits per plant and 100-seed weight compared with control plants.

Naruka and Paliwal (2000) revealed that the effects of gibberellic acid (GA) and NAA, both at 25, 50 and 75 ppm, on okra cv. PusaSawani were studied in Rajasthan, India during 1996. The increase in GA and NAA levels resulted in a corresponding increase in plant height, number of leaves per plant, main stem girth, days taken to 50% flowering, number of fruits per plant, mean fruit weight and yield.

Vijayaraghavan (2000) revealed that the okra cv. MDU-1 seeds were treated with 25, 50 or 75 ppm each of IAA or gibberellic acid or 20, 40 or 60 ppm benzyladenine. Seed treatment with 50 ppm gibberellic acid produced the highest germination percentage, seedling establishment, total dry matter, harvest index fruits/plant and the highest fruit yield of 15.7 t/ha. The control yield was 8.07 t/ha.

Pal and Hossain (2001) reported that the all chemicals significantly increased the length and fresh weight of 7-day-old seedlings, plant height and number of pods per plant compared with dry seed and untreated controls, but such treatments failed to produce any marked influence on seed germination, dry weight of 7-day-old seedlings, pod length and seed weight per plant. GA3 at 100 ppm, ascorbic acid at 10 ppm and potassium dihydrogen phosphate at 0.5% were identified as the best treatments.

Hussaini and Babu (2004) reported that the growth regulators gibberellic acid (GA3; 100 or 200 ppm), NAA (20 or 40 ppm) and maleic hydrazide (500 or 1000 ppm) were sprayed to plants 4 times at 15-day-intervals starting at 15 days after sowing. Plants treated with 200 ppm GA3 recorded the greatest plant height (100.87 cm), pod weight (15.00 g), pod length (15.33 cm), and yield per plant (0.116 kg) and per ha (13.65 kg). The number of flowers per plant (17.50), number of pods per plant (11.83), and number of seeds per pod (53.83) were greatest in plants sprayed with 40 ppm NAA. The number of days to 50% flowering was lowest with 20 (35.00) and 40 ppm NAA (35.17).

Kumar and Sen (2004) revealed that the values of plant height, number of branches, number of nodes on the main axis, number of fruits per plant, fruit yield per plant and yield/ha were higher with seed soaking in 50 ppm gibberellic acid.

Singh et al. (2004) reported that the gibberellic acid up to 150 ppm increased the percent fruit set, number of fruits per plant, length of fruit, diameter of fruit, number of pickings, duration of harvesting, mean fruit weight, yield and dry matter yield of fruit. The increasing levels of gibberellic acid also brought substantial reduction in days to 50% flowering of okra.

Singh and Kumar (2005) revealed that the highest number of leaves per plant was recorded with 75 ppm GA3. The highest number of seeds per fruit (44.60) and seed yield (20.08 q/ha) were recorded with 150 ppm GA3.

Kumar and Sen (2005) revealed that the seeds soaked in 50 ppm GA3 had higher germination percentage, plant height, number of fruits per plant, fruit yield per plant and yield per hectare compared to the control.

Singh et al. (2005) reported that the plant height, number of branches per plant, plant spread, stem girth, leaf area, yield per plant and yield per hectare increased with increasing N, P and GA3 rates.

Kokare *et al*. (2006) reported that the maximum plant height (117.33 cm) was observed in plots sprayed with GA at 200 ppm, while spraying the plants with NAA at 200 ppm increased the leaf number (20.00), leaf area (28.10 cm2), plant dry weight (18.55 g/plant), pod number (18.03), pod girth (2.12 cm), pod yield per plant (187.51), pod yield per ha (138.89) and ascorbic acid content (17.35 mg/100 g) over the control.

Surendra *et al*. (2006) reported that the GA3 at 25 and 50 ppm (15.81 and 18.69 t/ha) gave the highest fruit yields. The latter treatments also recorded the greatest number of flowers per plant (23.2 and 26.8), total number of fruits per plant (18.4 and 22.1), harvest index (50.4 and 65.5%), fruit length (21.3 and 23.4 cm), total dry weight of fruits (66.19 and 90.49 g per plant), number of seeds per fruit (51.0 and 55.0), seed weight per fruit (4.55 and 6.15).

Singh et al. (2006) revealed that seed yield per plant increased significantly with the treatment of GA3 in wider spacing (60x45 cm) with pronounced improvement in seed quality at harvest, i.e. vigour index and speed of germination. Though maximum yield was obtained in close spacing (45x30 cm), emergence remained unaffected by spacing's. Significant beneficial effect of GA3 (150 ppm concentration) was found for seed yield.

