

EFFECTS OF SPACING AND POULTRY MANURE ON THE YIELD PARAMETERS OF TOMATO (*Solanum lycopersicum* L.) IN YOLA ADAMAWA STATE, NIGERIA\

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ABSTRACT

*Tomato (*Solanum lycopersicum* L.) is one of the most important vegetables worldwide. As it is a relatively short duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily. It is widely grown in many tropical areas of the world including Nigeria. However, average yield as obtained by the local farmers in Nigeria has been low, due mainly to lack of adequate information on the spacing and incorporation of poultry manure for optimal yield. Field experiment was conducted at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University, Yola, Adamawa State, Nigeria, in the cropping seasons of 2021, 2022 and 2023 to evaluate the effects of Spacing and poultry manure levels on yield Parameters of tomato (*Solanum lycopersicum* (L)). The treatment consisted of five poultry manure levels (0 tons/ha, 15 tons/ha, 20 tons/ha, 25 tons/ha and 30 tons/ha) as the main plot treatments and five spacing intervals (90x60 cm, 80x40 cm, 60x30 cm, 50x50 cm and 40x20 cm) as sub-plot treatments. The experiment was laid on a split plot design and was replicated three times. Three Tomato cultivars (Tandino, UTC and Dansiriya) were used. Appropriate agronomic practices recommended for the production of tomato were carried out to ensure optimum performance. The parameters measured were days to 50% flowering, days to 50% fruiting, fruit weight and number of fruits per plant. The data collected were subjected to analysis of variance and significantly different means were separated using Least Significant Difference (LSD). The result showed that 30tons/ha poultry manure significantly affected number of fruits per plant (26.689), days to 50% flowering (29.422 days) and days to 50 % fruiting (43.29 days), while 15 tons/ha poultry manure performed better on fruit weight (61.87g). The tomato Plant that were spaced 60x30 cm significantly affected the fruit weight. Across the year's interaction between Dansiriya X 30 tons/ha X 40x20 cm spacing produced the highest (34.667) number of fruits per plant. so also, interaction effect between 2022 cropping season X UTC cultivar X 30 tons/ha PM recorded the highest (26.266) number fruit per plant. It is therefore recommended that farmers should plant Tandino cultivar and applies 30 tons/ha rate of poultry manure as well as adopt spacing of 60x30 cm for optimum tomato yield in the study area.*

INTRODUCTION

Tomato belongs to the kingdom Plantae, the family Solanaceae and the genus, *Solanum*. Its botanical name is *Solanum lycopersicum* (L) (Ohlson, et al., 2018). The word "tomato" may refer to the plant or the edible, typically red, fruit that it bears. Tomato originated in America, and was spread around the world following the Spanish colonization of the Americas. It was reported that Tomato was domesticated in Mexico and that the name Tomato was derived from the word "tomatillo" in the Nahua dialect of Mexico (Ara et al., 2007). Many varieties are now widely grown, often in greenhouses in cooler climates. Tomato is consumed in diverse ways, including raw, as an ingredient in many dishes and sausages, and drinks. While it is botanically a fruit, it is considered a vegetable for culinary purposes. The fruit is rich in lycopene which may have beneficial health effects (Ud Din, 2023; Jeffrey, 2013). The plant belongs to the nightshade family, typically grow to 1–3 meters (3–10 ft.) high with a weak stem that often sprawls over the ground and vines over other plants (Jeffrey, 2013).

Tomato was introduced to West Africa and Nigeria in particular at the end of the 19th century (Villareal, in Ilodibia & Chukuma, 2015). There are many vegetable fruits recognized in Nigeria, but, Tomato, as a vegetable fruit is a major food component, as an ingredient utilized by many households.

Record confirmed that Nigeria produces approximately 1.8 million metric tons of fresh fruits for domestic consumption, with national demand of about 2-3 million metric tons annually with a demand gap of about 500,000 metric tons (Oyewole, et al., 2011). Nigeria is ranked 14th among the countries that produce tomato in the world and is the second in Africa after Egypt. Tomato is an important vegetable grown commercially on a large scale because it is a cheap source of vitamin C.

Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars, and dietary fibers. Tomato contains vitamin B and C, iron, and phosphorus. Tomato fruits are consumed fresh in salads or cooked in sauces, soup, and meat or fish dishes. Fresh tomato provides half the recommended dietary allowance of vitamin C for an adult for a day (Splittstooesser, in Ilodibia & Chukuma, 2015). They can be processed into purées, juices, and ketchup. Canned and dried tomatoes are economically important processed products. Yellow tomatoes have higher vitamin A content than red tomatoes, but red tomatoes contain lycopene, an antioxidant that may contribute to protection against carcinogenic substances. Tomato is currently one of the most important fruit with high nutritive value in West Africa, especially Nigeria; despite these nutritive values, several production constraints which include diseases, pests, and costly chemical and bad practices affect production.

Soil fertility decline has been identified as a contributor to low yield. Soil organic amendments such as cow dung and poultry manure are valuable sources of plant nutrients. Organic manure provides an essential nutrient to crops when decomposed and also acts as a soil conditioner. Most developing countries including Nigeria are trying to get rid of expensive chemical fertilizers by supplementing them with some organic-based sources (Adejide, et al., 2020).

Consequently, widespread soil degradation has been brought about by the loss of organic matter, leading to soil acidity, nutrient imbalance, and low crop yields (Zhu, et al., 2020; Agbede, et al., 2008). The current yield of tomato is not satisfactory and the low yield of tomato is due to several factors such as deficiency of soil nutrients, cultural practices, spacing, etc. are considered as the major constraints to successful upland crop production. Soil organic matter is the storehouse of plant nutrients that maintain long-term soil fertility, a reservoir of metabolic energy, and make available nutrients into the soil. Good agricultural soil should have around 2% organic matter but in our country, the soils of most regions have less than 1.5%, some soils even have less than 1% organic matter.

Organic material such as poultry manure is identified as a suitable organic fertilizer. Poultry manure, if properly handled is the most valuable of all animal manures (Oyewole, et al; 2014). The use of poultry manure for soil fertility maintenance, growth and yield of tomato had been reported to be very effective (Oyewole, et al., 2011; Adekiya & Agbede, 2009; Akanni & Ojeniyi, 2017; Ewulo, et al., 2016). However, inappropriate use of poultry manure can greatly reduce manure efficiency and negatively affect productivity of the soil. Also, to obtain maximum economic value of plant nutrients in poultry manure it should be applied to match nutrient need of crops (Ozores-Hampton, 2012). The demand of nutrients by growing crop generally varies through the growing season, with the highest uptake associated with the period of most rapid growth. Timing of nutrient application, therefore, ensures the availability of the nutrients when the crop needs them. This will also avoid nutrient losses which can be before and after periods of crop demand which in the long run result in wastage of resources (Ndukwe, et al., 2011). An important part of optimizing crop response to a fertilizer nutrient is placing the nutrient in such a way that it provides rapid uptake by crop and reduces potential losses (Mehdizadeh, et al., 2013).

The spacing and application of poultry manure have been recognized as factors that influence the growth and yield of tomatoes. However, there is inadequate research investigating the combined impact of spacing and poultry manure on the growth parameters (such as plant height, number of leaves, number of branches and stem diameter) and yield parameters (such as days to 50% flowering,

days to 50% fruiting, fruit weight, fruit length, fruit diameter, number of fruits, and number of marketable and unmarketable fruit) of tomatoes. Therefore, this study aims to fill this gap by assessing the effects of different spacing arrangements and varying levels of poultry manure application on the yield parameters of tomatoes, providing valuable insights for tomato farmers and researchers towards optimizing tomato production practices.

