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RESPONSE OF TOMATO (*LYCOPERISCON LYCOPERSICUM* (L) KARST) TO VARIOUS RATES OF GIBERRELLIC ACID

***Yahaya, S. U. and Gaya, U. H.**
Department of Crop Science, Kano University of Science and Technology P.M.B. 3244, Wudil.
*Correspondence author: suyahya2007@yahoo.com

ABSTRACT
Field trials were conducted in the 2008/2009 and 2009/2010 dry seasons to assess the efficacy of various rates of giberrellic acid on the growth and yield of tomato (Lycopersicon lycopersicum (L) karst. The treatments consisted of seven rates (0, 50, 100, 150, 200, 250 and 300 ppm) of giberrellic acid. These were laid in a randomized complete block design and replicated three times. Data were recorded on plant height, number of leaves, number of branches, number of flowers and fresh fruit weight. These were subjected to analysis of variance. Where treatment means differed significantly, they were compared using DMRT. Results of the study showed that giberrellic acid concentration had significantly (P ≤ 0.05) enhanced the growth, yield components as well as total yield of tomato. Best results were recorded from plants treated with 300 ppm giberrellic acid compared to all other rates applied. It is suggested that tomato be treated with 300 ppm giberrellic acid for improved yield.
Keywords: Giberrellic acid, Growth, Response, Tomato, Yield.

INTRODUCTION

Giberrellic acid is one of the most important growth stimulating substance used in agriculture. Giberrellic acid is a chemical substance that occur naturally in many plants. It regulate various important functions such as elongation of stems, creation of proteins and germination of seed plants. The effectiveness of giberrellic acid in tomato and many other vegetable crops solely depends on the right quantity applied, time of application, soil condition as well as prevailing temperature (Miko and Mojiea, 2005., Basnizki *et al*., 1986).

As Nigerian population is increasing at almost geometrical sequence, threats of food shortage in a near future is eminent. Tomato production is also faced with problems of low yield which arose from poor production practices and degraded soils among others. Considering the importance of this crop as vegetable source, it is noteworthy that its production be enhanced by giving due consideration through the application of growth hormones (Nisar *et al.*, 2001). Despite of the response of vegetables to giberrellic acid treatment, some of these responses may be undesirable and hence recommendations for its use on different vegetables may be dynamic (John, 1987). As such application of research results elsewhere is of little or no significance as the crops response to cultural practices vary with geographical location owing to the vagaries of weather elements (Miko, 1999). The aim of this research is to determine the response of tomato to different levels of giberrellic acid and to determine the best rate of GA that could enhance growth and yield of Tomato in the study area.

MATERIALS AND METHODS

Site Description

The experiment was conducted at the Kano University of Science and Technology, Wudil, Teaching and Research Farm located on Lat. $10^{0}33'$S., Lon. $7^{0}34'$N to $9^{0}24'$E, and 428 m above sea level in the Sudan Savanna agro ecological zone of Nigeria.

Cultural Practices

The land was harrowed to a fine tilth and levelled. Twenty one (2 x 3 m) plots were earmarked. Each plot was separated from one another by a 0.5 m border and also 1 m between blocks. Uniform dose of 100 kg P_2O_5 in form of Super phosphate and 50 kg N ha^{-1} was applied before transplanting of the seedlings (Nisar *et al.*, 2001). At this stage, 3 weeks old tomato seedling (Roma V.F) were transplanted at 45 x 75 cm spacing on an erected ridges. Stands with dead or faulty seedlings were supplied a week after. Two manual hoe weeding were done to combat weeds at the third and fifth week after transplanting (WAT). The plants were foliar sprayed with giberrellic acid during the 2 WAT.

