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Seedling development and juvenile growth of two yellow passion fruit genotypes as influenced by poultry manure rates

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ABSTRACT

Yellow passion fruit, consumed mainly as juice in many parts of the world, is an emerging fruit crop in south-eastern Nigeria. Farmers need vigorous seedlings for optimum performance in the field. For such, a study was conducted to evaluate the effect of poultry manure (PM) rates on seedling development and juvenile growth of yellow passion fruit. Two yellow passion fruit genotypes ('KPF-4' and 'Conventional') received five poultry manure rates (0, 10, 20, 30 and 40 t/ha). The experiment was laid out as a split plot in completely randomized design and replicated thrice. The result revealed that the early seedling growth performance of the two genotypes did not statistically (P>0.05) vary. On the other hand, there was a progressive increase in the growth parameters with increasing rate of PM. Specifically, the application of 20 t/ha PM produced tallest seedlings, broadest stems and highest number of leaves in the first five weeks after PM application. However, most vigorous vines (vine length, number of leaves, fresh weights of leaves, shoots, roots) and highest accumulation of dry matter were produced by KPF-4 vines grown with 40 t/ha PM although these did not vary significantly with values recorded with 20 t/ha PM application. In view of the economics of fertilizer use, it was recommended to apply poultry manure at 20 t/ha during nursery in the study area.

Keywords: dry matter partitioning, fertilizer, nursery, *Passiflora edulis*, vine

INTRODUCTION

Passion fruit is a dicotyledonous herbaceous woody vine with auxiliary tendrils and belongs to the Passifloraceae family. It has about 500 species distributed in the tropical and subtropical regions and has two edible varieties namely, purple passion fruits (*Passiflora edulis* var. edulis) and yellow passion fruit (*Passiflora edulis* var. flavicarpa) (Thokchom and Mandal, 2017). The mostly produced and marketed variety is *Passiflora edulis* Sims var. flavicarpa (Dos Reis et al., 2018). Passion fruit is grown majorly for its juice and fresh pulp (Zeraik and Yariwake, 2010). The yellow passion fruit, whose origin has been linked to southern Brazil was introduced into Nigeria in 1980s and was grown majorly in some parts of Northern and Western Nigeria (Alegbejo 2004). Ani and Baiyeri (2008) noted that the crop has a bright future in Nigeria but faces the challenge of adequate agronomic package for highly successful cultivation. There is currently few information/productions technology package for the yellow passion fruit in Nigeria (Alegbejo, 2004). However, documentations on specific production package of passion fruit for south-eastern Nigeria exist especially as it relates to providing fertilizer recommendations for the sustainable production of passion fruit (Ndukwe and Baiyeri, 2018a, 2018b, 2018c; 2019; Ndukwe et al., 2021).

Quality seedling of passion fruit is important for production of vigorous vines and fruits in the field. Good substrate is one of the factors that determines quality seedlings. Nutrient concentration and availability of the substrate is key to achieving quality seedling. These nutrients are supplied by the application of organic manure. In southeastern Nigeria, poultry manure is commonly utilized in crop production. Poultry manure is also accessible in Awka, Anambra State among other organic manures (Ndukwe et al., 2014) as a result of rise in poultry production in the state. Poultry manure has a high content of nutrient such as nitrogen, phosphorus and potassium when compared to other animal manures (Mohammed et al., 2010). There is scarcity of information on the adequate rate of poultry manure that could give optimum growth and development of passion fruit seedlings in Nigeria.

Plant productivity can also be determined by the distribution of assimilates among various organs. Dry matter partitioning is the end result of the flow of assimilates from source organs to vegetative and reproductive sinks (Marcelis, 1996; Amanullah et al., 2021). Mohammed (2002) reported significant increase in yield and crop quality in fruit tree when nutrient was adequate. Thus, there is a relationship between adequate nutrient, growth, yield and quality of fruit harvested. Therefore, the objectives of the research was to evaluate the seedling development and early growth of two genotypes of yellow passion fruit as influenced by poultry manure rates.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in a high tunnel of about 2-3 m high between 2016 and 2017. The tunnel was located in the Research and Teaching farm of Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Awka, Nigeria. The research farm lies on latitude 06°15´N and longitude 07°08´E, with an average rainfall of 1920 mm per annum while the mean minimum and maximum temperatures were 27 °C and 30 °C respectively with relative humidity of 72.3%. During the period of the experiment, the average temperature of the tunnel was 34.74 °C and the average relative humidity was 89.75%.