The purpose of the study

The study determined the effects of spacing and poultry manure levels on the growth and yield parameters of tomato (*Solanum lycopersicum* L.). The specific objectives are to: -

1. Determine the effects of spacing and poultry manure levels on days to 50% flowering and fruiting of tomato (*Solanum lycopersicum* L.).
2. Determine the effects of spacing and poultry manure levels on number of fruits and fruits weight of tomato (*Solanum lycopersicum* L)

MATERIALS AND METHOD

Experimental design: The study is an experimental study that was laid in split plot design in a factorial fashion replicated three times. Each plot was 2m x 2m having 1m space between the block and 0.5 m between plots. The experiment consist of nine blocks and each block has twenty-five plot

Experimental site: The field experiment was conducted at the Teaching and Research farm of the Department of Crop Production and Horticulture, Faculty of Agriculture, Modibbo Adama University, Yola, Adamawa State in Northeast Nigeria. The farm lies between Latitude N 9⁰ 20¹ 38¹¹ and Longitude 12⁰ 30¹ 51¹¹ East of the equator at an altitude 232.3m above sea level. The cropping history of the experimental site was taken, the farm attendant detailed the researcher on the type of crop cultivated on experimental site year before the experiment.

Soil analysis: The composite soil sample of the experimental site was collected and analyzed for the following particle size, soil organic matter, total N, available P, exchangeable K, Ca, and Mg, and pH at the laboratory of the department of soil science of Modibbo Adama University, Yola. The result is presented in Table 1.

Agronomical Practices: Nursery beds were prepared and raised to 15 cm above the ground level to avoid erosion. The seed of all the Cultivars that were sown underwent a viability test using the floatation method by (Kelly & Boyham, 2010) to be sure of the viability of the seeds. This was done by putting the seed in a container and pouring water on it to observe all the seeds that float above to be discarded. The seeds also underwent germination tests where ten seeds from each cultivar was sown and observed its germination to be sure of the germination capability of the seeds. The seeds were sown by drilling at 10cm deep and covered with fine sand and some dry grasses. Watering was done twice daily morning and evening by using a watering can to ensure sufficient moisture for seed germination. As soon as the seeds germinate the dry grasses were removed for proper seedlings establishment. Other cultural practices were observed until the seedlings are ready for transplanting. Three tomato Cultivars were used Tandino, UTC, and Dansiriya Cultivars which were obtained from local tomato farmers in Yola. The implement used for the experiment includes a Knapsack sprayer, herbicide, cutlass, local hoe, rake, garden fork, measuring tape, measuring ruler, rope, watering can, and poultry manure.

Transplanting: Transplanting of the tomato seedlings to the experimental plots was done when the seedlings are four weeks old after sowing when the seedlings had 3 to 4 true leaves (Kisetu & Heri

(2014). The transplanting was done in the evening in order to reduce transplanting shock. One seedling was transplanted per hole.

Weed control: Weeding was done to control weeds to avoid competition for nutrients between the plants and the weeds. The weeding was done using local hoe and handpicking. Pest and diseases were controlled by the use of pesticide the reason is that wood ash may affect the treatment which eventually will affect the result of the study. On the event of advert temperature water was spread around the experiment site to reduce the effect of high temperature on the growing plants. On the event of moisture stress water was sprinkle on the plots using watering can.

Poultry manure application: The poultry manure was weighed using an electric sensitive weighing balance in the Crop Production and Horticulture, laboratory Faculty of Agriculture, Modibbo Adama University, Yola. It was incorporated into the experimental plots 3 weeks before transplanting the seedlings to the field at 0 tons (control), 15 tons, 20 tons, 25 tons and 30 tons per hectare.

Method of Data Collection: The days to 50 % flowering, days to 50% fruiting, were taken through daily inspection of the plots to determine the number of days to 50% flowering and when the flowering was noticed in the 50 % of the plant per plot, it was considered as 50% flowering, and number of days taken from the day of transplanting to this stage was considered as days to 50% flowering. The same is applied to days to 50% fruiting. Number of fruits and fruit weight, were evaluated after each harvest.

Method of Data Analysis: The data generated from the research were organized using Microsoft Excel (MS Excel) and then were subjected to Analysis of Variance (ANOVA) using SPSS version 22. The differences among the treatment mean for significant result was performed using Least Significant Difference at 0.05 confidence level.

