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Effect of Sowing Date and Plant Density on Growth and Yield of Tomato (Lycopersicon Esculentum, Mill.)

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Abstract: The effect of sowing date and plant density on two cultivars were investigated in field trail in two successive seasons (2002/03 and 2003/04) at North Kordofan of Sudan, to determined the optimum sowing date and plant density. Peto 86 and Red Star cultivars of tomato were sowing at October[1st], October[15th] and November[1st] in three plant densities of 71,428, 47,619 and 35,714 plants ha^{-1}. The results revealed that, the variety Red Star had a larger fruit diameter, highest fruit weight and highest yield (t/ha). The highest plant density (71,428 plant ha^{-1}) gave the highest and marketable yield. The sowing at October[1st] increased the productivity of tomato as it positively influenced the plant height, stem diameter, days to 50% flowering, fruit yield and marketable yield.

Key words: *Lycopersicon Esculentum*, Mill., Photoperiod, plant spacing, tomato

INTRODUCTION

Tomato (*Lycospersicon esculentum* Mill) fruit is an essential component of human diet for the supply of vitamins, minerals and certain types of hormones precursors in addition to protein and energy[4,9].

Commercially tomato is very important throughout the world for both the fresh fruit market and processing. Tomato occupied 2.4 million hectares in the world with leadership of Europe followed by Asia and America, and produced each year more than 4 million tones of tomato, but only 15% is produced in the tropics. This is mainly due to climate and to the production techniques which are not well developed[1].

In the tropics, tomato is mainly grown during the cool season, because of the adverse conditions during summer which greatly affect productivity and quality. Tomato is grown successfully on open fields varies from 52˚ South and 54˚ North latitudes, and also grown under controlled conditions in green houses[23].

In the Sudan, tomato is ranking second to Onion in vegetable consumption. The crop represents one of the cash vegetable crops. It is grown almost in every part of the country during the winter season and sometimes during the rainy season. The total area cultivated in the Sudan is about 60,158 ha. Winter is the main growing season; however, it can be grown in summer and autumn. The yield is very low in the summer season, because of higher temperature and lower relative humidity, which adversely affect the plant flowering and fruiting. Productivity of tomato is about 3.5-4.5 tons ha^{-1} in the research fields[13].

Tomato produce in Kordofan is derived from a few older introduced cultivars, well adapted to the local environment, but of low to medium market quality and productivity[15].

On the other hand, there is increasing evidence that the uses of poor cultural practices (especially the practice of wider spacing) as well as traditional cultivars and sowing date are the main yield limiting factors. Presumably, the adoption of high population densities by farmers meant the avoidance of a climate risk. Yet, the improvement of yield through manipulation of plant density and use of early maturing cultivars and optimum sowing date is possible. Accordingly, the present investigation was carried out to determine the effect of sowing date and plant density on yield of two tomato cultivars in environment of North Kordofan of Sudan.

MATERIALS AND METHODS

The experiment was conducted in a clay fertile soil at Abu- Haraz, (longitude 29˚ 30´ N, latitude 12˚ 13´ E), 53 km west of El-Obeid, in North Kordofan State, Sudan, during the 2002/03 and 2003/04 seasons. The climate of the area is semi- arid and tropical. Average maximum daily temperatures varied between 30˚ to 35˚ C most of the year [22].The two varieties of tomato namely, Peto 86 and Red Star (designated as V1 and

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V2, respectively) were used in the experiment. The plants were sown at four sowing dates: October[1st], October[15th] and November[1st] (designated as D_1, D_2 and D_3 respectively) in three plant densities: 71,428, 47,619 and 35,714 plants ha^{-1}, designated as P_1, P_2 and P_3 respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD) in four replications. The plot size was 4 × 3 meters with three ridges, each three meters long and 0.7m apart.

The seeds were obtained from Arab- Sudanese Seed Company, El-Obeid.

The chisel plow was used to prepare the experimental plots before sowing, which was done on ridges.

Transplanting one seedling per hill, along ridge on first of October, 15th October and first November according to treatments in the two seasons. Spacing was: 20, 30 and 40 cm between hills according to population needs. Irrigation was applied at intervals of five days.

Three hand hoeing were practiced during each season after 30, 45 and 75 days from transplanting.