Ilias *et al.* (2007) reported that the stem and leaf dry masses and stem length were significantly enhanced by the application of exogenous GA3, but prohexadione-Ca inhibited growth. Control and prohexadione-Ca treated okra plants took more time to bloom than did GA3 treated plants. In the fruits of all the cultivars a decrease in fructose content was observed, while protein content remained almost unchanged after the application of the two growth regulators.

Marie et al. (2007) reported that the foliar spraying with GA have actively increased the plant height, dry weight of plant, number of branches, number of seeds/plant, pods & seed yield per plant and unit area.

Katung *et al*. (2007) reported that the GA3 affected the number of days to flowering, fruit set and yield of the two okra cultivars in the dry season only. A reduction in the number of days to flowering in cv. White velvet with the application of 75 ppm GA3 was observed in 1998 and 2000 in the year of dry seasons. The same concentration (75 ppm) of GA3 increased fruit set by 22.9 and 45.5% in cv. White Velvet and 12.2 and 33.6% in cv. Ex-Borno in 1998 and 2000, respectively and increased number of fruits/plant, dry weight/fruit and fruit yield by 13.7, 12.5 and 40.1% respectively in cv. White Velvet and by 21.9, 42.9 and 20.9%, respectively in cv. Ex-Borno in the dry season. A higher concentration (150 ppm) of the plant growth regulator had an appreciable effect on all the parameters of the two okra cultivars tested.

Patil *et al*. (2008) concluded that the germination and vegetative characters, viz., plant height, number of internodes and length of internodes, seed treatment with gibberellic acid at 50 ppm concentration exhibit statistically maximum value amongst all other treatments. Whereas in respect of number of branches and number of leaves per plant, seed treatment with maleic hydrazide at 80 ppm exhibit significantly maximum number over remaining all other treatments.

Tyagi *et al*. (2008) concluded that the spraying of growth regulators was done at 30 days after sowing. The results revealed that GA3 at 90 ppm concentration proved to be the best for all parameters of growth and yield in okra followed by LAA.

Pateliya *et al*. (2008) showed that the foliar application of CCC at 300 ppm at 25 and 50 DAS retarded the duration of reproductive phase and decreased the days to first flower opening and internodal length. However, the fruit yield per plant, number of fruits per plant and fruit yield/ha were also highest in the same treatment.

Sindhu and Neelamegam (2009) revealed that the maleic hydrazide foliar spray on okra seedling affects the growth parameters than control. Ascorbic acid foliar treatment on okra seedling shows little or no significant effect on growth parameters as compared to maleic hydrazide foliar treatment. Ascorbic acid pre/post treatment as foliar spray on okra seedling with maleic hydrazide foliar spray reduced the adverse effect of MH on okra. Ascorbic acid post treatment favors more growth of okra seedling than the ascorbic acid pre-treatment with maleic hydrazide. From the results it is evident that the ascorbic acid foliar spray treatment either alone or in combination with maleic hydrazide showed better growth as compared to maleic hydrazide treatments alone in okra seedlings.

Nabi *et al.* (2009) growth regulators showed significant results on all characters except fruit length. Foliar spray of 150 ppm NAA was best NAA at 150 ppm increased number of fruits/plant (14.67), weight of fruits/plant (79.33 g), fruit weight (7.63 g), fruit length (19.69 cm) and fruit yield (59.49 q/ha). Therefore, on the basis of results obtained in present studies, it was suggested that 150 ppm NAA foliar spray 30 and 50 days after sowing in okra cultivar P-8 could result in increased yield.

Patiland Patel (2010) reported that the GA3 at 15 mg/l recorded the highest percentage of seed germination, stem girth, number of branches, number of leaves per plant, early flowering, fruit girth, fruit length, fruit weight, fruit yield per plant and fruit yield per hectare. While GA3 at 45 mg/l found to be beneficial with respect to plant height, number of internodes and internodal length. However, GA3 at 30 mg/l produced maximum number of fruits per plant.

Dhage *et al*. (2011) revealed that the significant effect for plant height (107.74 cm), internodal length (3.1 cm) was obtained in treatment GA3 at 150 ppm whereas, numbers of branches (3.53) were found maximum in treatment IAA at 100 ppm. However, significantly minimum number of days required for first flowering (39.67 days) and first harvesting (44.67 days) were recorded in treatment GA3 at 150 ppm. The significantly maximum parentage of fruit set (74.79) and fruit yield per hectare were observed in same treatment.

