Original Research Article

Effect of ~~Foliar application of~~ plant growth regulatorson~~influences~~ seed yield and seed quality traits in tomato (*Solanum lycopersicum* L.) cv. Kashi Adarsh

ABSTRACT

A field experiment was conducted at the College of Agriculture and Research Station, Kunkuri, Jashpur, Chhattisgarh, during *rabi* 2020-21 with an aim to standardize foliar spray of plant growth regulator for higher seed yield in tomato. The experiment was laid out in randomized complete block design having nine treatments and three replications. Seedling quality traits were recorded in laboratory in completely randomized design. Foliar application of GA_3, NAA, Cycocel and Salicylic acid in various concentrations in tomato were applied as foliar spray at 30 and 45 days after transplanting of tomato seedlings of cultivar Kashi Adarsh. Results revealed that maximum plant height (121.89 cm), number of branches per plant (10.39), number of fruits per plant length of fruit (33.06), length of fruit (4.66 cm), diameter of fruit (4.52 cm), seed yield per plant (19.14 g) was recorded in treatment foliar spray of GA_3 @ 50 ppm. In laboratory condition seedling traits were evaluated and the highest germination (96.25 %), root length (6.78 cm), shoot length (8.76 cm), root fresh weight (0.81 g), shoot fresh weight (3.37g), root dry weight (0.061 g), shoot dry weight (0.209 g), vigour index- I (789.25) and vigour index- II (22.66) was alsorecorded in GA_3 @ 50 ppm.

Keyword: Tomato, plant growth regulator, GA_3, seed yield

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L., 2n = 2x = 24) is one of the important vegetable crop belongs to solanaceae family and is ~~being~~ cultivated throughout India. Tomato ~~is one of the most important "protective foods" because of its special nutritive value and widespread production as far as the nutritive value is concerned with respect to human health, it~~ has rich source of lycopene, minerals and vitamins such as ascorbic acid and β-carotene which are anti-oxidants and promote good health. Chhattisgarh accounts forabout 4.98% of the total production of tomato in the country. The productivity oftomato crop in Chhattisgarh is 16.42 MT/Ha.which is found lower to all India average of21.99 MT/Ha. The major tomato producingdistricts are Raipur, Durg, Bastar, Balod andJaspur. In Chhattisgarh, total production oftomato is 11.33 lakh MT from an area of about 0.65 thousand Ha [1]. Non-availability of quality seeds, absence of suitableseed production technology, heavy flower drop~~ping~~ andheavy incidence of pest and diseases, inadequate post-harvest handling operations and lack of knowledge aboutvarieties by farmers lead to fall in productivity of tomato in Chhattisgarh. It could beenhanced by developing suitable low-cost seed productiontechnology by combining conventional and scientificpractices for achieving the commercial success of the crop[2].Low seed yield is also attributed to shortening of growing seasonand its impact on reproductive phase which might decrease in the number of flowers [3]. Attempts areto be taken to develop the seed productiontechnique of tomato under

Chhattisgarh conditions which can flourish tomato seed production as well as to compensate high cost of seed.

Seeds may require special treatments like spray of growth regulators for improving germination and overcoming dormancy[4]. However,theimprovement in yield and quality of the cropmainly depends on the concentration of plantgrowthregulators,methodandtimeofapplication. In the present study we are concerned with plants growth regulators like NAA GA_3, Cycocel and Salicylic acid. NAA is commonly used in horticultural crops. It also affects the physiological process, hasten maturity and produces better quality fruits and some other aspects such as to increase the number of branches, increased fresh weight, and yield[5]. Itmaypromote cell elongation and cell division thushelps in the growth and development of many plants species.Gibberellinsaffect shootelongationinitiationofflower,stigmaposition,andfruitset,breakingdormancy,fruitsizeandseednumberinthefruit.Keepingthesefactsinviewthepresentinvestigationwascarriedouttostudythe effect of naphthalene acetic acid (NAA) andGibberellicacid (GA_3)ongrowthandfruitqualityof tomato.Salicylic acid (SA) can affect seed germination, cell growth, stomatal opening,Klessig et al. [6]. Moreover, SA as vase solution of gladiolus caused a significant reduction in respiration rate, and improved the vase life[7]. Cycocelhas been reported to be very effective in improvingyield and quality of certain vegetable crops, which causesretardation of vegetative growth and diversion of assimilatestowards reproductive growth[8].Information regarding the effect of foliarapplication of plant growth regulators on seedproduction of tomato aremeagre in Chhattisgarh.Considering the above facts, the present studywas undertaken to investigate the effect offoliar application of plant growth regulatorson seed production of tomato.

