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# Effect of $GA_3$ and NAA with pruning levels on growth, sex expression and yield attributes of cucumber (*Cucumis sativus* L. Malini $F_1$) under protected condition

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**Abstract**
Evidence had accumulated from a number of experiments indicating that plant growth regulators levels may modify the sex expression of flowering plants. The effect of foliar application of $GA_3$ (25 ppm and 50 ppm), NAA (500 ppm and 1000 ppm) and pruning (no pruning and double stem pruning) on growth, flowering, yield and quality of cucumber (*Cucumis sativus* hyb. Malini $F_1$) were studied at Precision Farming Development Center (PFDC), Department of Horticulture, University of Agricultural Sciences GKVK, Bangalore during (2017-18) under protected condition. The plant growth regulators were applied on 4 true leaf stages. The results of the study revealed that, combined application of $GA_3$ and NAA (50 ppm + 500 ppm) with double stem pruning had more significant effects on vegetative growth, increased the flowering, suppressed the staminate flowers and enhanced the pistillate flowers, so that the fruit yield was more higher per plant and per hectare than control and other treatment combinations.

**Keywords:** $GA_3$, NAA, Malini $F_1$, Plant growth regulators, NP: no pruning, DSP: double stem pruning

## Introduction
Cucurbitaceae is one of the largest families in vegetable kingdom consisting of largest number of edible type species. One of the valuable plant among them is cucumber (*Cucumis sativus* L.) most important cross pollinated and popular vegetable having chromosome no. 2n=14. It is an endemic vegetable of India. It is commonly a monoecious, annual, trailing or climbing vine having hirsute or scabrous stems with triangular ovate leaves with shallow and acute sinuses. Unbranched lateral tendrils developed at the leaf axils. As the lateral branches are developed, flower clusters appear at leaf axils. The sex expression of *Cucumis sativus* is determined by genetics as well as environment (e.g. photoperiod, temperature etc.). Change from vegetative growth to generative stages is a complex process regulated by many factors, and can be influenced by application of plant growth regulators. Growth regulators can alter the sex ratio and sequence if applied at the two- or four-leaf stage, which is the critical stage at which the suppression or promotion of either sex is possible (Hossain *et al*., 2006) [14]. Flowering in cucurbits is very important phase of development because fruiting and yield depends on this process. Cucumber generally is a monoecious plant; the first flowers to appear near the base of a cucumber plant are male. A week after male flower initiation takes place the female flowers appear with the small cucumber fruits at the base. Plant growth regulators (PGRs) are organic compounds, other than nutrients that modify plant physiological processes. PGRs, called bio stimulants or bio inhibitors act inside plant cells to stimulate or inhibit specific enzymes or enzyme systems and thus regulate plant metabolism. Normally, they are active in low concentrations in plants. About sixty plant regulators are commercially being used and several of them have reached considerable importance in crop production. Growth regulators include both growth promoters and retardants which have shown to modify the canopy structure and other yield attributes. Growth regulators have tremendous effects on sex expression and flowering in cucumber crop leading to either suppression of male flowers or an increase in the number of female flowers without imposing any deleterious effect on the environment and human health. Plant growth regulators are also used to control the vegetative growth of cucumber plants, thereby increasing the plant population per unit area with regard to yield (Al-Masoum *et al.,* 2006). Plant growth regulators have a key role in various physiological and biochemical process in plant system.

Growth regulators are known to have an effect on production of earliest flower, yield ratio of male/female flower number of fruits, weight of fruit. Initiation of flower bud, development of flowers and fruits are controlled by physiological process. In many agricultural plants, these processes can often be used to alter by proper application of plant growth substances. (Gedam *et al.,* 2007) [10]. Therefore, an experiment was laid out to find out the impact of growth promoters ($GA_3$ and NAA) with pruning levels on growth, sex expression and yield attributes of cucumber Hybrid Malini $F_1$.