Singh *et al*. (2012) conducted a experiment during kharif season 2011 to study the performance of plant growth regulators on yield and yield traits of okra. The field trial consisted of one genotype (VRO-4) and different levels of growth regulators IBA and GA3 (0, 40, 80, 120 and 160 ppm of each), replicated three times and was laid out in a randomized block design. The observations were recorded on eight parameters like node at which 1st flower appears, number of nodes per plant, number of pods per plant, average pod weight, number of seeds per pod, 100 seed weight and pod yield per hectare. All the characters under study increased significantly by the application of higher concentration of both IBA (160 ppm) and GA3 (160 ppm) under field condition. Application of 160 ppm GA3 was found to be the best for all parameters as compared to the rest of the treatments. It can be suggested that yield attributing characters and yield of okra could be manipulated by the application of growth regulators.

Panwar *et al*. (2012) reported that the among six characters along with yield like node at which 1st flower appears, number of seeds per plant, average fruit weight, number of nodes per plant, number of fruits per plant and fruit yield (q/ha), it was noticed that application of 120 ppm GA3 and 30 ppm NAA was found to be better for almost all yield and yield attributing characters as compared to control.

Singh *et al*. (2012a) evaluate the response of GA3 and IBA on plant characters and yield of okra. The experiment consisted of one genotype (VRO-4) and different GA3 and IBA levels (control, 40, 80, 120 and 160 ppm of each) and observations were recorded on eight parameters like days to 1st flowering, days to 50% flowering, plant height (cm), number of branches per plant, internodal distance (cm), pod length (cm), pod diameter (cm) and pod yield per hectare. Application of higher concentration of both the growth regulators GA3 and IBA (160 ppm) was found to be better for all the parameters. An increasing pattern was noticed for all the parameters with the increasing levels of both the growth regulators. It can be suggested that GA3 and IBA have beneficial role on plant characters and yield of okra.

Ayyub *et al*. (2013) revealed that the increase in number of foliar application of GA3 substantially improved the vegetative as well as reproductive growth of okra comparing to control plants. It was found that application at different growth stages of okra predominantly boosted the stem elongation, number of leaves per plant, number of pods per plant, number of seeds per pod, seed weight and seed yield. Therefore it can be concluded that foliar application of GA3 may be an effective strategy for maximizing the growth and yield of okra.

Effect of gibberellic acid and maleic hydrazide on physiological parameters

Stefanini *et al*. (1998) reported that the application, of GA3 (50 or 100 mg/liter), ethephon (100 or 200 mg/liter) and CCC [chlormequat] (1000 or 2000 mg/liter) plants were harvested at 14-day intervals. GA3, ethephon and CCC did not significantly influence specific leaf area (SLA), but CCC at 2000 mg/liter had some non-significant effects on leaf mass rate (LMR) and leaf area rate (LAR) for some harvests.

Rahman et al. (2004) reported that the early planting had a favorable effect on plant height, number of leaves per plant, dry weights of leaves, total dry matter, leaf area index, crop growth rate and yield.

Ngatia *et al*. (2004) reported that the GA3 was sprayed at 0, 2.5, 5.0 and 7.5 mg/liter to whole bean plants at 7, 14 or 28 days after emergence (DAE). The effect of GA3 and timing of application on growth, yield and yield components was significant. Applications of GA3 led to increased plant height, leaf area index (LAI), fractional solar radiation interception and root, shoot and total dry mass. The yield per plant, pods per plant, 100-seed mass and harvest index also increased due to the GA3 applications. The highest seed yields were equivalent to 1854 and 5890 kg/ha in 1997 and 1998, respectively. These yields were high when compared to the average national yield of 500 kg/ha. Significant differences in the measured parameters were generally observed at 14 DAE in GA3-treated plants.

Singh et al. (2005) reported that the leaf area increased with increasing N, P and GA3 rates.

Surendra *et al*. (2006a) reported that the data were recorded for leaf area index, specific leaf weight, leaf area duration, chlorophyll content, nitrate reductase activity, and fresh fruit yield. The values of all morpho-physiological and biochemical parameters were significantly higher with the application of GA3 compared with the other plant growth regulators and micronutrients. GA3 at 25 and 50 ppm also recorded the highest fresh fruit yields of 15.81 and 18.69 t/ha, respectively.

Emongor (2007) reported that the application of GA3, 7 days after emergence at 30, 60 or 90 mg L-1 significantly increased cowpea plant height, first node height, leaf area and leaf number/plant, nodulation, plant dry matter accumulation, pod length, pod number/plant, seed number/pod, 100 seed weight, harvest index and seed yield ha-1. Gibberellic acid had no significant effect on cowpea plant senescence. The result of this study suggests that exogenous application of GA3 can be used to modify growth and development of some cowpea varieties.