Treatments, experimental design and planting material

The factors were two yellow passion fruit genotypes (‘Conventional’ and ‘KPF-4’) and five poultry manure rates (0, 10, 20, 30, 40 t/ha). The experiment was laid out as a split plot experiment in a completely randomized design (CRD). Planting materials used were seedlings raised from seeds obtained from previously grown passion fruits which received the same varying poultry manure rates (0, 10, 20, 30, and 40 t/ha). The KPF-4 genotype is a hybrid developed by Kenya Agricultural and Livestock Research Organization (KALRO), Thika. The genotype is among two other hybrids which were products of natural crosses between coastal yellow varieties and purple skinned varieties (Wangungu, 2012). It is judged to yield fruits with high juice and sugar contents as well as tolerates *Fusarium*, a pathogen that affects the purple variety. On the other hand, seeds of the Conventional genotype were obtained from fruits harvested from Federal University of Agriculture, Abeokuta Research farm, Ogun State, Nigeria. This genotype has not received any genetic characterization. The physicochemical properties of the top soil and poultry manures are shown Table 1.

Cultural practices

Seeds were planted in potted topsoil at 1 cm depth. Seedlings were transplanted at six weeks after emergence. Transplanting was done in the evening. At the time of transplanting, the seedlings were at 8-10 leaf stages and at average height of 12 cm with a mean stem girth of 0.22 cm. Three seedlings were transplanted into pots containing 10 kg topsoil. The varying rates of poultry manure (at 10% moisture content) were applied as top-dressing two weeks after transplanting. Thereafter, the substrate was covered with dry grass mulch to prevent the seedlings from exposure of water splash during watering which was done daily. Care was taken in the watering in order not to erode the media (non-erosive velocity) so as not to disturb the roots of the seedlings. Weeding was also done by pulling the weeds as they appear on the media. The high tunnel was kept weed-free by hand weeding. Collection of growth data commenced one week after application of the varying rates of poultry manure.

At 3 months after application of poultry manure, the passion fruit vines were coppiced at 40 cm height using a sharp knife, thereafter the plants were fertigated daily for three consecutive days. At two weeks after coppicing, the plants received another dose of the varying rates of poultry manure, at 10% moisture content, also as top-dressing. The vines were trained with the help of a rope. The biomass production and distribution pattern were monitored at three months after coppicing (20 weeks after seedling emergence). Three plants per manorial treatment and genotype were sampled for destruction and separated into leaf, vine, and root. Fresh weight of the leaf, vine and root were obtained with the aid of a digital weighing balance. Dry weights of the different parts were obtained by drying them at about 105 °C.

Table 1. Chemical properties of the topsoil and poultry manure utilized

Chemical properties	Top soil (0-15 cm)	Poultry Manure
pH (water)	5.80	7.9
Phosphorus (mg/kg)	9.28	1.060
Nitrogen (%)	0.098	2.476
Organic Carbon (%)	0.113	46.08
Organic Matter (%)	0.195	76.45
Calcium (meq/100g)	2.80	116.00
Magnesium (meq/100g)	1.60	98.00
Potassium (meq/100g)	0.330	1.830
Sodium (meq/100g)	0.287	0.630
Exchangeable H^+	1.520	-
CEC (meq/100g)	6.537	-
Base saturation (%)	76.75	-

Data collection and analysis

Baseline growth parameter (seedling height, seedling stem girth, number of leaves) were collected immediately after transplanting. Seedling height was taken with the help of flexible meter rule, from the substrate surface to the apex of the stem while seedling stem girth was measured at 20 cm with digital venier caliper. To assess the early growth of the seedling, the vine length was measured at in 1, 2, 3, 4, and 5 weeks after treatment application (WATA) from the ground level to the stem apex. The numbers of leaves were obtained by counting fully opened leaves at 1, 2, 3, 4, and 5 WATA. Vine girth at 1 cm above the ground was measured at 1, 2, 3, 4, and 5 WATA with help of digital venier caliper. Leaf area was also determined per plant as the product of the leaf width and length all in cm.