## Material and Methods

The present investigation was carried out during the Rabi season of 2017-18, at Precision Farming Development Center (PFDC), Department of Horticulture, University of Agricultural Sciences GKVK, Bangalore at the experimental greenhouse of PFDC. The hybrid used in this experiment was Malini $F_1$. Malini one of the high yielding $F_1$ hybrid, produced by Semins seed Company is authorized by the Government for commercial cultivation by farmers in the state of Karnataka. The soil of the experimental greenhouse was red sandy loam in texture having pH of (6.25). After bringing the soil to fine tilth, beds were raised of 1 meter width, 30 cm in height and 15 meter length. The spacing between two beds was 60 cm and between plants 45 cm. sowing was done in the month of November at two seeds per hill at a depth of 2-3 cm in zigzag manner (quanix method). Later, gap filling and thinning were done to retain one plant per hill. Regular watering and plant protection measures were carried out as and when required. The experiment was carried out in a factorial randomized complete block design, with three replicates, using two growth regulators at three different concentrations namely, $GA_3$ at two levels (25 and 50 ppm) and NAA at two levels (500 and 1000 ppm). Solutions were applied at the 4 true leaf stages at 3 times; with two pruning levels namely (no pruning and double stem pruning). Total nine treatments were tried including control. The treatments were consisted of

$T_1$ (control)
$T_2$ (25 ppm $GA_3$+ 500 ppm NAA+ double stem pruning)
$T_3$ (25 ppm $GA_3$+ 500 ppm NAA+ no pruning)
$T_4$ (25 ppm $GA_3$+ 1000 ppm NAA+ double stem pruning)
$T_5$ (25 ppm $GA_3$+ 1000 ppm NAA+ no pruning)
$T_6$ (50 ppm $GA_3$+ 500 ppm NAA+ double stem pruning)
$T_7$ (50 ppm $GA_3$+ 500 ppm NAA+ no pruning
$T_8$ (50 ppm $GA_3$+ 1000 ppm NAA+ double stem pruning)
$T_9$ (50 ppm $GA_3$+ 1000 ppm NAA+ no pruning)

Four plants in each plot were randomly selected for recording observations.

### Morphological Measurements

1. Vine length: The length of the primary stems was measured at three different growing stages from ground level (the point of emergence of the plant) to the top of the vine on each tagged plant with the help of a meter scale and the average length was calculated.
2. Number of leaves and branches: All leaves and branches appearing on the main stem were counted at three different growing stages on each tagged plant and the average was calculated.
3. Fresh and dry weight: weight of the plant was recorded both at fresh stage and after completely drying stage 60 days after sowing.

### Floral Measurements

1. Days to first male and female flower appearance after sowing The number of days to the appearance after sowing of the first male and female flower was recorded on each tagged plant and the average was calculated.
2. Days to 50 per cent flowering was recorded on each tagged plant and the average was calculated.
3. Number of male and female flowers per plant was recorded on each tagged plant and the average was calculated.

### Yield Measurements

1. Number of fruits per plant was recorded on each tagged plant and the average was calculated.
2. Fruit yield per plant was recorded on each tagged plant and the average was calculated.
3. Fruit setting per centage was recorded on each tagged plant and the average was calculated.
4. Fruit yield per hectare was calculated by multiplying the fruit yield per plant by the total number of plants on one hectare.

### Statistical Analysis

Experimental design was a factorial randomized complete block with three replications. ANOVA was run for the variables by MSTATC soft word and means were separated by LSD multiple range test at 0.05.

