Original Research Article

Influence of Plant growth regulators on growth and yield of tomato (*Lycopersicon esculentum* L.)

Abstract

The present investigation was under taken to study "Influence of Plant growth regulators on growth and yield of tomato (*Lycopersicon esculentum* L.) during *Kharif* season of 2021 at Crop Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The experiment was laid out in Randomized block design wit 10 treatments and each replicated thrice. The treatments consists plant growth regulators GA_3 @ 10, 20, 30 ppm, NAA @ 10, 20, 30 ppm and 2,4-D @ 2,3,4 ppm and a control plot. The results revealed that among all the treatments foliar application of GA_3 (30 ppm) is significantly gave positive impact on growth, yield and quality parameters i.e., plant height (81.68 cm), number of clusters per plant (36.66), days to 50% flowering (63.11 days), flowers per plant (72.22), fruits per plant (55.33), fruit yield per plant (3.90 kg), fruit yield per hectare (58.5 t), total soluble solids (4.2 $Brix^0$), acidity (0.41%), gross returns (2,34,000 Rs/ha), net returns (1,87,792.5 Rs/ha) and Benefit : Cost ratio (4.06) were obtained among all other treatments with foliar application of GA_3 @ 30 ppm compared to other treatments.

Keywords: *Economics, GA3, NAA, Tomato, Yield, 2,4-D.*

Introduction

Tomato (*Lycopersicon esculentum* L.) belongs to the genus Lycopersicon under Solanaceae family. Tomato is a herbaceous sprawling plant with weak woody stem. The flowers are yellow in colour and the fruits are red in colour due to lycopin pigment. Fruits of cultivated varieties vary in size like cherry tomatoes from 1-2 cm in size and beefsteak tomatoes about 10 cm or more in diameter. Most cultivars produce red fruits when ripe. Tomato is one of most important "protective foods" because of its nutritive value. It is most one of the versatile vegetable with the wide usage in Indian culinary tradition. Tomatoes are used for soups, salad, pickles, ketchup, puree, sauces and in many other ways it is also used as vegetable salad vegetable. Tomato has very few competitors in the value addition chain of processing.

Tomato is the world's largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetable. The total global area under tomato is 46.16lakh/ha and the global production is to the tune of 1279.93 lakh tonnes. The major tomato producing countries are Brazil, China, Egypt, India, Iran, Italy, Mexico, Spain turkey USA and others. In Indian total cultivated area is 535000 hectares with production of 9362000 tonnes and the productivity is 17.50 tonnes per hectare. Andhra Pradesh is the leading state in India with area of 76,500 hectares, production of 1,453,500 tonnes, productivity followed in Bihar, Chhattisgarh and Gujarat etc

Tomatoes are commercially important crop throughout the world for both fresh fruits market and for processing food industries. Believed to have its origin in tropical America (Thompson and Kelly, 1957) it is one of the most popular vegetable around the world. It ranks third largest vegetable crop. But it tops in the list of canned vegetable. It is one of the most attractive crops. It is cultivated as cash crop as well as a vegetable crop on commercial scales in almost all parts of India

The crop is grown from almost MSL to an altitude of 1500 m in tropical and subtropical region , with an annual rainfall of 60-150 cm. very high rainfall during its growth is harmful. When growth under a hot weather, it is cultivated as an irrigated crop. The winter crop is planted from august to September. For organic farming of tomato has been found to be ideal.

Well detained sandy loam soil with high level of organic contents is best suitable for tomato cultivation. Soils with high acidity are not suitable for tomato cultivation. 3 to 4 q of suitable

lime can be applied in the field in an interval of three years to reduce the level of acidity to tolerable limits. There is a need to go for soil testing at the beginning of the crop season.

Tomato is "Poor man's orange". It is a good source of vitamin A, B and excellent source of vitamin C. According to **Rai *et al.* (2002)** tomato contains 94.5 % water, energy 23 calories, 1.0 g calcium, 7.0 g magnesium, 1000 iu vitamin, 22mg ascorbic acid, 0.09 mg thiamin, 0.03 riboflavin and 0.8 mg niacin. It can be eaten as a fresh fruit and is one of the most popular salad vegetables. It is used for culinary purpose or is also used in preparation of soups, salads, pickles, ketchup's, sauces and many other products. Under normal conditions fruit setting in tomato does not have any serious problem. But when the crop is planted late in the spring and summer crop with a view to have harvest in spring and early summers, fruit production is often limited. High temperature during day time and comparatively cooler night, results in to abscission of flowers, it is also affected by heavy rainfall and high humidity (Singh and Choudhary, 1966).