2. MATERIAL AND METHODS

The ~~*rabi*~~field experiment was conducted during *rabi* season at thePandaripani Farm, College of Agriculture and Research Station, IGKV, Kunkuri, District Jashpur, Chhattisgarh during 2020-21. The pure ~~foundation~~seeds of tomato variety, “Kashi Adarsh” were obtained from IndianInstitute of Vegetable Research, Varanasi, Uttar Pradesh. Seedlings were raised in the nursery bed at the Pandaripani Farm.Healthy seedlings of 25 days old were used for transplanting. Four plant growth regulators withtwo concentrations of each (GA_3, 25 and 50 ppm; NAA, 25 and 50 ppm;Cycocel, 250 and 500 ppm;Salicylic acid, 150 and 300 ppm)were appliedas foliar spray at 30 and 45 days after transplanting of tomato seedlings of cultivar Kashi Adarsh. One control (T_0) was used as treatment for comparing the effect of PGR’s with farmer’s practice, thus total nine treatments were used during the investigation.The field trial was laidout in randomized complete block design with threereplications. The seedlings were transplanted at ~~adistance~~a distance of 60x45 cm. Twenty plants weremaintained in a plot of 5.40 m^2area. All the culturalpractices and plant protection measures werefollowed as standard cultivation practices. The harvested seeds were tested for seedling quality traits in laboratory conditions in completely randomized design.

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The observation on days to flowering, plant height (cm), number of fruits per plant, number of branches per plant, length of fruit (cm), diameter of fruit (cm), seed weight per fruit (g) and seed yield per plant was recorded in field level. The harvested seeds from each treatment were analyzed for quality traitsviz., germination percentage, root length (cm), shoot length (cm), root fresh weight (g), shoot fresh weight (g), root dry weight (g), shoot dry weight (g), vigour index-I (length) and vigour index-II (mass) during May 2022 in Horticulture Laboratory, College of Agriculture and Research Station, Kunkuri in completely randomized design with three replications.Data were collected from fiverandomly selected plants from each plot. The meansfor all the treatments were calculated and theanalyses of variance for all the characters wereperformed by F test. The significance of differencebetween the pairs of means was separated by LSDtest at 5% and 1% levels of probability[9].

Table 1. Physical, chemical and biological properties of experimental soil (0-20 cm)

Particulars	Value	Methods
Sand (%)	62	[10]
Silt (%)	17	[10]
Clay (%)	21	[10]
pH (1 : 2.5:: Soil : Water)	6.50	[10]
Organic carbon (%)	0.49	Walkley and Black'smethod [11]
N (kg/ha)	161	Alkaline potassium permanganate method [12]
P (kg/ha)	19.17	Olsen's method [13]
K (kg/ha)	184	Flame photometer [14]

3. RESULTS AND DISCUSSION

31. Effect of plant growth regulators in growth and seed yield traits of tomato

Four different plant growth regulators at two different concentrations were assessed to see the effect on growth and seed yield traits in tomatocv. Kashi Adarsh and data is presented in Table 2. All seed yieldattributing traits (days to flowering, plant height, branch numbers, fruit numbers, fruit length, fruit diameter, seed numbers, seed weight and seed yield) were found significant except days to flowering in tomato with respect to different plant growth regulators.

Effect of different plant growth regulators did not differ significantly for days taken for flowering in tomato and it varied from 35.43-36.87 days. However, control treatment took maximum days for flowering. These ~~Re~~results are~~ is conformity~~in conformity with the finding ofSharma et al.[15]who reported that growth regulators did not influence days to flowering in tomato.It was observed that application of different plant growth regulators significantly increased plant height as compare to control treatment (T_0). Application of GA_3 at 50 ppm (T_2) resulted ~~gave~~in the highest plant height (121.89 cm) over the rest of treatments and it was significantly superior overall other ~~used~~ treatments. Results are in line with the finding of Rahman et al. [16] and Ramteke et al.[17].Likewise, significantly highest number of branches per plant (10.39) were produced in T_2, whereas Control (T_0) exhibited similar lowest trend for growth and seed yield traits viz; days to flowering (37.07 days), plant height (92.05 cm) and number of branches per plant (8.31).Tomato plant treated with GA_3 @ 50 ppm showed significantly higher number of branches per plant than untreated control. This might be due to the rapid increase in cell division and cell elongation in the meristematic region. Results are in line with the finding of Rai et al. [18].