Treatments and Experimental Design

The experimental treatments consisted of seven rates of giberrellic acid (0, 50, 100, 150, 200, 250 and 300 ppm). These were prepared using standard procedures as described by John (1987). Some 2000 ppm stock solution were prepared by dissolving 125 mg (0.125 g) of gibberellic acid crystals in a 60 ml distilled water. The stock solutions were used to prepare the various rates as follows;

500 ml distilled water was used as a control = 0 ppm
12.5 ml of stock solution diluted with 487.5 ml water in a 500 ml flask = 50 ppm
25 ml of stock solution diluted with 475 ml water in a 500 ml flask = 100 ppm
37.5 ml of stock solution diluted with 462.5 ml water in a 500 ml flask = 150 ppm
50 ml of stock solution diluted with 450 ml water in a 500 ml flask = 200 ppm

62.5 ml of stock solution diluted in 437.5 ml water in 500 ml flask = 250 ppm

75 ml of stock solution diluted in 425 ml water in 500 ml flask = 300 ppm

The prepared concentrates were foliar applied using hand pump sprayer (CP Cooper 15 ml model) to the designated plots at 2 WAT.

Data collection and Analysis

Data on plant height, number of leaves per plant and number of branches per plant were collected on weekly intervals across 2 – 5 WAT, while the number of flowers per plant recorded at a time when about 75% of the plants had produced opened flowers. Total fresh fruit yield were however deduced by harvesting the mature fruits for 5 weeks. At each harvest, the fruits were weighed and recorded. These were pooled to obtain the total fresh fruit weight and later converted into tonne per hectare.

All the data collected were subjected to analysis of variance using general linear method (GLM) procedures of SAS 1999, inc. The effect of giberrellic acid rates in all the parameters measured were considered. Where treatments differed significantly, their means were ranked using Duncan Multiple Range Test (DMRT) as described by Duncan (1955).

RESULTS AND DISCUSSION

The results of the study showed that the measured parameters were significantly influenced by the application of giberrellic acid. The giberrellic acid rates applied as well as the seasons significantly differed on all the growth parameters at 3, 4 and 5 weeks after transplanting (WAT). Similarly, the number of flowers per plant and the total fresh fruit yield were significantly affected by the GA_3 rates and seasons, while the interaction effects were not significant.

Plant Height

Plant height of tomato significantly increased with every increase in applied GA_3 across 50 – 300 ppm in all the sampling periods (Table 1). This could be ascribed to the roles of GA_3 in promoting cell enlargement and cell division of which the two important processes enhanced plant height in tomato (Arteca, 1996). This is also in agreement with the findings of Khan *et al.* (2006) who reported that spray of tomato with giberrellic acid was beneficial irrespective of the concentration applied. Significantly taller plants were recorded in 2008/2009 than 2009/2010 season. This may be as a result of the variation of temperature of the two seasons with 2008/2009 season having lower air temperature (Table 5).

Number of Leaves per Plant

Compared with the water sprayed control treatment, there were significant increase in number of leaves per plant of tomato with every increase in GA_3 rate at 3, 4 and 5 WAT sampling periods (Table 2). Results of the study indicated 300 ppm GA_3 treated plants recorded significantly higher number of leaves at 4 and 5 WAT sampling periods. Nisar *et al.* (2001) made similar observation and reported that stem elongation in young tomato plants increased by all concentrations across 2 - 450 mg liter $^{-1}$. Similarly, Moore (1989) reported GA_3 as important in cell division which in turn leads to more number of leaves per plant.

Significantly higher number of leaves were recorded in 2008/2009 than 2009/2010 season (Table 2). This may be due to variation in the climatic conditions obtained in the two seasons with 2008/2009 season recording the lowest temperature. This confirmed the report of Miko and Manga (2005) who asserted the response of crop to different practices as dynamic due to fluctuations of weather elements. This also confirmed the report of Iknur *et al.*(2008) who asserted the functionality of giberrellic acid as dependant on eligible temperature and correct dose. This suggests interaction of low temperature and dose as important for maximum effect.

