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RESPONSE OF TOMATO (*SOLANUM LYCORPERSICUM* L.) TO TRANSPLANTING AGE AND NUTRIENT SOURCE IN BAUCHI STATE, NIGERIA

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ABSTRACT
Field experiment was carried out for two years during the dry seasons of 2020 and 2021 to study the response of tomato (*Solanum lycopersicum* **L.**) to transplanted age and nutrient source in Miri ward, Bauchi state, Nigeria. Five transplanted ages (1, 2, 3, 4, and 5 weeks) after emergence from nursery and three nutrient sources, mineral fertilizer NPK, poultry manure, and control were used for the study. The five transplanted ages and three nutrient sources gave 15 treatment combinations and these were factorially combined and laid in a randomized complete block design (RCBD) with three (3) replications. During the research, growth characters such as plant height, number of branches and stem diameter were measured. Similarly, yield characters such as number of fruits per plant, fruit weight, and fruit yield/hectare were also measured. The results obtained revealed that tomato respond to both transplanted age and nutrient source. Transplanting 5 weeks old seedlings significantly ($P \leq 0.05$) led to higher growth characters such as plant height, number of branches, stem diameter and yield characters such as fruit yield/ha than the other transplanted ages used. Among the different nutrient sources applied, application of poultry manure at the rate of 9t/ha and NPK at the rate of 110:45:45kg/ha produced significantly ($P<0.05$) higher growth characters such as plant height, branches, stem diameter and yield characters such as fruit weight and fruit yield (kg/ha). Based on the findings of this study, transplanting 5 weeks old seedlings and application of either poultry manure at the rate of 9t/ha, or NPK 15:15:15 at the rate of 110:45:45kg/ha led to higher yield of tomato than the control and can be used by farmers to improve tomato production in the study area.

Keywords: NPK fertilizer, Poultry manure, Tomato, Transplanting age, Yield.

INTRODUCTION
Tomato (*Lycopersicon esculentum* L.) is one of the most widely grown vegetable crops in Nigeria and in the world. Tomato ranked in importance to potato and many countries and it is a major source of minerals, vitamins, essential amino acids. In Nigeria, the crop is widely grown in Northern Guinea Savanna under irrigation system. In Nigeria, majority of tomato producers are of the peasant category that suffers a lot of production problem one of which transplanting age and nutrient source are one of them. Improved agronomic practices, identifying suitable transplanted age of seedlings is one of the important factors that will increase the quality and growth rate of seedlings which in turn allow produced to emerge and resources is therefore of paramount, maximum yield of the crops and economic use of the land (Islam *et al.*, 2010; Aliyu *et al.*, 2011).

Application of organic or mineral fertilizer have been reported to increase growth yield of tomato by providing significant quantity of nutrients which are supply to the soil in slow rate over a long period which reduce the nitrate losses in drainage water (Addiscot *et al.*, 1991); it improves the activities of microorganisms in the soil as well as improves water movement and good aeration of the soil Aini and Vimala (2002) observed that organic fertilizer contains

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many nutrients element required for the growth and yield of tomato. This experiment was therefore carried out to study the response of tomato to transplanted age and nutrient source.

Materials and Methods

Field experiment was carried out during 2019/2020 and 2020/2021 dry seasons in Miri ward Bauchi (10◦ 22'N and 9◦ 47' E) in the northern guinea savannah ecological zone of Nigeria. The treatments consist of five transplanting age (1, 2, 3, 4, and 5 weeks old) seedlings and two nutrient source (NPK 15 15 15 at 110kg/ha and Poultry manure at 9t/ha) and a control. The different transplanting age and the nutrient sources were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. Soil sample was collected from the experimental field and taken to soil science laboratory for physicochemical analysis. The experimental field was ploughed, harrowed and made into fine tilt. Poultry manure was applied at the rate of 9t/ha two weeks before transplanting in other to allow for proper decomposition. Nursery was established where tomato seeds were broadcasted and maintained for five weeks. Transplanting was carried out at weekly intervals starting from one week after emergence. NPK 15 15 15 fertilizer was applied as basal at the rate of 45 45 45kg/ha, the remaining 65kgN was applied using urea (46%N) at two split doses at 3 and 6 weeks after transplanting. The seedlings were transplanted at 60cm x 60cm inter and intra row spacing. Data were collected on growth and yield components of tomato. All data collected were subjected to analysis of variance (ANOVA). Significantly different means were separated following Duncan multiple range test (DMRT).