Tomatoes are usually staked, tied, or caged to keep the stems and fruits off the ground, and consistent watering is necessary to avoid blossom-end rot and cracking of the fruits. The plants are susceptible to a number of pests and diseases, including bacterial wilt, early blight, mosaic virus, Fusarium wilt, nematodes, and tomato hornworms. Many of these problems can be controlled with crop rotation, the use of fungicides and pesticides, and the planting of resistant varieties. The tiny currant tomato (S. pimpinellifolium) is a closely related species and has been used by breeders to hybridize several pest- and disease resistant tomato varieties.

Plant growth regulators are synthetic substances; they stimulate and control the physiological processes in the plant. The most commonly used growth regulators are, GA_3, NAA, 2, 4-D. They can be applied in small concentration, which is profitable for farmer. However, the improvement of yield and quality of crop vary greatly depending on the type of growth regulators, its concentrations and the method and time of application. Their actions are quite different; however they have effect on growth, yield and quality of vegetable crops. They have variable effects on the physiological processes e.g. Auxins increases cell division in cambium but inhibit lateral growth. Gibberellins also promote cell division and cell elongation in shoot regions (Pandey and Sinha, 1995).

Gibberellic acid (GA3) is a naturally occurring hormone or growth-regulating chemical that is found to varying degrees in all parts of plants. GA3 stimulates both cell division and elongation and has been used to manipulate flowering and fruit development in selected horticultural crops for many years.

NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products; it is a rooting agent and used for the vegetative propagation of plants from stem and leaf cuttings. It is also used for plant tissue culture.

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves.

Materials and Methods

A field experiment entitled “Influence of GA3, NAA and 2,4-D on plant growth and yield of tomato is going out to be carried out on Experimental Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences during *Kharif* season 2021. The climate of the region is semi-arid subtropical.

Experimental design and treatment combinations

The experiment was laid out in Randomized Block Design. The treatment consists of three levels of GA3 (10 ppm, 20 ppm, 30 ppm), three levels of NAA (10 ppm, 20 ppm, 30 ppm) and 2,4-D (2 ppm, 3 ppm, 4 ppm) was applied in the form of foliar application and a control plot. The treatments are T_0 control, T_1 GA3 10 ppm, T_2 GA3 20 ppm, T_3 GA3 30 ppm, T_4 NAA 10 ppm, T_5 NAA 20 ppm, T_6 NAA 30 ppm, T_7 2,4-D 2 ppm, T_8 2,4-D 3 ppm, T_9 2,4-D 4 ppm. Benefits: GA3 stimulates both cell division and elongation and has been used to manipulate flowering and fruit development in selected horticultural crops for many years. NAA is a rooting agent and used for the vegetative propagation of plants from stem and leaf cuttings. It is also used for plant tissue culture. 2,4-D is a widely-used herbicide that affects plant cell growth and division. These 9 nine treatments were replicated thrice.

Crop management

Tomato variety (TMTH288) transplanted at the rate of 500 gm/ha. This is a new hybrid variety developed by Trimurti Plant Sciences P Limited Hyderabad, Telangana. Tomato hybrid suitable for cultivation during *Kharif* and *Rabi* seasons and gives high yield potential. Harvesting starts from 75-80 days after transplanting. It is a semi-determinate plant type. The average weight of fruit varies from 90-100 gm are firm. The recommended dose of fertilizer 200:250:250 NPK kg/ha. The nutrient sources were Urea, SSP and MoP to fulfill the requirement of nitrogen, phosphorous and potassium. 6-7 irrigations were given to the crop. 3-4 weedings was done manually with khurpi.

Results and discussion

The present field experiment entitled “Influence of Plant growth regulators on growth and yield of tomato (*Lycopersicon esculentum* L.)” was aimed at identifying various levels of plant growth regulators. Ten treatment combinations including control plot were evaluated during *Kharif* season 2021 in the experimental field of Department of Horticulture, Sam

Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The results of the experiment are as following.