## Results and Discussion

### Effect of GA3, NAA and pruning levels on growth parameter

The result indicated that there were significant effects between all treatment combinations on the growth characteristics (Table 1). Growth attributes were significantly higher at foliar application of $GA_3$ 50 ppm + NAA 500 ppm concentrations with double stem pruning compared to $GA_3$ 25 ppm + NAA 1000 ppm concentrations with no pruning. Among all treatment combinations significantly higher vine length at 30, 45 and 60 days after sowing (50.67, 105.97 and 172.67 cm respectively) was noticed in $T_6$ *viz.,* ($GA_3$ 50 ppm + NAA 500 ppm + double stem pruning) and lower vine length at 30, 45 and 60 days after sowing (28.33, 68.00 and 125.00 cm respectively) was noticed in $T_1$ (control). The epinastic effect was observed immediately after first spray of plant growth regulators with different doses except control. This might be due to more cell growth on the ventral side of leaf surface immediately after the spray, this wilting of the plants, however was temporary, this is due to the translocation of chemical to other part of the plant and thus neutralizing the cell activities and ultimately plants regained the normal condition. The present findings are in close conformity with the earlier results of Baruah *et al.,* (2015) [5], he postulated that higher concentration of NAA affects the respiration of plant which in turn brings undesirable morphological changes. The increased vine length is a result of rapid elongation of internodes by both cell division and cell elongation (Krishnamoorthy, 2002) [19]. The mechanism involving the conversion of starch to sugar was inferred by analogue with known effect of $GA_3$, which increases the height of the plant. Double stem pruning recorded higher vine length this might be due to optimum uptake of plant nutrients and by pruning the side shoots flow of auxins will stop because this will lead to excessive vegetative growth which is not desirable for plant growth, air circulation will inhibit sun light to whole plant parts and the main stem will remain weak. Ullah *et al.,* (2011) [25] reported that pruning of cucumber plants increased the

vine length, he has noted that pruning the cucumber plants, increased the number of vine length, vegetative shoots, fruit set and fruit size.

Significantly higher number of leaves per plant at 45 and 60 days after sowing (11.67, 36.70 and 47.00) was noticed in $T_7$ *viz.,* ($GA_3$ 50 ppm + NAA 500 ppm + no pruning) followed by $T_3$ *viz.,* ($GA_3$ 25 ppm + NAA 1000 ppm + no pruning) (35.77 and 46.33). This might be due to stimulatory effect of growth and quick cell division. And regarding pruning levels no pruning recorded higher number of leaves, this might be due the excessive vegetative growth of plant. These above findings clearly indicate that the application of 50 ppm $GA_3$ and 500 ppm NAA played a very important role on the growth of cucumber. This might be due to most important primary site of action as the cell division is stimulated in the shoot apex especially more in basal maristematic cells from which large files of cortex and pith cells develop. These results were in conformity with those of Jasim *et al*., (2007) [17]. Number of leaves at 30 days after sowing did not differed significantly due to different doses of plant growth regulators.

Significantly higher number of branches at 30 and 45 DAS was noticed in $T_7$ *viz.,* ($GA_3$ 50 ppm + NAA 500 ppm + double stem pruning) and lower number of branches was noticed in $T_1$ (control). This might be due the fact that combined application of $GA_3$ and NAA influencing a range of developmental processing in stem elongation, germination, flowering, sex expression, enzyme induction and can improve the seedling vigor. Applications of $GA_3$ with NAA have prompted the metabolic activities in plants due to enhancing in vegetative growth, Hilli *et al*., (2010) [13]. Treatment combination of $T_6$ *i.e,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly higher fresh and dry weight (278.13 and 135.80 g respectively) followed by $T_7$ *i.e*., (50 ppm $GA_3$+ 500 ppm NAA + no pruning) that is (267.33 and 127.67 g respectively). Significantly lower fresh and dry weight per plant (249.47, and 101.33 g respectively) was recorded in control. The above data revealed that fresh and dry weight per plant was significantly higher under greenhouse condition. This may be due to the better development of plants and more assimilation and translocation of photosynthesis from source to sink in the plant system was more in controlled condition as compared to other treatments, Arora *et al*., (2001) [3].

**Table 1:** Effect of foliar application of $GA_3$, NAA and pruning levels on vine length, number of leaves, number of branches, fresh weight and dry weight of cucumber.