RESULTS and DISCUSSION

Plant Height

Effect of transplanting age and nutrient sources on plant height of tomato is presented in table 1, the result revealed a significant ($P \leq 0.05$) difference among the various treatments used throughout the study period. The results further showed that transplanting 5 weeks old seedlings was observed to be produced significantly ($P \leq 0.05$) taller plant than other treatment used. However, four weeks old seedling produced significant taller plant at 3, 5, 7 and 11 weeks after transplanting while transplanting one (1) week seedling produced the least. Nutrient sources on the other hand, the result indicated that application of poultry manure produce significantly ($P \leq 0.05$) taller plant throughout the study period. NPK fertilizer on the other hand produced significantly taller plant at 3 and 7 weeks while control produced the least.

The significant ($P \leq 0.05$) difference observed when 5 weeks old seedling was transplanted could be attributed to the fact that older seedlings pick up quickly and continuous to elongate than the younger ones. This finding agrees with the reports of Schrader (2000) and Zolek, (2001) who concluded that vegetables transplanted at their older age, develop faster generatively than vegetatively.

The increase in plant height with application of poultry manure revealed the strong effects of poultry manure on growth of tomato by supplying both macro and micro nutrients which are essential for tomato growth. This assertion is supported by Oladotum (2002) who reported that poultry manure contains both macro and micro nutrient such as NPK, Ca, Mg, Cu, Mn, Zn, Bo, and Fe which improved plant growth.

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Table 1: Effect of transplanted age and nutrient source on plant height of tomato taken during the dry season of 2020 and 2021

Treatment	**Weeks after transplanting**				
	3	**5**	**7**	**9**	**11**
Transplanted age	7.48^{b}	10.51^{c}	25.35^{b}	35.19^{bc}	37.28^{c}
1					
2	4.68^{b}	12.98^{c}	28.03^{b}	30.31^{d}	40.92^{b}
3.	7.07^{b}	16.52^{b}	29.21^{ab}	32.19^{cd}	45.41^{a}
4	10.22^{a}	23.17^{a}	29.63^{ab}	37.76^{b}	47.50^{a}
5	16.96^{a}	24.70^{a}	33.75^{a}	43.24^{a}	47.86^{a}
LS	**	**	**	**	**
SE (±)	0.966	1,093	1.551	1.145	0.920
Nutrient source (N)					
NPK 15:15:15	9.35^{ab}	17.38^{b}	30.53^{a}	35.42^{b}	44.12^{b}
Poultry manure	10.60^{a}	20.49^{a}	30.51^{a}	38.85^{a}	46.78^{a}
Control	7.89^{b}	14.85^{c}	26.54^{b}	32.94^{b}	40.49^{c}
LS	**	**	**	**	**
SE (±)	0.749	0.847	1.204	0.887	0.713
Season					
2020	9.45	17.21	29.07	35.33	44.56
2021	9.11	17.94	29.32	36.15	43.3
LS	NS	NS	NS	NS	NS
SE (±)	0.611	0.691	0.983	0.724	0.582
Interaction					
N x T	NS	**	NS	**	**
N x S	NS	NS	**	NS	NS
T x S	**	NS	NS	NS	NS
N x T x S	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group are not significantly different following DMRT NS=Not significant, SE= Standard error, *=significant at 5%, N=nutrient, S season WAT-week after transplanting.