Four plants were randomly selected from middle ridge to measure the following observations:

1. Stem diameter (mm): It was measured using a Vernier-caliber at third node.
2. Plant height (cm): The plant height was measured from the soil surface to the tip of the main stem.
3. Number of branches per plant: The number of reproductive branches of each sample plant was taken as average.
4. Number of leaves per plant: by counting the number of leaves of all sample plants and the average was recorded.
5. Days to 50% flowering: The number of days from transplanting to the time when 50% of the plants at the plot had been commence flowering (at least one flower/plant was considered).
6. Days to first fruit set per plot: The number of days from transplanting to the time when first fruit set in the plot
7. Number of fruits per plant: The total number of red ripe mature fruits which were harvested from each plant.
8. Fruit diameter (cm): Vernier caliper was used to measure fruit size on two sides; length and width, and then the average was calculated.
9. Fruit weight (g).
10. Fruit yield (kg/ha): The total weight of red ripe fruits was harvested from sample plots each season and total yield was calculated by the following formula:

$$\text{Fruit yield (t/ha)} = \frac{\text{Fruit weight (t/ha)}}{\text{Harvested plot area (m2)}} \times 10000$$

Statistical Analysis: The collected data were analyzed from the estimation of the statistical parameters according to Gomez and Gomez[8] procedure for a Randomized Complete Block Design (RCBD).

For comparison between means, Duncan Multiple Rang Test (DMRT) was used at 0.05 level of significance according to the procedure described by Gomez and Gomez[8].

RESULTS AND DISSCUSSION

The cultivars had significant effect on stem diameter in the first season. Largest stem diameter was recorded in variety Red Star (Table 1). This result was confirmed the findings of Mahmoud[11].

Sowing date and plant density had no significant effect on plant height (Table 2). Yohannes and Tadesse [26] reported that spacing between plants did not show any significant differences in plant height.

The cultivars had significant effect on number of leaves per plant. The variety Red star gave the highest number of leaves than the variety Peto 86. These results confirm the observations of Mohammed[13] Omara[16] and Mahmoud[11] .They indicated that the cultivar Red star was characterized by dense foliage. Plant densities had no significant effect on number of leaves per plant. These results agree to those of Mahmoud [11] and Ahmed[2].

Sowing date had significant effect on the number of branches per plant (Table 2). The early sowing date (first of October) showed higher number of branches compared to the late sowing date. No significant differences were detected among varieties on number of branches per plant. This may be due to differences on growth habit of genotypes. These results are quite similar to the findings of Silvy[20]. However plant density showed no significant differences in number of branches per plant. Similar results were obtained by Ahmed[2].

Analysis of variance revealed highly significant differences among sowing dates in days to 50% flowering (Table 2). The earliest flowering was detected at first of October followed by 15th of October and first of November. Similar results have been reported by El Hilo[6]. who observed that early October proved to be suitable date to planting tomatoes in the field. Also Peyvast[18] reported that the early sowing date significantly affected tomato inflorescence. Varieties and plant density had no significant differences in the number of days to 50% flowering. Similar results were found by Rawshan[19].

Sowing on the first and 15th of October were earliest in fruit set (Table 3). The same results were reported by El Hilo[6], Taha *et. al*.[21] and Ali[3].

The highest number of fruits was recorded by the variety Peto 86 (Table 3). Similar results were reported by Mohammed[13] and Mahmoud[11]. The sowing date first of October was scored a highest number of fruits (Table 3). These results were agreed with findings of El Hilo[6] and Taha *et. al*.[21]. Plant density had no significant effect on number of fruits per plant. This is in line with results of Yohannes and Tadesse [26] who reported that the marketable fruits number per plant was not affected by plant density. El Hassan[5] found that the increase of fruits in closer spacing is due to increase in number of plants per unit area rather than the increase in number of fruits per plant.

The analysis revealed significant differences among varieties and sowing date in fruit diameter (Table 3). The variety Red Star had the largest fruit diameter in the two seasons than the variety Peto86. Similar findings were obtained by Mohammed [14].The late sowing on the first of November had a lesser fruit size. Similar results were obtained by El Hilo[6] and Taha *et. al*.[21]. Plant density had no significanf effect on fruit size. These results are in line with those of Yohannes and Tadesse [26] who reported that the plant spacing did not show any significant effect on fruit size. Massy *et. al*.[12] found that the fruit size could be manipulated by improving the cultural practices.

The variety Red Star scored the highest weight of fruit (Table 4). This may be due to better translocation and partitioning of assimilates from source to sink (fruit).This result is in agreement with Omara[16]. Sowing dates first and 15th of October resulted in highest fruit weight than the first of November. Similar results were shown by Pereira and Rreisser[17]. There were no significant differences detected among plant density on fruit weight in the two seasons. These results were in lined with the results of Rawshan[19] who reported that spacing between plants did not show any significant differences in fruit weight.