With effect from four weeks after coppicing the plants, vine length, number of leaves, number of branches and vine girth were recorded at two weeks interval. The vine length, vine girth and number of leaves were determined as earlier stated but the number of branches were determined by counting the number of developed branches.

The data collected were subjected to analysis of variance using GENSTAT (2007) Release 7.2 DE, statistical software package following procedure for split-plot experimental design in completely randomized design while the mean separation was performed using least significant difference (LSD) at 5% probability level.

RESULTS

Main effects of genotype and poultry manure rates on seedling height of yellow passion fruit

The seedling heights of both 'conventional' and 'KPF-4' passion fruit genotypes were not significantly different ($P>0.05$) at 1, 2, 3, 4 and 5 weeks after treatment application (WATA) (Table 2) but at 3, 4 and 5 WATA the poultry manure had significant ($P<0.05$) effect on the seedling height.

Seedling height increased with increase in poultry manure rate with tallest seedlings obtained in plants that received 20 t/ha poultry manure while shortest seedlings were observed in plants that received no poultry manure.

Main effects of genotype and poultry manure rates on number of leaves of yellow passion fruit seedlings

Similarly, the number of leaves did not significantly ($P>0.05$) vary between the two genotypes at all the periods of sampling (Table 3).

Table 2. Main effects of genotype and poultry manure rates on seedling height (cm) of yellow passion fruit

	1 WATA	2 WATA	3 WATA	4 WATA	5 WATA
Genotype					
Conventional	14.85[a]	18.8[a]	26.4[a]	40.9[a]	55.0[a]
KPF – 4	14.94[a]	18.7[a]	25.1[a]	39.0[a]	54.1[a]
$LSD_{0.05}$	ns	ns	ns	ns	ns
Poultry manure rate (t/ha)					
0	14.37[a]	16.6[a]	18.9[b]	20.7[c]	22.2[c]
10	15.54[a]	20.0[a]	26.6[b]	39.0[b]	51.5[b]
20	18.59[a]	26.3[a]	39.8[a]	60.7[a]	74.1[a]
30	13.19[a]	15.8[a]	21.8[b]	39.6[b]	60.5[a]
40	12.76[a]	15.1[a]	21.7[b]	39.6[b]	64.3[a]
$LSD_{0.05}$	ns	ns	10.1	11.9	15.6

WATA = Weeks after treatment application; Means in a column with different alphabets are significantly different at 5% level of significance

Table 3. Main effects of genotype and poultry manure rates on number of leaves of yellow passion fruit seedlings in weeks after treatment application (WATA)

	1 WATA	2 WATA	3 WATA	4 WATA	5 WATA
Genotype					
Conventional	9.24[a]	10.47[a]	11.98[a]	13.38[a]	13.90[a]
KPF – 4	8.44[a]	0.93[a]	11.53[a]	13.16[a]	14.21[a]
$LSD_{0.05}$	ns	ns	ns	ns	ns
Poultry manure rate (t/ha)					
0	10.28[a]	9.89[a]	10.56[a]	10.56[a]	10.61[b]
10	8.78[b]	10.17[a]	12.06[a]	13.72[a]	14.67[a]
20	9.78[a]	11.33[a]	13.28[a]	14.22[a]	15.39[a]
30	7.61[b]	9.78[a]	11.17[a]	14.00[a]	15.20[a]
40	7.78[b]	9.83[a]	11.72[a]	14.00[a]	15.20[a]
$LSD_{0.05}$	1.47	ns	ns	ns	2.23

WATA = Weeks after treatment application; Means in a column with different alphabets are significantly different at 5% level of significance

However, poultry manure rates significantly influenced the number of leaves especially at 5 WATA where highest number of leaves were recorded in plants that received 20 t/ha poultry manure while lowest number of leaves observed in plants grown without poultry manure.