Number of Branches

Effect of transplanting age and nutrient sources on the number of branches of tomato is presented in Table 2. The result indicated significant ($p \leq 0.05$) difference among the various treatments used throughout the study period. The result further revealed that transplanting of 5 weeks old seedlings significantly ($p \leq 0.05$) gave higher number of branches throughout the study period. However, transplanting of 4 weeks old seedlings produce significantly higher number of branches at 3, 9 and 11 weeks after transplanting. Application of NPK 15 15 15 and poultry manure significantly produces similar higher number of branches at 3, 5 and 7 weeks after transplanting and control produces the least. The higher number of branches observed with 5 weeks old seedlings could be due to the fact that older seedlings establish quickly after transplanting them by utilize the available nutrient through partitioning of assimilates to various part of the plant including the branches. This finding agrees with that of Spring (1998) who reported that number of branches tend to increase linearly with increase transplanting age of tomato. The better performance of tomato as observed with application of plant nutrient over

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control could be due to their impact in increasing the nutrient content of the soil which in turn led to increase in number of branches especially the nitrogen content in both NPK and poultry manure. This is in conformity with the findings of Onasaya *et al.* (2009) who reported that nitrogen play an important role in plant growth as protein constituent and also major component of many other compounds that are essential for plant growth.

Table 2: Effect of transplanted age and nutrient source of the number of branches of tomato taken during the dry season of 2020 and 2021

Treatment	**Weeks after transplanting**				
	3	**5**	**7**	**9**	**11**
Transplanted age					
1	4.19^{b}	6.22^{c}	11.93^{c}	31.17^{b}	46.38^{a}
2	4.56^{b}	6.88^{bc}	12.22^{c}	20.60^{d}	32.19^{b}
3	5.11^{a}	7.05^{bc}	16.94^{b}	25.76^{c}	37.01^{b}
4	5.53^{a}	8.36^{b}	17.00^{b}	38.51^{a}	`47.01^{a}
5	6.56^{a}	10.98a	24.50a	39.78a	49.36a
LS	**	**	**	**	**
SET (±)	0.323	0657	1.45b	1.131	1.770
Nutrient source					
NPK 15 15 15	5.35^{a}	8.06 ^{a}	16.94^{ab}	38.53^{a}	46.98^{a}
Poultry manure	5.47 ^{a}	9.14 ^{a}	18.07a	32.61^{b}	42.85^{b}
Control	4.75^{b}	6.49^{b}	14.54^{b}	22.35^{c}	37.35^{c}
LS	**	**	**	**	**
(SE (±)	0.250	0.494	1.128	0.876	1.371
Season					
2020	5.54a	7.31b	16.78	31.08	42.42
2021	4.84b	8.48a	16.46	31.23	42.36
LS	**	**	NS	NS	NS
SE **(±)**	0.204	0.403	0921	0.716	1.119
Interaction					
N x T	**	NS	**	NS	NS
N x S	NS	NS	NS	NS	NS
T x S	NS	NS	NS	NS	NS
N x T x S	NS	NS	NS	NS	NS

Means followed by the same letter within a treatment group are not significantly different following DMRT NS=Not significant, SE=Standard error, *=significant at 5%, N=Nutrient, T=Transplanted week, S=season WAT=weeks after transplanting

Stem Diameter (cm)

Table 3 presented the result on the effect of transplanted age and nutrient source on the stem diameter of tomato. The results shows that transplanted age significantly influence stem diameter throughout the study period except 11 weeks which recorded not significant. The results show that transplanting 5 weeks old seedling produced significantly large stem diameters throughout the study period than the other transplanted age used. Nutrient source shows that application of NPK 15 15 15 and poultry manure produced similar large stem at 3-, 7- and 11-weeks old seedling transplant while the control plot produced the least.