Number of fruits per plant were maximumwith application of GA_3 50 ppm (T_2)and it was significantly superior overall other used treatments. Significantly least number of fruits per plant were recorded in control (T_0). The length of fruit showed a gradual increasing trend for different plant growth regulators in comparison to control (T_0). Application of GA_3 50 ppm (T_2) exerted significantly highest length (4.66 cm) of fruit and it was remained superior over othertreatments. Control (T_0) treatment exerted significantly the minimum length (3.96 cm) of fruit in tomato. GA_3promote cell enlargement and cell division that enhance plant height, number of branchesand number of leaves which results in higher accumulation of photosynthates in the plants. These results are in agreement with results of Sanyal et al. [19] and Gelmasaet al.[20]in tomato. Spraying of GA_3 @ 50 ppm, exerted significantly maximum diameter(4.52 cm) of fruit. The significantly least diameter (3.03 cm)of fruit was observed in control(T_0). Generally, fruit yield is dependent on the yield attributes such as: number of fruits per plant, size (length and diameter) and weight of fruits. If such attributes contribute positivelydue to growth regulators resulting in higher yield.The results are in conformity with the findings of Tiwari and Singh [21] and Singh et al. [22]in tomato.

Application of both NAA @ 50 ppm(T_4) and salicylic acid @ 300 ppm (T_8) produced significantly maximum number of seedper fruit(126.43). While, significantlyleast number of seed (115.33)per fruit was recorded in Cycocel 250 ppm (T_5). Similar trend was recorded for seed weight which was significantly highest in both T_4 and T_8(0.39g). The minimum seed weight per fruit was observed in Cycocel 250 ppm (0.24 g).Application of GA_3 @ 50 ppm(T_2) produced significantly highest seed yield per plant(19.14 g).Whereas, as other traits, significantly minimum seed yield(15.40g) per plant also was produced in control (T_0). The higher seed yield and number of seeds in plant growth regulators treatments might be due to an inhibition of vegetative growth and thusmaking available the food reserves for developing fruits, which was evident from thesignificantly increased number of fruits and seed yield per plant.Results are in accordance with findings ofUddainet al.[23]in tomato.

Table 2. Effect of plant growth regulators in growth and seed yield traits in tomato

Treatment	Days to flowering	Plant height (cm)	Number ofbranches per plant	Number of fruits per plant	Length of fruit (cm)	Diameter of fruit (cm)	Number of seeds per fruit	Seed weight per fruit (g)	Seed yield per plant (g)
T_0: Control	37.07	92.05	8.31	26.20	3.96	4.03	119.51	0.31	15.40
T_1: GA_3 @ 25 ppm	35.43	109.32	9.56	31.23	4.36	4.34	116.56	0.27	18.02
T_2: GA_3 @ 50 ppm	34.81	121.89	10.39	33.06	4.66	4.52	118.14	0.26	19.14
T_3: NAA @ 25 ppm	36.87	106.74	9.12	29.54	4.23	4.09	123.34	0.29	17.98
T_4: NAA @ 50 ppm	35.19	110.86	9.33	31.82	4.54	4.38	126.43	0.39	18.44
T_5: Cycocel @ 250 ppm	36.32	95.43	9.65	28.67	4.17	4.23	115.33	0.24	17.06
T_6: Cycocel @ 500 ppm	36.25	100.65	9.82	29.94	4.19	4.27	118.47	0.25	17.48
T_7: Salicylic acid @ 150 ppm	36.21	105.43	9.42	29.75	4.28	4.17	121.43	0.32	17.98
T_8: Salicylic acid @ 300 ppm	35.99	109.86	9.98	31.12	4.44	4.38	126.43	0.39	18.64
S.E.m ±	0.78	3.02	0.25	0.69	0.12	0.13	1.97	0.01	0.32
C.D. (p=0.05)	NS	8.99	0.73	2.01	0.36	0.37	5.68	0.03	0.91

3.2 Effect of plant growth regulators in seed germination and seedling traits of tomato

Data pertaining to germination, root length, shoot length, root and shoot weight (fresh and dry) vigour index-I & II during subsequent growing found significant with respect to different plant growth regulators which are depicted in Table 2.

GA_3@ 50 ppm (T_2)gave significantly highest (96.25%) germination followed by salicylic acid @150 ppm (93.50). While, ~~with no any contribution, significantly~~ minimum seed germination(86.00%) was noticed in Cycocel@ 250 ppm(T_5). Endogenous GA helps in breaking dormancy ofseed. It also catalyzes different biochemical reactionsinside the seed, which improves germination rate andits uniformity. Higher germination may be due to increased activity of redox enzyme in seeds harvested in GA_3 treatment, which helps in quick breakdown of complex food into simple soluble sugars and also increase germination.The present findings are in conformity with the findings of Patil et al. [24].