Main effects of genotype and poultry manure rates on stem girth of yellow passion fruit seedlings

The seedlings stem girth of the genotypes not significantly (P>0.05) different at 1, 2, 3, 4 and 5 WATA. On the other hand, poultry manure rates had significant (P<0.05) effect on the stem girth at 1, 2, 3, 4 and 5 WATA (Table 4). At 2, 3 and 4 WATA, the thickest stems were obtained with 20 t/ha poultry manure application while at 5 WATA the thickest stem was observed with the application of 40 t/ha poultry manure although the mean value (0.4989 mm) was not significantly different with the mean value (0.4870 mm) recorded with 20 t/ha poultry manure application. Slimmest stems at 2 and 3 WATA were observed when they received 10 t/ha poultry manure while at 5 WATA the slimmest was obtained with no poultry manure application.

Main effects of genotype and poultry manure rates on vine length (cm) of yellow passion fruit after coppicing

Table 5 shows that the vine length of the genotypes did not significantly differ (P<0.05) except at 8 weeks after coppicing (WAC) where the Conventional genotype had longer vines (196.4 cm) than the KPF-4 genotype (188.3 cm). Poultry manure rates significantly influenced the seedling vine length at 4, 6, and 8 WATA (P<0.05). Application of poultry manure generally increased the vine length with the longest vines observed with 20 t/ha poultry manure was applied.

The interaction between the genotype and poultry manure rates significantly (P<0.05) influenced the seedling vine length at 4, 6, and 8 WAC (Table 6). The application of poultry manure increased the vine length of the Conventional genotypes. The longest vines were observed in KPF-4 genotype when 40 t/ha of poultry manure was applied. However, the mean values (191.7, 201.6, 218.4 cm) recorded at 4, 6 and 8 WAC, respectively were not significantly (P>0.05) different with those obtained (172.4, 188.7, 212.1 cm) in the Conventional genotype when it received 20 t/ha poultry manure.

Table 4. Main effects of genotype and poultry manure rates on stem girth (mm) of yellow passion fruit seedlings

	1 WATA	2 WATA	3 WATA	4 WATA	5 WATA
Genotype					
Conventional	0.265^{a}	0.306^{a}	0.367^{a}	0.43^{5a}	0.468^{a}
KPF – 4	0.251^{a}	0.288^{a}	0.345^{a}	0.383^{a}	0.445^{a}
$LSD_{0.05}$	ns	ns	ns	ns	ns
Poultry manure rate (t/ha)					
0	0.306^{a}	0.328^{b}	0.394^{a}	0.389^{b}	0.409^{c}
10	0.238^{c}	0.261^{e}	0.306^{b}	0.389^{b}	0.451^{b}
20	0.286^{b}	0.339a	0.398^{a}	0.455^{a}	0.487^{a}
30	0.224^{c}	0.275^{d}	0.334^{b}	0.381^{b}	0.437^{b}
40	0.235^{c}	0.283^{c}	0.348^{a}	0.319^{c}	0.499^{a}
$LSD_{0.05}$	0.059	0.004	0.063	0.051	0.045

WATA = Weeks after treatment application; Means in a column with different alphabets are significantly different at 5% level of significance

Table 5. Main effects of genotype and poultry manure rates on the vine length (cm) of early growth of yellow passion fruit

	4 WAC	6 WAC	8 WAC	12 WAC
Genotype				
Conventional	162.0^{a}	179.2^{a}	196.4^{a}	219.7^{a}
KPF – 4	153.6^{a}	170.2^{a}	188.3^{b}	213.7^{a}
$LSD_{0.05}$	ns	ns	4.78	ns
Poultry manure rate (t/ha)				
0	145.8^{b}	162.3^{b}	176.2^{b}	209.5^{a}
10	136.1^{b}	152.3^{b}	166.7^{b}	196.8^{a}
20	171.8^{a}	188.3^{a}	209.7^{a}	226.2^{a}
30	163.5^{a}	186.9^{a}	207.0^{a}	221.8^{a}
40	171.8^{a}	183.6^{a}	202.2^{a}	229.2^{a}
$LSD_{0.05}$	20.07	19.15	20.53	ns