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The increase in stem diameter observed with 5 weeks old seedlings could be attributed to the fact older seedlings more nutrients as a result of it greater root-shoot volume. This finding is constant with that of Spring (1989) who reported that stem diameter increase linearly with increasing seedling age. Similarly, the significant increase in stem diameter observed when NPK and poultry manure were applied could be due to the importance of primary and trace elements in the nutrient source which are essential for plant growth. This agrees with the findings of Nicholson *et al*. (1999) and Ajayi *et al.* (2009) who reported that organic and inorganic manure is regarded as store house of both primary and trace nutrients elements.

Table 3: Effect of transplanted age and nutrient source on the stem diameter of tomato taken during the dry season of 2020 and 2021

Treatment	**Weeks after transplanting**				
	3	5	7	9	11
Transplanted age					
1	1.60^{b}	2.67^{a}	3.18^{b}	3.63^{a}	4.10
2	1.11^{c}	2.69^{a}	2.65^{c}	3.24^{b}	4.43
3	1.03^{c}	2.13^{b}	2.93^{bc}	3.32^{a}	4.22
4	1.79^{b}	2.61^{a}	2.98^{b}	3.34^{ab}	4.33
5	2.14^{a}	2.67^{a}	3.61^{a}	3.56^{ab}	4.36
LS	**	**	**	**	NS
SE **(±)**	0.096	0.112	0.102	0.103	0.103
Nutrient source					
NPK15 15 15	1.70^{a}	2.56^{b}	3.34^{a}	3.77^{a}	4.49^{a}
Poultry manure	1.62^{a}	2.91^{a}	3.31^{a}	3.48^{b}	4.56^{a}
Control	1.29^{b}	2.20^{c}	2.55^{b}	3.01^{b}	3.81^{b}
LS	****	****	****	****	****
SE (±)	0.074	0.087	0.079	0.079	0.080
season					
2020	1.57	2.68	3.05	3.36	4.23
2021	1.50	2.43	3.09	3.47	4.23
LS	NS	NS	NS	NS	NS
SE (±)	0.061	0.071	0.065	0.065	0.065
Interaction					
N X T	**	NS	NS	NS	**
N X S	NS	NS	NS	NS	**
T X S	NS	NS	NS	**	NS
N X T X S	NS	NS	NS	**	**

Means followed by the same letter within a treatment group are not significantly different following DMRT NS=Not significant, SE=Standard error; *=significant at 5%, N=nutrient, T=transplanted week, S=season WAT=week after transplanting.

Number of Fruits per Plant

Effect of transplanting age and nutrient sources on number of fruits is presented in Table 4, the result showed that 1 week old and 5 weeks old seedlings significantly ($p \leq 0.05$) produce higher number of fruits compare to other treatment used. However, nutrient source on the other hand, the results revealed that application of NPK 15 15 15 and poultry manure recorded higher number of fruits per plant while control records the least. The higher number

of fruits observed with 1- and 5-week-old might be due to the weather condition at the first transplanting. The colder weather condition might have encouraged number of fruits in the crop. These findings agree with report of Dhalwal *et al.* (2017) that optimum temperature for production of high font fruit of tomato is from 250℃ to 30℃ day and 15-20℃ night temperature.

The higher number of fruits recorded with application of NPK 15 15 15 and poultry manure revealed the important of organic and inorganic fertilizer in enhance the growth and yield of tomato. This is in line with Chinda (2006) who recorded higher number of fruits from application of NPK 15 15 15 and poultry manure.

Fruit Weight (g)

Table 4 presented the result on the effect of transplanting age and nutrient sources on fruit weigh of tomato. The result revealed a significant difference ($P \leq 0.05$) among the various treatments considered. The result further indicated that transplanting 5 weeks old seedling produce higher fruit weight throughout the study period compared to other treatment applied. Similarly, application of NPK 15 15 15 fertilizer and poultry manure gave higher fruit weight than other treatments. The increase in fruit weight with increase in transplanting age could be due to the fact that the older seedlings have large volume of root to shoot ration which encourage the production of heavy fruit size. This finding is in line with Jainkauskiene and Brazaityte (2005), Lopes and Crotol (2003) who reported that transplant age affects the average fruit weight, the younger the transplant, the lighter the average fruit weight.