Chahal and Mukherjee (2008) reported that the all the biometric parameters increased with delay in sowing. Among the different cultivars, Punjab 8 showed the highest plant height, more dry weight and more leaf area index (LAI) followed by Punjab 7, ArkaAnamika and Shagun. Crop growth rate was maximum in 10 June in Punjab 8. Total fruit yield was maximum in 10 June sowing followed by 10 May sowing. Punjab 8 performed best under all the dates of sowing. Regression models were also developed by using dry matter and fruit yield as independent variables and accumulated growing degree days, accumulated heliothermal units, accumulated photothermal units and LAI as dependent variables. The R2 values were very high in both the models.

Ekinci *et al*. (2008) reported that the number of leaves, mean of individual leaf area, leaf area index, leaf chlorophyll content, plant height and seed yield were studied in okra leaf shape cotton cultivars. The coefficient correlation between cotton seed yield and all characters was analysed. The normal leaf shape cultivars were higher than okra leaf shape cultivars for mean of individual leaf area, leaf area index and plant height. Seed yield was positively correlated with leaf area index, but was negatively correlated with number of leaves per plant.

Singh *et al*. (2011) reported that the maximum increase was recorded in plant height, basal girth, total and inoculable shoot length to the tune of 24.4, 20.0, 67.7 and 113.3 per cent, respectively under single row planting system of Flemingia semialata for winter lac crop with vegetable crops (Okra, Garlic and Bitter Gourd) as compared to sole single planting pattern (without intercrops). Whereas the maximum increase in number of leaves per bush and leaf area index (LAI) were 77.16 and 87.68 per cent, respectively at paired row planting for summer lac crop with vegetable crops Schedule I. The main root and rootlets length and number of rootlets per bush of the host plants increased by 13.82, 21.55 and 16.22 per cent, respectively on account of raising intercrops as compared to no intercrops (control).

Ghalandari *et al*. (2011) reported that the 50 ppm hormone gibberellins acid, more leaf area index (LAI) with 1.98 in comparison with other surfaces have been in the treatment group a was used Hormone gibberellins acid applied best courses in the vegetative period before flowering leaf dry weight, 752.2 kg/ha been in a treatment group were. And the flowering period to Pod set treated with 678.3 kg/ha-level statistical treatment Pod set b to aggregation with 666.6 kg/ha c level was statistically. Dose of the hormone gibberellins acid maximum height of internodes 4.07 inches compared to other hormone levels have been in statistical was. Other doses differ quite significantly with this level did not have the lower levels were. The results showed that the hormone gibberellins acid increased crop growth rate to 35 percent in d3=20.15 g/m2/day treatment than control treatment was d0=14.5 g/m2/day.

Dube (2011) reported that the plant growth regulators (GA, IAA and IBA at 50 ppm sprayed at planting, 30th and 60th days) in alone and combination treatments.

Economics

Kumar and Sen (2005a) reported that the application of GA3 at 50 ppm was recorded highest fruit yield 141.07 q/ha, net return Rs. 47 479/ha and B:C ratio of 2.0 4.

Surendra *et al*. (2006) reported that the GA3 at 25 and 50 ppm (15.81 and 18.69 t/ha) gave the highest fruit yields, net returns (77 701 and 93 481 rupees/ha) and benefit cost ratio (4.52 and 5.00).

Pateliya *et al*. (2008) showed that the highest net return with higher cost benefit ratio was also recorded with CCC at 300 ppm.

MATERIALS AND METHODS

Experimental material : The experimental materials for this study comprises 7 treatments are presented as follows.

Details of treatments :

Factor A - For MH M1 : 60 ppm M2 : 100 ppm

Factor B- For GA3 G1 : 20 ppm G2 : 40 ppm G3 : 60 ppm

Treatment Details :

S. No.	**Treat. Symb.**	**Treatments**
1.	T1	M1G1
2.	T2	M1G2
3.	T3	M1G3
4.	T4	M2G1
5.	T5	M2G2
6.	T6	M2G3
7.	T7	Control

Design of experiment: The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication consists of 7 treatments. All the treatments were randomized separately in each replication. The plan of layout is given as below:-

Design	:	RBD
Replication	:	3
Treatment	:	7
Crop	:	Okra[*Abelmoschus esculentus* (L.) Moench]
Season	:	Kharif (2017-2018)
Sowing Time	:	Feb-March
Date of Sowing	:	8 th feb 2018
Name of Variety	:	Ganga (Research Bhindi)
Source of Variety	:	Green Land

Observation to be recorded

I. Number of days to sprouting
II. Plant height (cm)
III. Number of branches per plant
IV. Number of leafs per plant
V. Leaf size
VI. Days to first flowering
VII. Days to 50% flowering
VIII. Number of days to fruit formation
IX. Number of fruits per plant
X. Fruit colour
XI. Fruit size
XII. Fruit Weight
XIII. Weight of fruits per plot
XIV. Yield per plant
XV. Yield per bed/plot

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