RESULT AND DISCUSSION

The result on table 2 shown that there was significant ($P < 0.05$) difference on the effect of PM levels on days to 50% flowering of Tomato. In 2021 cropping season 25ton/ha attained 50% flowering in 34.13 days, followed by 20 tons/ha PM which reached 50% flowering in 34.67 days. The control took longer (41.33) days to reach 50% flowering in 2021 rainy season. Similarly, in 2022 cropping season 25 tons/ha PM attained 50% flowering within (29.4222) days followed by 30 tons/ha PM which attained 50% flowering within (29.467) days. The control took longer (38.289) days to attained 50% flowering in 2022 cropping season. In 2023 cropping season 15 tons/ha PM attained 50% flowering early (31.24) days than other PM levels, followed by 25 tons/ha which took 31.47days to attain 50% flowering. While the control took longer (39.49) days to reach 50% flowering. The combined analysis indicated that 25 tons/ha attained 50% flowering within (31.6741) days. While the control recorded the longer (39.7037) days to attain 50% flowering. This accords with findings of Olaseken & Agbede (2016) who reported that growth and yield of tomato is influenced by application of poultry manure.

Result on table 3 revealed that PM had significant ($P < 0.05$) effect on days to 50% fruiting of Tomato. In 2021 cropping season 25 tons/ha PM took significantly shorter (49.49) days to reach 50% fruiting though not significantly different from 20 tons/ha PM which reached 50% flowering in (49.80) days, followed by 30 tons/ha with (50.29) days which was not significantly different from 15 tons/ha at (50.33) days. The longer (62.92) days to fruiting of Tomato was recorded from the control. In 2022 cropping season 25 tons/ha reached 50% fruiting earlier (43.29) days though not significantly different from 20 tons/ha PM which attained 50% fruiting in (43.58) days. The longer (56.42) days to attain 50% fruiting was from the control. In the 2023 cropping season 25 tons/ha PM reached 50% fruiting

at (43.29) days though not significantly different from 20 tons/ha PM which attained 50% fruiting in (43.58) days. The treatment with the longer (56.42) days to attain 50% fruiting was the control. In 2023 cropping season 15 tons/ha PM reached 50% fruiting earlier at (50.29) days though was at par with 20 tons/ha with (50.93) days followed by 25 tons/ha (51.02) which significantly was at par with 30 tons/ha PM (51.58) days to 50% fruiting. The longer (59.89) days to 50% fruiting of Tomato was recorded from the control. The combined analysis indicated that 25 tons/ha PM reach 50% fruiting in (47.9333) days. This is in line with the findings of Adebisi et al. (2020) whose report indicate that tomato plant performed better under organic production. The longer (59.89) days to attain 50% fruiting was the control. Regard to spacing there was no significant ($P>0.05$) effect on days to 50% fruiting of Tomato throughout the sampling period. The combined analysis followed the same trend.

The result on table 4 indicated that there was significant ($P<0.05$) difference among the various levels of poultry manure as it affects the number of fruits per plant throughout the sampling periods. In 2021 cropping season 30 tons/ha PM recorded the highest (26.244) number of fruits per plant, followed by 15 tons/ha PM which produced (24.444) number of fruits per plant. The least (17.844) number of fruits per plant was recorded from the control. In 2022 cropping season 30 tons/ha PM produced the highest (26.689) number of fruits per plant, followed by 15 tons/ha which recorded (26.6676) number of fruits per plant which was significantly not different from 25 tons/ha PM that had (25.556) number of fruits per plant. The least (22.756) number of fruits per plant was recorded from the control. In 2022 cropping season 30 tons/ha PM recorded the highest (25.11) number of fruits per plant, followed by 25 tons/ha PM which produced (23.91) number of fruits per plant. The least (19.98) number of fruits was recorded from the control. The combined analysis indicated that 30 tons/ha PM produced the highest (26.014) number of fruits per plant. In comparison with the control, poultry manure treated plots had significantly higher yield than the control (Table 4). This result accords with the findings of Al-munsur et al. (2019) whose result indicates that number of fruits of plant increased with increased in the concentration of poultry manure.