| Treatments | | Vine length (cm) | | | No. of leaves per plant | | | No. of branches per plant | | | Fresh weight (g) | Dry weight (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAS | 45 DAS | 60 DAS | 30 DAS | 45 DAS | 60 DAS | 30 DAS | 45 DAS | 60 DAS | 60 DAS | 60 DAS |
| $T_1$ | Control | 28.33 | 68.00 | 125.00 | 6.20 | 21.57 | 33.67 | 3.53 | 6.13 | 15.30 | 249.47 | 101.33 |
| $T_2$ | 25 ppm $GA_3$+ 500 ppm NAA+ DSP | 33.00 | 85.83 | 153.00 | 8.47 | 26.07 | 40.67 | 5.33 | 8.00 | 17.53 | 254.23 | 114.73 |
| $T_3$ | 25 ppm $GA_3$+ 500 ppm NAA+ NP | 34.00 | 82.73 | 141.00 | 7.27 | 27.30 | 43.00 | 5.63 | 8.17 | 17.57 | 261.17 | 111.30 |
| $T_4$ | 25 ppm $GA_3$+ 1000 ppm NAA + DSP | 36.67 | 83.47 | 149.00 | 8.67 | 35.77 | 46.33 | 5.20 | 11.20 | 17.07 | 252.97 | 123.63 |
| $T_5$ | 25 ppm $GA_3$+ 1000 ppm NAA + NP | 36.67 | 85.97 | 155.00 | 8.33 | 25.40 | 38.33 | 7.00 | 11.03 | 18.67 | 262.90 | 131.40 |
| $T_6$ | 50 ppm $GA_3$+ 500 ppm NAA + DSP | 50.67 | 105.97 | 172.67 | 10.67 | 23.50 | 39.33 | 6.87 | 9.57 | 19.07 | 278.13 | 135.80 |
| $T_7$ | 50 ppm $GA_3$+ 500 ppm NAA + NP | 36.00 | 96.30 | 158.33 | 11.67 | 36.70 | 47.00 | 8.03 | 13.77 | 19.70 | 267.73 | 127.67 |
| $T_8$ | 50 ppm $GA_3$+ 1000 ppm NAA + DSP | 45.33 | 84.27 | 152.67 | 8.80 | 22.67 | 39.33 | 6.13 | 10.10 | 18.87 | 244.04 | 114.03 |
| $T_9$ | 50 ppm $GA_3$+ 1000 ppm NAA + NP | 38.33 | 93.10 | 147.67 | 8.00 | 30.73 | 38.00 | 5.80 | 9.50 | 18.83 | 260.10 | 125.10 |
| F-test (p=0.05) | | * | * | * | NS | * | * | * | * | NS | * | * |
| SEm± | | 0.89 | 1.87 | 1.27 | 0.97 | 1.34 | 1.95 | 0.64 | 1.14 | 1.08 | 2.08 | 1.64 |
| C.D (p=0.05) | | 2.64 | 5.57 | 3.80 | - | 3.99 | 5.82 | 1.90 | 3.41 | - | 6.21 | 4.91 |

**Effect of GA3, NAA and pruning levels on phonological parameter**

**Sex Expression**

Sex expression in cucumber is subjected to genetic set up and environmental reaction of the plant. Several research workers like Geeta, (2008) [11], Gedam *et al.,* (2007) [10], and Kumar *et al.,* (2012) clearly brought out that each of this sex controlling factors act independently and in combination. Tiedjen (1923) was the first pioneer worker to report the alteration of sex expression in cucumber by changing the light intensities and nutrition levels. Choudray and Phaldak, (2002) [6] reported that auxin levels could change the manifestation of staminate and pistillate flowers in cucumber plant. Ghani *et al*., (2013) [12] later reported the possibility of modification of sex by external application of plant growth regulators in almost all cucrbateacous vegetable crops. In the present study exogenous application of chemicals ($GA_3$ and NAA at different doses) at 2-4 true leaf stages, has a direct effect on sex expression and its inferred that combined application of $GA_3$ and NAA on cucumber plant takes part in the metabolic activities, which ultimately resulted in change of sex expression. The results of the present study do agree with the hypothesis that auxin levels takes part in the manifestation of sex. It is also suppressed that sex differentiation within the plant takes place at early stage of growth *i.e*., at one or 2 leaf stages, because plant growth regulators applied at this particular stage were found to be effective in alteration of sex. And at this particular stage the floral primordia either male or female can be chemically suppressed or enhanced by foliar feeding of growth hormones. These findings are in close conformity with Choudray and Phaldak, (2002) [6].