The increase in fruit weight as observed in which the application of NPK 15 15 15 and poultry manure produce higher fruit weight indicate the importance of these fertilizer to the soil fertility. This is in line with Babajide and Salami (2021) reported that tomato responded to both NPK fertilizer and poultry manure for best growth and fruit yield.

Fruit Yield (kg/ha)

Effect of transplanting age and nutrient source on fruit yield of tomato is also presented in table 4, the result revealed significant ($P \leq 0.05$) among the treatment used on fruit yield of tomato. The result further showed that transplanting seedlings at 5 weeks produce significantly ($P \leq 0.05$) higher yield compared to other treatment. Application of NPK 15 15 15 fertilizer and poultry manure produce higher fruit yield while the control produces the least. The increase in fruit yield as observed in this study with transplanting 5 weeks old seedlings could be attributed to the fact that older seedlings have lower mortality percentage than young seedling. Thus, reduce cost of production. This finding is in line with McGraw and Grieg (1986) reported that younger seedlings are difficult to transplant from the cell than older seedling and suggested that transplant of 5-8 weeks old seedlings are more effective for higher fruit yield.

Furthermore, significantly higher fruit yield per hectare with application of NPK 15 15 15 fertilizer and poultry manure could be as a result of deficiency of plant nutrient in the soil. Therefore, addition of organic and inorganic fertilizer made more nutrients available to the plant. This is in line with the work of Adenawola and Adejoro (2005) that reported that poultry manure increase growth and yield of tomato.

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Table 4: Effect of Transplanted Age and Nutrient Source on the Field and Yield Compound of Tomato taken during dry season of 2020 and 2021

Treatment	Number Fruit/plant	F/Weight (g)	Fruit Yield (kg/h)
Transplanted age			
1	7.11^{a}	257.79^{b}	5801.82^{ab}
2	5.17^{bc}	192.14^{b}	4199.84^{bc}
3	4.67^{c}	175.05^{b}	3031.53^{c}
4	5.56^{bc}	193.95^{b}	4389.37^{bc}
5	6.11^{ab}	290.02^{a}	6536.51^{a}
LS	**	**	**
SE ±	0.455	30.683	569.199
N-source			
NPK 15:15:15	6.47^{a}	279.27^{a}	5754.82^{a}
Poultry manure	6.23^{a}	257.63^{a}	5722.05^{a}
Control	4.47^{b}	128.48^{b}	2898.56^{b}
LS	**	**	**
SE±	0.352	23.767	440.900
Season			
2020	6.40a	232.39	4816.88
2021	5.04b	211.19	4766.75
LS	****	NS	NS
SE±	6.40	19.406	359.993
Interaction			
N X T	NS	NS	NS
N X T	NS	NS	NS
T X S	NS	NS	NS
N X T X S	NS	NS	NS

Means followed by the same letter within a treatment group are not significantly different following DMRT NS=Not significant, SE=Standard error, *= Significant at 5%, N=Nutrient, T=transplanted week, S=season WAT=week after transplanting. N/Fruit=Number of Fruit, F/Weight=fruit weight.

CONCLUSION AND RECOMMENDATION

In conclusion however, transplanting age and application of nutrients source had a significant effect on growth and yield of tomato. Based on the result of this findings, transplanting 5 weeks old seedlings and application of any of poultry manure at the rate of 9t/ha or NPK 15 15 15 at the rate of 110 45 45kg/ha can be used for increased productivity of tomato in the study area. Further research with more weeks before transplanting and higher rates of organic or inorganic fertilizer is recommended to exploit more inference in the study area.

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