Regarding plant spacing there was significant ($P<0.001$) difference among the various spacing intervals of tomato plant on number of fruits per plant throughout the sampling periods. In 2021 cropping season the 60 x 30 cm spacing produced the highest (24.000) number of fruits per plant, followed by 50x50cm spacing that recorded (23.055) number of fruits per plant. The least (19.822) number of fruits per plant was recorded from 90 x 60 cm spacing. In 2022 cropping season 40 x 20 cm spacing recorded the highest (26.800) number of fruits per plant, followed by 60 x 30 cm spacing that recorded (26.600) number of fruits which was not significantly different from 50 x 50 cm spacing which recorded (26.378) number of fruits per plant. The least (21.533) number of fruits was obtained from 90 x 60 cm spacing. In 2023 rainy season the 40 x 20 cm spacing recorded the highest (24.80) number of fruits per plant, followed by 50 x 50 cm spacing that recorded (24.40) number of fruits per plant and was significantly at par with 60 x 30 cm spacing. The least (19.80) number of fruits was recorded from 90 x 60 cm spacing. The combined analysis indicated that 60 x 30 cm spacing produced the highest (25.2000) number of fruits per plant. This result accords with the findings of Falodun & Emede (2019) who reported that closer spacing of tomato resulted in increased yield of tomato. The least (20.3852) number of fruits per plant was recorded from 90 x 60 cm spacing of tomato plant.

The result from table 5 shown a significant ($P<0.05$) difference on the effect of PM on fruit weight of Tomato. In 2021 rainy season 15tons/ha recorded the highest (60.79g) fruit weight though at par with 20 tons/ha (59.05g) fruit weight, followed by 30 tons/ha PM (58.87g) which was at par with 25 tons/ha (58.57g) fruit weight. The least (34.41g) fruit weight was obtained from control. In the 2022 rainy season 15 tons/ha recorded the highest (61.87g) fruit weight but at par with 30 tons/ha (61.62g) fruit weight, 20 tons/ha with (60.45g) fruit weight and 25 tons/ha with (60.44g) fruit weight. The least (36.22g) fruit weight was obtained from the control. In the 2023 rainy season the highest (61.80g) fruit

weight was produced from 15tons/ha though at par with 30 tons/ha and 25 tons/ha (60.56g and 60.04g respectively). The least (33.65g) fruit weight was recorded from control. The combined analysis indicated that the 30 tons/ha PM produced the highest (61.4859g) fruit weight. This is in line with the findings of Islam et al. (2021) who reported that tomato fruit weight increased with increase in manure source. The least (34.7635g) was obtained from the control. There is no significant ($P>0.05$) difference among the various spacing interval on fruit weight of Tomato in all the sampling period Table 4.

CONCLUSION

The result of this study shown that the application of poultry manure at 30tons/ha as well as spacing interval of 60 x 30 cm significantly resulted in optimum yield of tomato. It can therefore be recommended for tomato producers in the study area.

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LIST OF TABLES

Table I: Physiochemical properties of the soil of the Experimental sites and PM

Soil Composition	2021	2021	2022	2022	2023	2023
Mechanical Comp. (gKg ⁻¹)	Soil	PM	Soil	PM	Soil	PM
Clay	23.30		21.30		16.30	
Silt	17.90		18.40		13.40	
Sand	58.80		60.30		70.30	
Textual Class	Sandy		Sandy		Sandy	
	Loam		Loam		Loam	
Chemical Composition						
PH(H2O)	7.32	7.20	7.92	7.62	7.52	7.35
PH(CaCl2)	6.71		6.82		5.61	
Organic Carbon gKg ⁻¹	0.35	8.30	0.50	8.06	0.51	8.11
Organic Matter gKg ⁻¹	0.61		0.86		0.88	
Available P(ppm)	29.05	6.90	42.30	14.0	45.50	15.5
Total N. gKg ⁻¹	0.17	1.26	0.15	0.28	0.20	0.58
Exchangeable bases (CmolsKg ⁻¹)						
CA	0.85	3.08	1.56	3.02	1.32	2.89
Ma	0.51	0.65	0.81	0.45	0.62	0.66
K	0.45	8.03	0.52	8.11	0.52	7.86
Na	0.74	0.12	0.87	0.15	0.85	0.14
Al	0.13		0.12		0.21	
H	0.52		0.94		0.51	
CEC	0.13		4.29		4.00	
EC YSCM ⁻¹	149.90		194.86		137.20	