**Days to first flowering**

An examination of data revealed that treatment combination of $T_6$ *i.e.,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly minimum number of days to first flowering (27.00) which was statistically *on par* with $T_7$ *i.e,* (50 ppm $GA_3$+ 1000 ppm NAA + double stem pruning), (27.32). Higher number of days taken to first flowering (31.33) was noticed in control. Combined application of $GA_3$ and NAA has influenced on sex expression and delayed the staminate flowering process for 25 to 30 days compared to control in cucumber. This might be due to the increased photosynthesis and respiration along with enhanced fixation by $GA_3$ that led to early flower bud initiation. Earlier finding confirmed with Choudray and Phadak *et al.,* (2002) [6] in cucumber and Kumar *et al.,* (2012) in bitter gourd. NAA is the substances that slow down the cell division and cell

elongation in maristematic tissue of shoot and regulated the plant height without change in the morphology and physiology of the plant (Hilli *et al.,* 2010) [13] in ridge gourd.

**Days to first female flower emergence**

A significant variation was observed in days taken to first female flowering due to different doses of plant growth regulators and pruning levels (Table 2). The interaction combination of T6 *i.e,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded the earliest days to first female flowering (29.33). $T_1$ (control) showed to require the lengthiest time (33.21) to first female flowering. This might be attributed to the fact that the initiation of first female primordia is dependent upon the chain of bio chemical events, in which auxin play a definite role, so foliar application of $GA_3$ and NAA can induce the endogenous amount of auxin and acts in this chain of biochemical events. Ghani *et al*., (2013) [12] generalized that any substance which can regulate flowering and growth habit of plant can be considered as auxin like.

**Days to 50 per cent flowering**

Days to 50 per cent flowering were significantly influenced by different doses of plant growth regulators and pruning levels. The interaction combination of $T_6$ *i.e.,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) showed the less time (37.00) for 50 per cent flowering. And $T_1$ (control) recorded the maximum time for 50 per cent flowering (45.22). Both the plant growth regulators *viz.*, GA and NAA gave very encouraging results. The application of $GA_3$ consistently proved effective in all the observations and characters, which cumulatively influenced sex expression. Application of $GA_3$ was also effective in producing more number of flowers. When NAA and $GA_3$ are compared, it was found that NAA is consistently more effective in modifying the sex expression. The reason might be that NAA suppressed the staminate flowers and increased the pistillate flowers, whereas $GA_3$ increased both staminate and pistillate flowers and thus acted in a different way. These findings are in close conformity with Choi *et al.,* (2015). A marked increased in 50 per cent flowering was noticed in the treatment combination of $T_6$ *i.e,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning). Application of these two plant growth regulators combinly were quite constant in their action in increasing 50 per cent flowering, it might be due to the enhanced metabolic activities and hence increase the assimilation and translocation in plant system, Hume and Lovell, (2003) [15].

**Number of male flowers per plant**

A perusal of data revealed that number of male flowers per plant differed significantly due to different doses of plant growth regulators and pruning levels. The best treatment combination of $T_6$ *i.e.,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly higher number of male flowers per plant (19.29). $T_1$ (control) noticed lesser number of male flowers per plant (11.89 respectively). Number of male flowers per plant was significantly increased by the application of 50 ppm $GA_3$ and 500 ppm NAA, this might be due to the fact that the effectiveness of growth hormones is obtained at high temperature under greenhouse condition due to its greater absorption and enhancing the endogenous amount of auxin levels by foliar application of growth hormones, Kim *et al*., (2004) [20].

**Number of female flowers per plant**

An examination of data (Table 2) revealed that number of female flowers per plant differed significantly due to different doses of plant growth regulators and pruning levels. The interaction combination of $T_6$ *i.e.,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly higher number of female flowers per plant (10.75). $T_1$ (control) noticed lesser number of female flowers per plant (5.81). Flower production depends on genotype of plant and environmental condition of the particular location. The present study indicates that the maximum number of female flowers (10.75) was produced in plants sprayed with combination of $GA_3$ (50 ppm) and NAA (500 ppm). Growth regulators advanced the female flower initiation in the present study, which might be due to increase the metabolization of auxin substances in plants and also reduce sugar thereby bringing a change in the membrane permeability. These results are in conformity with the Baruah and Sarma (2015) [5]. Combined application of $GA_3$ and NAA at optimum doses could be attributed to the suppression of staminate flowers and promoted more number of pistillate flower. Sex ratio mainly depends on the viable and compatible features of male and female organs. The narrower sex ratio by the combined application of NAA and $GA_3$ is possibly due to the fact that these substances are reported to increase functional female organs and compatibility besides reducing the embryo abortion in plants. Similar results were obtained earlier by Banerjee and Basu (2013) in better gourd.