WAC = Weeks after coppicing; Means in a column with different alphabets are significantly different at 5% level of significance

Table 6. Interaction effect of genotype and poultry manure rates on the vine length (cm) of early growth of yellow passion fruits

	Poultry manure rate (t/ha)	4 WAC	6 WAC	8 WAC	12 WAC
Conventional	0	183.1^{a}	195.7^{a}	210.2^{a}	216.0^{a}
	10	144.4^{c}	158.1^{b}	165.7^{bc}	210.0^{a}
	20	172.4^{b}	188.7^{a}	212.1^{a}	236.0^{a}
	30	158.0^{bc}	187.9^{a}	208.0^{a}	217.7^{a}
	40	151.9^{bc}	165.7^{b}	185.9^{b}	218.7^{a}
KPF – 4	0	108.6^{d}	129.0^{c}	142.2^{c}	203.0^{a}
	10	127.7^{d}	146.5^{b}	167.7^{bc}	183.7^{a}
	20	171.2^{b}	187.9^{a}	207.2^{a}	216.3^{a}
	30	169.1^{b}	186.0^{a}	206.0^{a}	226.0^{a}
	40	191.7^{a}	201.6^{a}	218.4^{a}	239.7^{a}
$LSD_{0.05}$		26.98	25.42	26.04	ns

WAC = Weeks after coppicing; Means in a column with different alphabets are significantly different at 5% level of significance

Main effects of genotype and poultry manure rates on the number of leaves of yellow passion fruits after coppicing

There was no significant different in the number of leaves of both 'Conventional' and 'KPF-4' passion fruit genotypes (Table 7) however, poultry manure rates significantly (*P*<0.05) influenced the number of leaves at 8 WAC. Application of poultry manure significantly enhanced the production of more leaves especially with the application of 20 and 40 t/ha poultry manure.

Table 7. Main effects of genotype and poultry manure rates on the number of leaves of early growth of yellow passion fruits

	2 WAC	4 WAC	6 WAC	8 WAC	12 WAC
Genotype					
Conventional	23.07ᵃ	30.60ᵃ	33.84ᵃ	37.07ᵃ	52.0ᵃ
KPF – 4	23.87ᵃ	27.71ᵃ	31.53ᵃ	35.27ᵃ	52.9ᵃ
$LSD_{0.05}$	ns	ns	ns	ns	ns
Poultry manure rate (t/ha)					
0	22.06ᵃ	26.33aᵃ	29.72ᵃ	32.94ᵇ	30.2ᵃ
10	22.33ᵃ	26.78ᵃ	30.28ᵃ	33.61ᵇ	53.0ᵃ
20	23.00ᵃ	30.56ᵃ	33.89ᵃ	37.17ᵃ	58.2ᵃ
30	23.89ᵃ	29.89ᵃ	32.56ᵃ	35.39ᵇ	41.2ᵃ
40	26.06ᵃ	32.22ᵃ	37.00ᵃ	41.72ᵃ	79.7ᵃ
$LSD_{0.05}$	ns	ns	ns	6.00	ns

WAC = Weeks after coppicing; Means in a column with different alphabets are significantly different at 5% level of significance

Table 8. Interaction effect of genotype and poultry manure rates on the number of leaves of early growth of yellow passion fruits