Table 2: Mean effects of spacing and PM on days to 50% flowering of Tomato (*Solanum lycopersicum* L) in 2021, 2022 and 2023 Growing Season

Treatment	2021	2022	2023	Comb
CULTIVAR				
Tandina	33.44b	28.453b	32.45b	32.1546a
UTC	37.31a	36.347a	34.75a	32.1098a
Dansiriya	37.25a	28.920b	32.97b	32.1345a
P^F	0.583	0.001	0.852	0.5643
PM				
15tons/ha	35.13d	29.489c	31.24a	31.9556b
20tons/ha	34.67b	29.533d	31.98a	32.0593b
25tons/ha	34.13a	29.422a	31.47a	31.6741b

30tons/ha	34.73c	29.467b	32.78b	32.3259b
Control	41.33e	38.289e	39.49	39.7037a
P^F	0.001	0.001	0.001	0.0001
SPACING				
90x60 cm	36.27a	31.156b	33.36c	33.5926a
80x40 cm	36.47a	31.333a	33.33c	33.4519a
60x30 cm	35.98b	31.378a	33.27d	33.7111a
50x50 cm	35.60b	31.311a	33.44b	33.5407a
40x20 cm	35.69b	31.022b	33.56a	33.4222a
P^F	0.246	0.001	0.939	0.9978

Means value in a column followed by the same letter(s) are not significantly different by LSD at (P<0.05)

Table 3: Mean effects of spacing and PM on days to 50% fruiting of Tomato (*Solanum lycopersicum* L) in 2021, 2022 and 2023 Growing Season

Treatment	2021	2022	2023	Comb
CULTIVAR				
Tandina	50.88b	42.13b	53.69a	51.5647a
UTC	53.31a	53.59a	53.87a	51.5356a
Dansiriya	53.52a	43.63b	50.67b	51.5712a
P^F	0.739	0.028	0.539	0.0453
PM				
15tons/ha	50.33b	44.49b	50.29a	48.3704b
20tons/ha	49.80a	43.58a	50.93a	48.1037b
25tons/ha	49.49a	43.29a	51.02b	47.9333b
30tons/ha	50.29b	44.47b	51.58b	48.7778b
Control	62.93c	56.42c	59.89c	59.7481a
P^F	0.001	0.001	0.001	0.0001
SPACING				
90x60 cm	52.71b	46.29a	52.89b	50.6296a
80x40 cm	53.09a	46.56a	52.49b	50.7111a
60x30 cm	52.60b	46.67a	52.69b	50.6519a
50x50 cm	52.42b	46.31a	52.56b	50.4296a
40x20 cm	52.02b	46.42a	53.09a	50.5111a
P^F	0.275	0.865	0.356	0.9922

Means value in a column followed by the same letter(s) are not significantly different by LSD (P<0.05)

Table 4: Mean effects of Spacing and Poultry manure on Number of fruits at first harvest, second harvest and third harvest of Tomato (*Solanum lycopersicum* L) in 2021, 2022 and 2023 Growing Season