Number of Branches per Plant

Number of branches per plant of tomato were significantly enhanced by applied GA_3 at 3, 4 and 5 WAT (Table 3). Plants treated with 300 ppm GA_3 produced significantly higher number of branches per plant, while the least number of branches were recorded from the water sprayed control treatments. This may be due to promoting effect of GA_3 in protein synthesis which consequently enhances biomass production of vegetative parts and their content as reported by Khan *et al.* (2006). Enhancement of enzyme activity would also result in biomass accumulation in plants as they advance with age.

Plants with significantly higher number of branches were recorded in 2008/2009 than 2009/2010 season. This may be due to interaction effect of GA_3 and lower temperature recorded in 2008/2009 (Table 5) as confirmed by Iknur *et al*. (2008).

Number of Flowers per Plant and Fresh Fruit Yield

Number of flowers per plant of tomato were significantly influenced by applied GA_3 across 50 – 300 ppm rates (Table 4). Significantly higher number of flowers were recorded from 300 ppm treated plants. This could be attributed to the higher number of branches which consequently bears more number of flowers. Similarly, The total fresh fruit yield were significantly higher from plants treated with 300 ppm GA_3 (Table 4) while the least yield were recorded from the water sprayed control treatment. This shows that yield is a function of crop vigour. The greater the number of branches that bear more number of leaves, the higher will be the photosynthetic capacity and hence assimilate production. These are consequently translocated to sink and hence higher will be the yield. Deore and Bharud (1990) reported similar observation in garlic in which they emphasize on the influence of giberrellic acid in increasing yield as dependence on plant height, leaf number and to some extent upon the assimilatory efficiency.

All the growth and yield parameters were best with 300 ppm GA_3 treated plants. This contradicts the findings of Nisar *et al.* (2001) who reported 60 mg liter $^{-1}$ as the best for tomato. The differences may be justified by the variation of temperature recorded for the two seasons (Table 5). Increasing air temperature above 20^0C was reported to result in poor roots development in vegetables and hence better performance recorded in 2008/2009 was not a surprise.

Table 1: Plant Height (cm) of Tomato as influenced by different rates of giberrellic acid at 2, 3, 4 and 5 weeks after transplanting

	Weeks After Transplanting			
Treatment	**2**	**3**	**4**	**5**
GA_3 Concentration (ppm)				
0	22.67	30.87d	39.73d	45.63d
50	21.97	36.40cd	45.73cd	55.97cd
100	21.63	37.43c	46.20cd	59.20c
150	21.99	38.93bc	49.17c	65.53c
200	22.17	40.50bc	59.10b	82.40b
250	21.63	43.17ab	60.63ab	88.30b
300	21.92	47.07a	66.63a	98.30a
SE ±	0.14	1.95	3.67	7.25
Season				
2008/2009	21.77	40.53a	53.11a	81.77a
2009/2010	21.65	37.69b	49.92b	77.53b
SE ±	0.06	1.00	1.60	2.13
Interactions				
Conc x Season	NS	NS	NS	NS

Means followed by the same letter (s) with in columns are not significantly different using DMRT at 5% level of probability.

Table 2: Number of leaves per plant of Tomato as influenced by different rates of giberrellic acid at 2, 3, 4 and 5 weeks after transplanting

	Weeks After Transplanting			
Treatment	**2**	**3**	**4**	**5**
GA_3 Concentration (ppm)				
0	10.33	16.63c	21.53e	31.07f
50	10.87	19.53c	25.97d	38.87e
100	10.37	22.40bc	30.30c	45.10d
150	10.97	22.93b	33.43c	49.07d
200	10.63	23.63ab	36.87bc	54.40c
250	10.75	25.87a	39.30b	61.97b
300	10.77	25.67ab	43.20a	78.43a
SE ±	0.09	1.25	2.87	5.90
Season				
2008/2009	10.67	21.99a	36.73a	55.19a
2009/2010	10.59	20.13b	34.15b	53.72b
SE ±	0.04	0.93	1.29	0.74
Interactions				
Conc x Season	NS	NS	NS	NS

Means followed by the same letter (s) with in columns are not significantly different using DMRT at 5% level of probability.