Influence of plant growth regulators on growth attributes of tomato:

Observations regarding the growth attributes of tomato are given in the Table 1. The maximum survival percentage (96.67) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), plant height (81.68 cm) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), number of clusters per plant (36.66) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), Days to 50% flowering (63.85) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), number of flowers per plant (72.22) was recorded in the treatment 3 with foliar application of (GA3 30 ppm).

Influence of plant growth regulators on yield attributes of tomato:

Observations regarding yield attributes of tomato are given in the Table 2. The Maximum number of fruits per plant (55.33) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), fruit yield per plant (3.90 kg) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), fruit yield per plot (23.40 kg) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), fruit yield per hectare (58.5 t) was recorded in the treatment 3 with foliar application of (GA3 30 ppm), Total Soluble Solids (4.2) ^{0}Brix was recorded in the treatment 3 with foliar application of (GA3 30 ppm), Acidity (0.41%)was recorded in the treatment 3 with foliar application of (GA3 30 ppm).

Influence of plant growth regulators on economics of tomato:

With the application of various plant growth regulators with different levels gross returns, net returns and B:C ratio was increased with increasing level of GA3, NAA and 2,4-D. the maximum gross returns (2,34,000 Rs), net returns (1,87,792.5 Rs) and B:C ratio (4) was recorded in the treatment T3 (GA3) and lowest was observed in the control plot with gross returns (1,62,000 Rs), net returns (1,15,950 Rs), and B:C ratio (4).

Conclusion:

Considering the result of the present experiment it may be concluded that treatment 3 with GA3 30 ppm/ha recorded highest fruit yield (58.5 t/ha) was found to be the best treatment for better plant growth, yield of tomato with benefit cost ratio (4). Therefore based on the above results treatment 3 can be recommended for cultivation of tomato.

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Table 1. Performance of growth attributes in tomato by growth regulators.

Treatments	Survival percentage (%)	Plant height (cm)	No. of clusters/plant	Days to 50% flowering	No. of flowers/plant
Control	91.33	65.76	23.66	78.22	50.22
GA3 10 ppm	93.67	77.06	33.44	67.33	64.67
GA3 20 ppm	94.67	80.36	35.44	64.00	70.11
GA3 30 ppm	96.67	81.68	36.66	63.85	72.22
NAA 10 ppm	93.33	72.68	29.55	73.11	59.44
NAA 20 ppm	94.33	73.58	31.11	71.44	60.77
NAA 30 ppm	94.67	74.92	32.00	69.33	63.44
2,4-D 2 ppm	94.33	71.92	27.77	77.00	57.11
2,4-D 3 ppm	92.67	70.42	25.89	76.44	55.44
2,4-D 4 ppm	91.67	68.53	25.33	75.44	52.78

Table 2. Performance of yield attributes in tomato by growth regulators.

Treatments	No. of fruits/plant	Fruit yield/plant (kg)	Fruit yield/plot (kg)	Fruit yield/hectare (t/ha)
Control	35.33	2.70	16.20	40.5
GA3 10 ppm	50.77	3.50	21	52.5
GA3 20 ppm	54.22	3.79	22.40	56
GA3 30 ppm	55.33	3.90	23.40	58.5
NAA 10 ppm	43.55	3.17	19	47.5
NAA 20 ppm	45.00	3.40	20.40	51
NAA 30 ppm	48.44	3.53	21.20	53
2,4-D 2 ppm	42.33	3.23	19.40	48.5
2,4-D 3 ppm	40.77	3.10	18.60	46.5
2,4-D 4 ppm	39.33	2.83	17	42.5

Table 3. Performance of quality parameters in tomato by plant growth regulators.

Treatments	TSS (^{0}Brix)	Acidity (%)
Control	3.27	0.31
GA3 10 ppm	3.9	0.38
GA3 20 ppm	4.1	0.39
GA3 30 ppm	4.2	0.41
NAA 10 ppm	3.6	0.37
NAA 20 ppm	3.9	0.38
NAA 30 ppm	4	0.4
2,4-D 2 ppm	3.5	0.35
2,4-D 3 ppm	3.4	0.34
2,4-D 4 ppm	3.3	0.32