GA_3@ 50 ppm (T_2)gave significantly longest root length (6.78 cm) and it was statistically at par with treatments NAA @ 25 ppm and NAA @ 50 ppm (T_3 and T_4). While, significantly smallest root length (4.45cm)was recorded in control (T_0).Shoot length was significantly influenced by GA_3 @ 50 ppm (T_2)which gavelongest shoot length (8.76cm) andsignificantly minimum (5.78cm)shoot length was observed in control (T_0).This might be dueto synthesis of protein in plants get accelerated,which is indirectly exhibited by increase in size ofdifferent plant parts.GA_3treatment helps to increase cell division, cell elongation andcell multiplication which might have reflected into maximumseedling shoot length. These results are in accordance withresults obtained by Thorat et al. [25].

The data presented in Table 3 revealed that GA_3 @ 50 ppm (T_2) exserted significantly highest root fresh weight (0.81g). The minimum root fresh weight (0.59g) was observed in control (T_0). Similarly, significantly highest shoot fresh weight (3.37g) was recorded in GA_3@ 50 ppm (T_2). The minimum shoot fresh weight (2.65g) was observed in control (T_0).Root dry weight was significantly influenced by GA_3 @ 50 ppm (T_2) and recorded maximum root dry weight (0.061g). The minimum root dry weight (0.042g) was observed in Cycocel @ 250 ppm (T_5). GA_3 @ 50 ppm (T_2) recorded significantly maximum shoot dry weight (0.209 g) and minimum shoot dry weight (0.162 g) was observed in control (T_0). The maximum dry weight of seedling with seed harvested in GA_3 treatment can be correlated with higher overall growth inthe corresponding treatment of GA_3. Hence, it can be statedthat increase in overall growth of the seedling has led to theoverall assimilation and redistribution of food material withthe seedling [26].

Vigour index showed similar trend in term of influence by different treatments and it was maximum in GA_3 @ 50 ppm (T_2) while it was minimum in control (T_0). Vigour index-I (789.25) was significantly highest in T_2 and at with other all treatments. The minimum vigour index-I (656.64) was observed in treatment T_0. Vigour index-II (22.66) was recorded significantly highest in T_2. Whereas, minimum vigour index-II (18.16) was observed in T_0 in tomato.The vigour index I of seedlings is directly dependent ongermination percentage and seedling length. Higher seedlingvigour index I in GA_3 treated seeds might be due to thecumulative effect of higher seedling length and germinationpercentage which were greatly influenced by GA_3 in tomato. The similarresults were reported byThorat et al. [25] and Vaja et al.[27].

Table 3. Effect of plant growth regulators in seed germination and seedling traits in tomato

Treatment	Germination (%)	Root length (cm)	Shootlength (cm)	Root freshweight (g)	Shoot freshweight (g)	Root dryweight (g)	Shoot dry weight (g)	Vigour index- I	Vigour index- II
T_0:Control	89.67	4.45	5.78	0.59	2.65	0.042	0.162	656.64	18.16
T_1:GA_3 @ 25 ppm	92.34	6.42	8.29	0.71	3.09	0.054	0.187	731.39	20.96
T_2:GA_3@50 ppm	96.25	6.78	8.76	0.81	3.37	0.061	0.209	789.25	22.66
T_3:NAA @25 ppm	89.00	6.48	8.23	0.71	2.99	0.051	0.173	696.31	18.98
T_4:NAA @50 ppm	92.10	6.76	8.29	0.73	3.13	0.057	0.185	721.29	20.46
T_5:Cycocel@ 250 ppm	86.00	6.18	7.89	0.64	2.89	0.041	0.167	666.35	18.98
T_6:Cycocel@500 ppm	90.10	6.34	8.02	0.67	3.02	0.046	0.181	704.22	20.46
T_7:Salicylic acid@ 150 ppm	93.50	5.64	7.89	0.64	2.87	0.048	0.171	692.88	19.03
T_8:Salicylic acid @300 ppm	92.10	5.24	8.22	0.70	3.08	0.053	0.182	701.19	21.24
S.E.m. ±	0.98	0.11	0.13	0.01	0.03	0.007	0.032	4.67	0.21
C.D. (p=0.05)	2.84	0.31	0.37	0.03	0.08	0.002	0.011	13.48	0.59

4. CONCLUSION

Application of GA_3 @ 50 ppm was found a best treatment, as it has produced the maximum parameters like plant height, number of fruits per plant, diameter of fruit and seed yield per plant except day to flowering. Day to flowering is non-significant means no effect in growth and development of plant and also seed production. Therefore, foliar application of GA_3 @ 50 ppm at 30 and 45 days after transplanting can increase seed yield and seed quality of tomato cv. Kashi Adarsh.

CONSENT

Notapplicable

ETHICAL APPROVAL

This study is a plant science studies and does not required any testing on animals and human being. This article does not contain any studies with human participants or animals performed by any of the authors.

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