Table 3: Number of branches per plant of Tomato as influenced by different rates of giberrellic acid at 2, 3, 4 and 5 weeks after transplanting.

	Weeks After Transplanting			
Treatment	**2**	**3**	**4**	**5**
GA_3 Concentration (ppm)				
0	2.50	3.63c	5.63c	8.30f
50	2.63	4.50b	6.87c	10.40e
100	2.77	4.53b	7.10c	12.07de
150	2.67	4.68b	7.87b	13.77d
200	2.97	5.10ab	9.10ab	16.17c
250	2.87	5.30a	10.50a	18.30b
300	2.91	5.53a	10.77a	20.07a
SE ±	0.06	0.24	0.73	1.61
Season				
2008/2009	2.61	4.73a	7.97a	14.77a
2009/2010	2.69	4.09b	7.13b	13.91b
SE ±	0.04	0.32	0.42	0.43
Interactions				
Conc x Season	NS	NS	NS	NS

Means followed by the same letter (s) with in columns are not significantly different using DMRT at 5% level of probability.

Table 4: Yield and yield related components of tomato as influenced by different rates of giberrellic acid.

Treatment	**Number of flowers per plant**	**Total fresh fruit yield (Tonne Ha^{-1})**
GA_3 Concentration (ppm)		
0	38.30e	6.87f
50	43.43e	9.62e
100	57.30c	11.27d
150	61.63c	13.84c
200	79.17b	17.84b
250	77.87b	18.23b
300	99.97a	22.95a
SE ±	8.21	2.12
Season		
2008/2009	73.21	15.72a
2009/2010	72.99	12.79b
SE ±	0.11	1.47
Interactions		
Conc x Season	NS	NS

Means followed by the same letter (s) with in columns are not significantly different using DMRT at 5% level of probability.

Table 5: Metreological data showing minimum and maximum temperatures, of the study area in 2008/2009 and 2009/2010 dry seasons

	2008/2009			2009/2010		
			Air Temp ^{0}C			
Month	**Days**	**Min**	**Max**	**Days**	**Min**	**Max**
	1 - 10	21.9	35.6		26.1	31.5
October	11 – 20	19.4	35.9	October	25.4	30.9
2008	21 – 31	21.1	36.3	2009	24.9	30.8
	1 – 10	17.5	35.4		27.6	38.6
November	11 – 20	17.3	35.7	November	20.2	30.9
2008	21 – 30	15.9	35.4	2009	11.9	25.0
	1 - 10	16.1	35.7		24.7	34.4
December	11 – 20	16.2	35.0	December	23.1	38.2
2008	21 – 31	15.1	34.9	2009	23.1	34.6
	1 – 10	15.5	34.2		18.8	31.0
January	11 – 20	14.7	30.4	January	19.1	32.1
2009	21 – 31	10.5	28.3	2010	20.4	29.6
	1 - 10	14.5	31.7		23.0	34.1
February	11 – 20	14.0	30.2	February	22.7	40.6
2009	21 – 29	14.6	32.8	2010	23.1	42.8
	1 – 10	18.5	37.5		25.6	44.7
March	11 – 20	17.9	37.1	March	25.5	43.2
2009	21 – 31	20.2	40.8	2010	24.3	36.8
Total		300.9	622.9	Total	409.5	629.8
Mean		16.7	34.6	Mean	22.8	35.0

Source: Metrological Unit. IAR, Samaru Zaria, Kano sub station

CONCLUSION

A significant sustained increase in all the growth, yield components and fresh fruit yield of tomato was observed through foliar application of giberrellic acid. This increased with every increase in giberrellic acid concentration. Best results were obtained from plant sprayed with 300 ppm in this experiment. Seasonal variation in respect of the characters tested were also recorded, with best results in 2008/2009 than the 2009/2010 season. Based on these findings therefore, improved growth and yield of tomato could be achieved by application of 300 ppm giberrellic acid. Further studies should be carried out to exploit the potentials of this growth stimulating hormone with a view to formulate the best character combination for enhanced performance of the major grown vegetables.

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