	Poultry manure rate (t/ha)	2 WAC	4 WAC	6 WAC	8 WAC	12 WAC
Conventional	0	25.33ᵇ	31.56ᵇ	34.44ᵃ	37.67ᵃ	30.7ᵃ
	10	22.56ᵇ	27.00ᶜ	31.22ᵇ	34.56	61.7ᵃ
	20	22.89ᵇ	32.89ᵇ	36.33ᵃ	39.33ᵃ	68.3ᵃ
	30	23.33ᵇ	32.22ᵇ	34.44ᵃ	37.22ᵃ	42.7ᵃ
	40	21.22ᵇ	29.33ᵇ	32.78ᵇ	36.56ᵇ	56.7ᵃ
KPF – 4	0	18.78ᵇ	21.11ᶜ	25.00ᵇ	28.22ᵇ	29.7ᵃ
	10	22.11ᵇ	26.56ᶜ	29.33ᵇ	32.67ᵇ	44.3ᵃ
	20	23.11ᵇ	28.22ᵇᶜ	31.44ᵇ	35.00ᵇ	48.0ᵃ
	30	24.44ᵇ	27.56ᶜ	30.67ᵇ	33.56ᵇ	39.7ᵃ
	40	30.89ᵃ	35.11ᵃ	41.22ᵃ	46.89ᵃ	102.7ᵃ
$LSD_{0.05}$		5.72	6.37	7.94	9.57	ns

WAC = Weeks after coppicing; Means in a column with different alphabets are significantly different at 5% level of significance

Number of leaves was also significantly (P<0.05) influenced by the combined effect of genotype and poultry manure rates at 2, 4, 6 and 8 WAC (Table 8). The highest and lowest number of leaves, across the sampling periods were obtained when 'KPF-4' genotype received 40 t/ha and no poultry manure, respectively. The highest mean number of leaves recorded in KPF-4 genotypes with 40 t/ha manure application were significantly at par with the mean number of leaves produced by the Conventional genotype with 20 t/ha poultry manure application.

Main effects of genotype and poultry manure rates on the vine girth (mm) of yellow passion fruits after coppicing

The seedling vine girth of both passion fruit genotypes were significantly (P<0.05) different only at 6 WAC (Table 9). The 'Conventional' genotype produced thicker vine (6.28 mm) at 6 WATA than the 'KPF-4' genotype (5.87 mm).

The poultry manure had significant (P<0.05) effect on vine girth of yellow passion fruit seedlings at 2, 4, 6, and 8 WAC (Table 9). The vine girth progressively increased as the poultry manure rate increased. At 2, 4, 6, 8 and 12 WAC, the thickest vines were obtained when the plants received either 20, 30 or 40 t/ha poultry manure whereas thinnest vines were observed in vines that received no poultry manure.

Dry matter partitioning

There was no significant effect (P<0.05) of the two different genotypes (Conventional and KPF-4) with respect to the dry matter partitioning parameters (Table 10).

Fresh weights of leaves, vines, roots and percentage dry matter accumulation content varied significantly (P<0.05) with poultry manure rates (Table 10). Fresh weights of leaves and vines of the passion fruits were highest with 40 t/ha poultry manure application. However, leaf fresh and dry matter accumulation obtained with 20 t/ha poultry manure were statistically at par with means recorded with 40 t/ha poultry manure application. Dry matter accumulations to the different parts of the plant were lowest in seedlings that received no poultry manure.

Table 9. Main effects of genotype and poultry manure rates on the vine girth (mm) of early growth of yellow passion fruits

	2 WAC	4 WAC	6 WAC	8 WAC	12 WAC
Genotype					
Conventional	5.78^a	6.28^a	6.28^a	6.28^a	5.80^a
KPF – 4	5.69^a	5.80^a	5.87^b	5.98^a	5.70^a
$LSD_{0.05}$	ns	ns	0.397	ns	ns
Poultry manure rate (t/ha)					
0	4.59^c	5.04^b	5.08^b	5.18^b	4.86^a
10	5.64^b	5.76^b	5.84^b	5.91^b	5.43^a
20	5.95^a	6.30^a	6.39^a	6.30	5.88^a
30	5.90^a	6.49^a	6.41^a	6.48	5.90^a
40	6.61^a	6.62^a	6.66^a	6.79	6.68^a
$LSD_{0.05}$	0.62	0.73	0.73	0.64	ns

WAC = Weeks after coppicing; Means in a column with different alphabets are significantly different at 5% level of significance

Table 10. Effects of genotype and poultry manure rate on percentage dry matter partitioning to various parts of plants at 20 weeks after seedling emergence