**Number of fruits per vine**

Number of fruits per vine was influenced significantly by the interaction combination of plant growth regulators and pruning levels. Interaction combination of $T_6$ *i.e.,* (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly higher number of fruits per vine (10.66). And lower number of fruits per vine (4.37) was recorded in control. The combined application of various doses of $GA_3$, and NAA with double stem pruning significantly influenced the yield and yield attributing characters as compared to control. This might be due to the fact that they increases the metabolic activity in plant, which resulted in enhancement of reproductive phase in cucumber. These results are similar with the findings of Chaudhary and Phayak (2002) [6]. Yield is a complex character which involves the interaction of several intrinsic and external factors. The yield of cucumber was found to be strongly influenced by the various doses of $GA_3$, NAA and combined application of growth regulators.

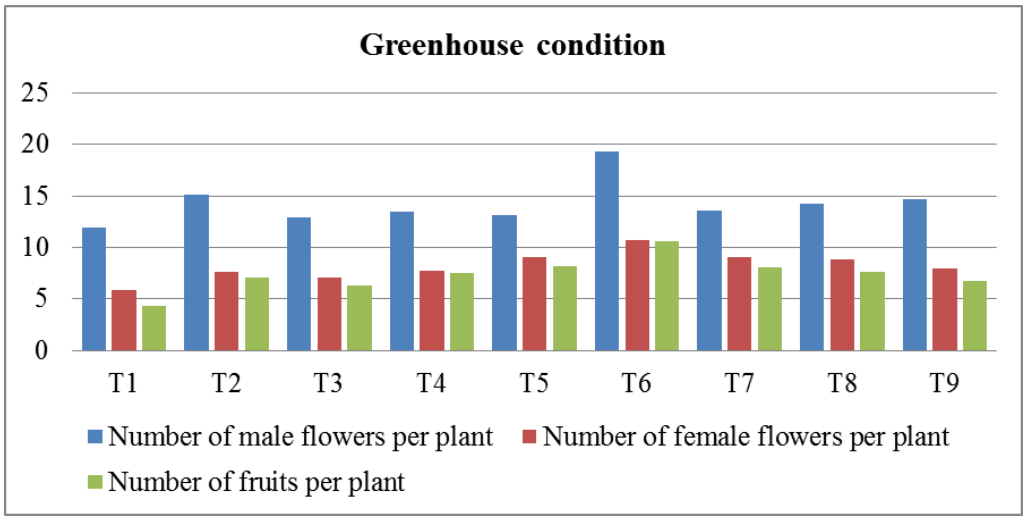


**Fig 1:** Number of male flowers, female flowers and fruits per plant under greenhouse condition

**Table 2:** Effect of foliar application of $GA_3$, NAA and pruning levels on days to 1st male flowering, days to 1st female flowering, days to 50 % flowering, number of male flowers per plant, number of female flowers per plant, number of fruits per plant, fruit setting per centage, yield per plant and yield per hectare of cucumber