The variety Red star gave the highest fruit yield ha^{-1} in the two seasons (Table 4). This may be due to its highly average fruit weight and size. These results were agreed with previous finding of Omara[16]. Increased plant density increased fruit yield ha^{-1} (Table 4). This may be attributed to the highest number of plants per unit area. Similar results were obtained by many workers: Wilcox[25]; Zahare[27]; El Hilo[6]; Fery and Junking[7]; Weenman[24] and Law-Ogbomo and. Egharevba [10]. Sowing on the first of October resulted in highest fruit yield ha^{-1}. This may be due to better availability of nutrients and better translocation of photosynthates from source to sink and may be due higher accumulation of photosynthates in the fruits.

These results were agreed with the results of El Hilo[6]; Ali[3]; Taha *et. al*.[21] and Peyvast[18] who reported that the earliest sowing date resulted in a significantly higher total fruit yield compared to the later sowing date.

Conclusion: For areas like Abu Haraz (North Kordofan of Sudan) intra -row spacing of 20 cm for Red star variety sowing at first of October is highly recommended to earn maximum marketable fruit yield of tomato.

Table1: Effect of sowing date and plant density and varieties on stem diameter, plant height and number of leaves per plant of tomato.

Treatment	2002/2003			2003/2004		
	Stem diameter (mm)Plant	Height(cm)	No. of leaves/ Plant	Stem diameter(mm)	PlantHeight(cm)	No. of leaves/ Plant
			Varieties			
V_1	10.278	47.338	77.903	11.530	51.528	84.611
V_2	9.701	47.118	70.743	11.310	51.167	85.583
			Plant density			
P_1	10.042	49.309	71.615	11.870	52.333	91.458
P_2	10.000	47.333	80.823	11.460	50.625	89.667
P_3	9.927	45.042	70.531	10.920	51.083	74.167
			Date of sowing			
D_1	10.500	50.167	73.323	11.620	51.500	92.458
D_2	9.938	46.236	78.896	11.040	48.833	84.083
D_3	9.531	45.281	70.750	11.580	53.708	78.750

Means followed by the same letter are not significantly different according to Duncan Multiple Range Test (DMRT).

Table 2: Effect of sowing date, Plant density and varieties on number of braches per plant and days to 50% flowering of tomato.

Treatment	2002/2003		2003/2004	
	No. of Branches/ Plant	Days to 50% Flowering	No. of Branches/ Plant	Days to 50% Flowering
		Varieties		
V_1	16.958	45.250	14.611	46.194
V_2	14.333	45.778	14.361	45.944
		Plant density		
S_1	15.240	45.667	15.292	46.042
S_2	16.667	45.167	14.750	46.250
S_3	15.031	45.708	13.417	45.917
		Date of sowing		
D_1	14.719[ab]	43.667	14.333	44.417 [b]
D_2	19.198[a]	44.542	13.625	45.083 [b]
D_3	13.021[b]	48.333	15.500	48.708 [a]

Means followed by the same letter are not significantly different according to Duncan Multiple Range Test

Table 3: Effect of sowing date, Plant density and varieties on days to first flowering, number of Fruits / plant and fruit size of tomato.

Treatment	2002/2003			2003/2004		
	Days to first fruit set	No. of fruits/ plant	Fruit size(cm)	Days to first fruit set	No. of fruits/ plant	Fruit size(cm)
			Varieties			
V1	45.500	39.538	4.607	46.861	44.750	5.011
V2	47.083	62.868	4.054	46.222	45.750	4.802
			Plant spacing			
S1	45.875	44.879	4.331	46.458	41.250	4.912
S2	46.667	54.438	4.316	46.458	43.792	4.937
S3	46.333	54.292	4.345	46.708	50.708	4.870
			Plant density			
D1	44.292	71.462 [a]	4.498 a	44.750 [b]	44.375	4.886
D2	45.042	53.973 [b]	4.468 a	45.083 [b]	48.375	5.043
D3	49.542	28.174 [c]	4.026 b	49.793 [a]	43.000	4.790

Means followed by the same letter are not significantly different according to Duncan Multiple Range Test

Table 4: Effect of sowing date, Plant density and varieties on fruit weight and yield of tomato.

Treatment	2002/2003		2003/2004	
	Fruit weight(g)	Yield(t/ha)	Fruit weight(g)	Yield(t/ha)
		Varieties		
V_1	62.517	86.692	70.172	124.049
V_2	40.384	82.759	65.596	104.749
		Plant density		
S_1	52.722	108.425 [a]	74.690	163.217 [a]
S_2	51.373	85.900 [ab]	63.317	103.569 [b]
S_3	50.256	59.852 [b]	65.646	086.411 [b]
		Date of sowing		
D_1	57.906 [a]	133.462 [a]	66.683	126.567 [a]
D_2	57.337 [a]	83.387 [b]	72.226	140.092 [a]
D_3	39.108 [b]	37.329 [c]	64.744	076.537 [b]

Means followed by the same letter are not significantly different according to Duncan Multiple Range Test