	Fresh weight (g)			Percentage dry matter accumulation		
	Leaf	Vine	Root	Leaf	Vine	Root
Genotype						
Conventional	42.2[a]	55.4[a]	12.7[a]	81.2[a]	73.2[a]	71.9[a]
KPF – 4	51.7[a]	57.5[a]	11.3[a]	81.8[a]	70.8[a]	72.2[a]
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns
Poultry manure rate (t/ha)						
0	32.0[b]	33.8[b]	9.9[a]	78.8[c]	67.5[c]	73.0[a]
10	41.6[b]	44.8[b]	11.7[a]	81.4[a]	71.6[b]	71.5[a]
20	44.8[b]	60.0[a]	10.9[a]	82.4[b]	72.6[b]	68.2[a]
30	39.1[b]	45.5[b]	10.8[a]	80.4[b]	71.1[b]	71.4[a]
40	77.2[a]	98.2[a]	16.8[a]	84.5[a]	77.2[a]	76.3[a]
$LSD_{0.05}$	27.9	39.7	ns	3.2	3.9	ns

Means in a column with different alphabets are significantly different at 5% level of significance

DISCUSSION

The two yellow passion fruit genotypes did not significantly vary in most of the early growth parameters evaluated. This probably suggested that they could be genetically related as there is scarcity of information on the genotypic characteristics of the yellow passion fruit already in existence in Nigeria which was utilized in this study. Other studies (Ndukwe and Baiyeri, 2018a, b, c, 2019; Ndukwe et al., 2021) with these planting materials and in the same geopolitical zone showed that they performed relatively similar. Hence, this confirmed the opinion of the previous authors that the passion fruit hybrid, 'KPF-4'could adapt to Awka, south-eastern, Nigeria. On the other hand, it is pertinent to characterize the already existing yellow passion fruit genotype in Nigeria.

All the growth and regrowth parameters of the seedlings (vine length, number of leaves, number of branches, and stem girth) recorded in this study were enhanced due to the application of poultry manure compared to seedlings that were grown without manure. This is in agreement with the existing claim that poultry manure possesses many plant nutrients for enhanced crop growth and yield (Lin et al., 2017). The use of organic manure especially from poultry source has become increasingly important even in south-eastern Nigeria because of its role in increasing the nutritive value of most fruit crops and leafy vegetables (Ndukwe et al., 2010, 2012; Ndubuaku et al., 2014). A progressive increase in the growth of the seedlings was observed with an increase in the poultry manure rate. The seedling growth parameters increased as the organic manure level increased, which is attributable to greater supply of plant nutrients with incremental application of poultry manure. Most of the growth parameters of the seedlings after emergence and coppicing performed with the application of 20 t/ha poultry manure suggesting that this rate must have supplied optimum nutrients and may represent the optimum rate of poultry manure during nursery. Applying poultry manure application at the rate of 20 t/ha has also been recommended for optimum yellow passion fruit production in Nsukka, south-eastern Nigeria (Ndukwe and Baiyeri, 2018a). However, number of leaves and stem girth of seedlings after coppicing were highest with 40 t/ha poultry manure application although the mean values were statistically at par ($P>0.05$) with 20 t/ha poultry manure application. This implies that it is most economical to apply the lower poultry manure rate during nursery.

CONCLUSIONS

The seedlings performance of KPF-4 (yellow passion fruit hybrid) and the Conventional yellow passion fruit genotype, already in existence in Nigeria were relatively similar suggesting that there could be genetic relationship between the two planting materials. Secondly, the hybrid (KPF-4) from highland zone of Kenya could adapt favourably in the study area (Awka, Nigeria). In addition, the study noted that there should be documented information on the characterization of the genotype already in existence in Nigeria.

The study also revealed that varying poultry manure rates had profound positive influence on the seedling development and early seedling growth of yellow passion fruit in Awka, south-eastern Nigeria. It was therefore recommended to apply poultry manure at the rate of 20 t/ha, considering economics of fertilizer use, for production of vigorous yellow passion fruit seedlings in the nursery in the study area.

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