| | Treatments | Days to 1st male flower | Days to 1st female flower | Days to 50 % flowering | No. of male flowers per plant | No. of female flowers per plant | No. of fruits per plant | Fruit setting per centage | Yield per plant (kg) | Yield per hectare (tons) |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Control | 31.33 | 33.21 | 45.22 | 11.89 | 5.81 | 4.37 | 67.15 | 1.67 | 64.1 |
| $T_2$ | 25 ppm $GA_3$+ 500 ppm NAA+ DSP | 29.27 | 32.33 | 40.33 | 15.09 | 7.58 | 7.08 | 76.30 | 1.88 | 75.07 |
| $T_3$ | 25 ppm $GA_3$+ 500 ppm NAA+ NP | 29.67 | 32.67 | 41.33 | 12.88 | 7.08 | 6.33 | 70.05 | 1.91 | 76.27 |
| $T_4$ | 25 ppm $GA_3$+ 1000 ppm NAA + DSP | 29.33 | 31.00 | 43.00 | 13.45 | 7.75 | 7.48 | 75.34 | 1.93 | 76.67 |
| $T_5$ | 25 ppm $GA_3$+ 1000 ppm NAA + NP | 29.00 | 32.00 | 39.33 | 13.10 | 9.11 | 8.13 | 76.40 | 2.07 | 80.40 |
| $T_6$ | 50 ppm $GA_3$+ 500 ppm NAA + DSP | 27.00 | 29.33 | 37.00 | 19.29 | 10.75 | 10.66 | 87.88 | 2.67 | 106.67 |
| $T_7$ | 50 ppm $GA_3$+ 500 ppm NAA + NP | 27.32 | 32.00 | 41.00 | 13.61 | 9.11 | 8.03 | 77.79 | 1.98 | 75.87 |
| $T_8$ | 50 ppm $GA_3$+ 1000 ppm NAA + DSP | 28.33 | 31.33 | 43.33 | 14.30 | 8.83 | 7.62 | 76.45 | 2.06 | 82.53 |
| $T_9$ | 50 ppm $GA_3$+ 1000 ppm NAA + NP | 28.50 | 32.33 | 43.00 | 14.67 | 7.91 | 6.73 | 76.38 | 1.96 | 78.53 |
| F-test (p=0.05) | | * | * | * | * | * | * | * | * | * |
| SEm± | | 1.19 | 0.73 | 0.65 | 0.18 | 0.17 | 0.22 | 1.48 | 0.07 | 2.53 |
| C.D (p=0.05) | | 3.55 | 2.18 | 1.93 | 0.53 | 0.51 | 0.66 | 4.42 | 0.22 | 7.55 |

**Fruit setting per centage (%)**

Fruit setting per centage was significantly influenced by the interaction combination of ($T_6$) *i.e.*, (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) and recorded significantly higher fruit setting per centage (87.88 %). And $T_1$ (control) recorded significantly minimum fruit setting per centage (67.15 %). Improvement in fruit setting per centage, according to Ahmed *et al.*, (2004) could happen in two ways *i.e.*, by adopting the existing varieties to grow better in their environment or by altering the relative proportion of different plant parts so as to increase the yield and fruit setting per centage of economically important parts. The plant growth regulators are capable of redistribution of dry matter in plants; thereby bring about an improvement in yield potential and thus increasing the fruit setting per centage, Arora *et al.*, (2001) [3].

**Fruit yield per plant and per hectare**

Yield per plant and yield per hectare was significantly influenced by the interaction combination of $T_6$ *viz.*, (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) recorded significantly higher fruit yield per plant and per hectare (2.67 kg and 106.67 tons respectively). $T_1$ (control) recorded significantly lesser fruit yield per plant and per hectare (1.67 kg and 66.67 tons respectively). It was concluded that among all the treatments, $T_6$ (50 ppm $GA_3$+ 500 ppm NAA + double stem pruning) was found to be more effective over other treatments and control. An increase in fruit yield per plant and per hectare in treated plants may be attributed to reason that plants remain physiologically more active to build up sufficient food for developing flowers and fruits, ultimately leading to higher yield. Similar results were reported by Arora *et al.*, (2001) [3] in Summer squash. Increase in fruit yield might be due to active cell elongation in the flower and prevents the flower abortion and thus increasing the fertilization process which resulted in more number of fruits per plant and per hectare. Mostly cucurbitaceous vegetables soon after flower anthesis fails to fertilize the embryo and the bisexual or pistillate flower aborted due to genetic makeup or environmental condition so this leads to lesser yield per plant, combined application of $GA_3$ and NAA will make the female part of the flower more active and hence reduce the abortion so better fertilization takes place. These findings are in close conformity with Aisha *et al.*, (2006).

**Conclusion**

The effect of the plant growth regulators applied at 2-4 true leaf stages and different pruning levels of the cucumber Hybrid, Malini $F_1$ on the growth, sex expression, and fruit yield attributes was found to be significant. The whole results of present experiment revealed that a combined application of $GA_3$ 50 ppm + NAA 500 ppm + double stem pruning was found to be superior in terms of growth, sex expression and yield as compared to control and other treatment combintations.

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