REFERENCES

1. Adams, C.F. and M. Richardson, 1977. Nutritive value of foods, Home and Garden Bull., Washington, U.S. Government printing office, 72: 40-42.
2. Ahmed, M.K., 1983. Optimum plant and nitrogen fertilization of sweet pepper in Sudan, Gezira, Acta. Hort., 143: 305-310.
3. Ali, A.Y., 1981. Tomato sowing dates and harvest maturity stage trials. Ann. Rep. (1980 – 1981) of the Gezira Research Station. Substations, pp: 352-355.
4. Boamah, P.O., L.K. Sam-Amoah and J.D. Owusu-Sekyere, 2010. Effect of irrigation interval on growth and development of tomato under sprinkler. Asian J. Agric. Res., 4: 196-203.
5. El Hassan, M.H., 1973. Effect of variety and spacing on yield of tomato Ann. Rep. of Hudeiba Research Station, Sudan
6. El Hilo, H.A., 1970. Evaluation of some tomato varieties. Hdeiba Research Station. Ann. Rep. Sudan.
7. Ferry, R.L. and J. Janick, 1971. Effect of time of harvest on the response of tomato to population pressure, J. Am. Soc. Hort. Sci., 96: 172-176.
8. Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for agricultural research. John and Sons, Ins. 606 Third Avenue New York, New York, 10158.
9. Kallo, G., 1993. Tomato In: Genetic improvement of vegetable crops. Oxford, England: Pergamon Press, pp: 6.
10. Law-Ogbomo, K.E. and R.K.A. Egharevba, 2009. Effects of Planting Density and NPK Fertilizer Application on Yield and Yield Components of Tomato (*Lycospersicon esculentum* Mill) in Forest Location. Journal of Agricultural Sciences, 5(2): 152-158.
11. Mahmoud, Sh.M., 2005. The effect of cultivars, seedbed preparation and plant density on the growth and yield of tomato (*Lycopersicon esculentum*). Msc. University of Kordofan.Sudan.
12. Massey, D.M., A.C. Haward, and G. W. Winser, 1958. Some responses of tomatoes to salinity in nutrient-film culture. Ann. Rep. Glass house crops Res. Inst., pp: 60-62.
13. Mohammed, B.M., 1995. Vegetable production in central Sudan. Integrated pest management Medani, Sudan, pp: 106.
14. Mohammed, A.A., 2000. Evaluation of select tomato (*Lycopersicon esculentum*, Mill) cultivar for fruit and seed yield using different extraction methods, phD. (Agric): Thesis, University of Gezira.
15. Obeidalla, A.A. and J.R. James, 1984. Development of horticultural potential of Kordofan Region of Sudan. Acta. Hort., 143.
16. Omara, S., 1995. Tomato experiments, International Institute for promotion Horticultural Exports. Khartoum. Sudan.
17. Pereira, J.F.M. and J.C. Reisser, 1998. Sowing date of tomato in plastic house for out-off-season. Embrapa Clima Temperado, Cx. Postal 403, CEP 96 001-970.
18. Peyvast, G.H., 2001. Study of some quality and quantity factors of tomato. Journal of vegetable crop production., 1049-6467: 15-22.
19. Rawshan, A. S. M., 1996. Effect of plant population density on tomato. In: ARC. – AVRDC training report. Ka: Bankok. Thailand: ARC. – AVRDC. P. 152-156.
20. Silvy, A., 1974. A study of modes of sympodial ramification in (*Lycopersicon esculentum*). Can. J. Bot., 52: 207-218.
21. Taha, A.A., A. Abdelfattah, M.S. Hassan and A. W. Ali, 1984. Effect of sowing date and stage of maturity at harvest on yield and quality of tomato for export. Acta. Hort. 143. tropical horticulture VIII.
22. Technoserve., 1987. Credit component baseline survey. Technoserve Inc., Agricultural Bank of Sudan, Us Agency for Agricultural Development, Elobeid, Sudan.
23. Villareal, R.L., 1980. Tomatoes in the tropics. West view press, boulder, colardo pp: 516
24. Weenman, G.E., 1978. Influence of planting distance on the production of fruit weight of early hot house tomato. Croenten en Fruit. Abstract. 43(16): 45-46.
25. Wilcox, G.E., 1970. Influence of row spacing and plant density in single harvest tomato yield J. Am. Soc. Hort. Sci., 95: 435-437.
26. Yohannes, F. and T. Tadesse, 1997. Effect of drip irrigation and plant spacing on yield of tomato at Dire Dawa, Ethiopia. Alemaya Univ. of Agric. Water management., 35: 201-207.
27. Zahare, M., 1970. Influence of plant density on yield of processing tomatoes for mechanical harvest. J. Am. Soc. Hort. Sci., 95: 510-512.