Treatment	First harvest			Second harvest			Third harvest			Com
	2021	2022	2023	2021	2022	2023	2021	2022	2023	
Cultivar										
Tandina	7.373	18.650b	13.116	18.560b	20.210	18.337	21.120	26.560	24.96a	24.213a
UTC	8.147	20.044a	12.651	21.440a	21.080	21.177	21.800	24.920	22.67b	23.133c
Dansiriya	7.893	17.637c	11.881	17.367c	23.420	17.289	24.240	24.133	21.92c	23.431b
P^F	0.360	0.004	0.086	0.004	0.016	0.007	0.016	0.006	0.004	0.0001
PM										
15 tons/ha	8.156c	19.442c	13.907a	19.422c	22.044c	19.422	23.444b	25.667b	23.31c	20.1926c
20 tons/ha	8.28d	19.479c	13.733a	19.489c	22.011c	19.489	22.511c	25.356c	23.51bc	23.1407b
25 tons/ha	8.378b	20.078b	13.073c	20.378b	22.867b	20.376b	21.889d	25.556b	23.98b	23.8074b
30 tons/ha	8.444a	20.178a	13.563b	22.178a	25.440a	22.178a	26.244a	26.689a	25.11a	26.0148a
Control	5.756e	13.178d	8.469d	14.178d	17.678d	13.207	17.844e	22.756d	19.98d	20.1926c
P^F	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0001
Spacing										
90x60 cm	6.467d	16.168e	11.889d	16.089d	19.778e	15.978d	19.822e	21.533d	19.80e	20.3852c
80x40 cm	8.022c	17.243d	12.660b	18.244c	22.324c	18.091c	22.111d	24.711c	22.56c	23.1259c
60x30 cm	8.222a	18.178c	13.278a	19.778b	23.896a	19.502b	24.000a	26.600b	24.33b	25.2000a
50x50 cm	8.133b	19.632b	12.647b	20.622a	22.889b	20.482a	23.055b	26.378b	24.40b	24.5778b
40x20 cm	8.178a	20.869a	12.273c	20.911a	21.968d	20.620a	22.956c	26.800a	24.80a	24.6593ba
P^F	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0001

Means values in a column followed by the same letter(s) are not significantly different by LSD (P<0.05)

Table 5: Mean Effects of spacing and PM on fruit weight of Tomato (*Solanum lycopersicum* L) at first harvest, second harvest and third harvest in 2021, 2022 and 2023 Growing Season

Treatment	First harvest			Second harvest			Third harvest			Com
	2021	2022	2023	2021	2022	2023	2021	2022	2023	
Tandina	52.93b	53.78b	52.59c	52.04b	51.97c	52.98c	52.68c	54.72c	53.70c	52.342a
UTC	54.50a	58.42a	57.63a	56.52a	55.20a	56.50a	56.71a	56.75b	55.74a	52.453a
Dansiriya	55.91a	55.81b	53.63b	56.53a	52.11b	54.91b	53.61b	56.90a	55.13b	52.543a
P^F	0.623	0.033	0.057	0.225	0.492	0.623	0.331	0.477	0.197	0.232
15tons/ha	61.72a	61.80a	58.97b	59.99b	58.01a	61.72a	60.79a	61.87a	61.80	59.241b

20tons/ha	58.14b	60.06a	59.91ab	59.37b	57.89ab	58.14c	59.05a	60.45	58.23	59.685b
25tons/ha	57.93b	59.58a	60.32a	59.20b	56.67c	57.93c	58.57b	60.44	60.04	60.342ba
30tons/ha	60.21a	59.86a	60.10a	61.06a	57.94b	60.21b	58.85b	61.62b	60.56	61.485a
0tons/ha	34.31c	35.42b	40.66	35.35c	34.97d	34.31d	34.41c	36.22	33.65	34.763c
P ^F	0.001	0.001	0.001c	0.001	0.001	0.001	0.001	0.001	0.001	0.001
90x60 cm	52.83d	54.96d	55.63b	53.56d	52.82c	52.83d	53.95c	55.47c	54.34b	54.581
80x40 cm	56.39a	56.30a	56.16a	56.07a	54.20b	56.39a	55.28a	57.82a	55.32a	56.140a
60x30 cm	54.53b	55.90b	55.53b	55.85b	55.02a	54.53b	54.89b	56.28b	55.33a	55.500ba
50x50 cm	54.95b	55.10c	56.17a	54.69c	54.01b	54.95b	54.05b	55.34c	54.94b	54.777b
40x20 cm	53.60c	54.53d	56.26a	54.80c	49.42e	53.60c	53.52c	55.69c	54.35b	54.520b
P ^F	0.490	0.149	0.970	0.406	0.001	0.490	0.059	0.486	0.097	0.090

Means values in a column followed by the same letter(s) are not significantly different by LSD (P<0.05)