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Growth and Fruit Yield of Yellow Passion Fruit (*Passiflora edulis* Var. *Flavicarpa* Deg.) In Response to Organic Fertilizer.

[1]Abiola, I.O. and [2]Aiyelaagbe, I.O.O
[1] Department of Horticulture and Landscape Technology, Federal College of Forestry, Ibadan.
[2]Department of Horticulture, Federal University of Agriculture, Abeokuta.
Corresponding author: abiolaisaacoluwaseyi@gmail.com Tel: +2348035149948

Abstract
A field study was conducted to investigate the growth and yield response of yellow passion fruit to organic fertilizer. The Poultry manure (PM) was applied at 0, 30, 45, and 60 t/ha in three split applications. Fertilizer rates were assigned in a randomized complete block design and replicated four times. Data were collected on vine length, leaf area, and number of branches, tendrils, flowers, and marketable fruit yield. Poultry manure of 60 t/ha produced significantly ($P < 0.05$) more leaves as well as larger leaf area, tendrils, flowers, and ripe fruit than lower rates. Application of 60 t/ha had similar effect on vine length as 45 t/ha, but was significantly superior to 30 t/ha and the control. Application of 60 t/ha of PM produced significantly higher yield (27.0 t/ha) than 0, 30, and 45 t/ha which produced 9.0 t/ha, 14.5 t/ha, and 17.5 t/ha, respectively. Based on its positive effect on growth and fruit yield, 60t poultry manure/ha is recommended for yellow passion fruit production in southwestern Nigeria.
Keywords: *Passion Fruits, Soil Fertilty, Organic Agriculture, Poultry Manure*

Introduction

Passion fruit (*Passifloraceae; Passiflora*) originates from tropical America (Viana *et al.,* 2003). There are more than 500 species of passiflora and more than 50 of these species are edible, while, only the purple passion fruit, *Passiflora edulis* Sims, *f. edulis* and yellow passion fruit, *p. edulis* Sims, *f. flavicarpa* Degener, are grown commercially (Mugwiza and Qian, 2009).The yellow passion fruit (*Passiflora edulis Sims. F. flavicarpa O. Deg.*) is the most widely cultivated *Passiflora species* in the world; it predominates the Brazilian market (Bellon *et al.,* 2007). Passion fruit is grown as a fresh fruit for making juice and direct consumption. Although the climatic conditions for its cultivation in Nigeria are favourable (Alegbejo and Audu, 2000), the yellow passion fruit is known to relatively few farmers in Nigeria and as such is rarely cultivated. Juice of the fruit is a good source of vitamin A and C, and its aroma and flavour makes pleasant contributions to drinks and deserts (Campbell and Knight, 1983). Rosson and Adcock (2000) estimated that in 1999 passion fruit juice represented 1-2% of all the fruit juice imported into the US, with 9 to 18 million gallons of passion fruit juice being imported annually in the 1990s. Organic fertilizers have a beneficial effect on passion fruit (Piere et al., 2009). And, organically produced fruit fetch a premium. Most of the passion fruit juice was consumed blended with other tropical fruit juices (Rosson and Adcock, 2000). The production of high quality fruit juice involves several cultural inputs. There is currently no production technology package for the yellow passion fruit in Nigeria (Alegbejo, 2004). Knowledge of fertilizer requirement is one of the vital aspects of production package. The few studies on the crop indicate that growth of passion fruit showed positive response to fertilizer application (Aiyelaagbe *et al.,* 1998 and 2004; Fagbayide and Joseph-Adekunle, 2002; Aiyelaagbe and Abiola 2008). Organic fruit production has not had extensive research and development backup in the tropics. Particularly, soil fertility has a significant effect on the nutritional characteristics of the juice. Thus, this study was designed to determine the effect of different rates of poultry manure on growth and yield of yellow passion fruit.

Material and methods

The field experiment was conducted at the Federal University of Agriculture, Abeokuta Ogun State, Nigeria (7^0 15'N and 3^0 25'E). The location is in the forest savanna transition zone commonly called derived savanna. It has a tropical and bimodal rainfall pattern. The soil to be used contains pH of 6.8, the Available Phosphorus (11.10 ppm), Potassium (0.32 me/100kg), total nitrogen was (0.34 %) and organic matter was (6.67 %). Also, the soil was sandy loam. Four-month old passion fruit seedlings were transplanted into the field. Treatments were applied at rates corresponding to 0, 30, 45, 60 t/ha and arranged in randomized complete block design, replicated four times. Four weeks after transplanting, seedlings were trained unto 1.5 m-high bamboo platforms. Data on vegetative and yield parameters that were collected were vine length (cm), number of tendrils, leaves, branches, leaf area (cm^2),cumulative number of flower, and cumulative marketable fruit yield (kg/ha). Data collected were subjected to Analysis of variance (ANOVA) to know treatments effect and the Least Significant Difference (LSD) technique was used for mean separation (Steel and Torrie, 1980).

Results

The rainfall and other climatic factors (Table 1) during the period of experiment were adequate and within the range recommended by Joy, (2010). The pre-planting soil analysis (Table 2) showed that the soil is sandy loam textural class and slightly acidic, low in total nitrogen and available phosphorus. The chemical analysis of poultry manure (Table 3) shows that it is high in organic carbon and nitrogen. Plants grown with 60 t/ha of poultry manure produced significantly ($p<0.05$) more leaves than the plants grown without fertilizer (control) at 56 and 60WAT. The plants also produced significantly ($p<0.05$) more leaves than plants that received 30 and 45 t/ha of poultry manure at 56 and 60WAT, respectively. Conversely, the leaf production in plants that received organic fertilizer was significantly ($p<0.05$) superior to plant grown without fertilizer (control) (Figure 1). There was sharp increase in leaf area development from 52 to 56WAT, thereafter the leaf area development plateau. Plants that received 45 and 60 t/ha of poultry manure had same effect on leaf area but, significantly ($p<0.05$) larger leaf area at 56 and 60WAT than leaf area of other plants that received lower fertilizer rates. Similarly, plants grown with 0, 30 and 45 t/ha of poultry manure had same effect on leaf area of yellow passion fruit (Figure 2). The number of branches of yellow passion fruit planted was significantly ($p<0.05$) improved throughout the weeks of observation by the fertilizer application. Plants grown with 60 t/ha of PM was significantly ($p<0.05$) superior to other lower PM rates at 60WAT (Figure 3). Number of tendrils increased significantly with fertilizer application. Plants grown with 60t/ha poultry manure produced significantly ($p\leq0.05$) more tendrils than plants that received lower rates of fertilizer and the control especially at 52 and 60WAT. The effect of lower rates of fertilizer (30 t/ha and 45 t/ha) did not differ significantly from one another, but at 60WAT plants that received 45t/ha of poultry manure produced significantly ($p<0.05$) more tendrils than the control plant (Figure 4). The different rates of poultry manure used significantly increased vine length of yellow passion fruit throughout the weeks of observation. Plants that received 60 t/ha of poultry manure produced significantly ($p<0.05$) longer vine, than plants that were grown with lower fertilizer rates especially at 56 and 60WAT. Similarly, 0, 30, and 45 t/ha had similar effect on vine length (Figure 5). The fertilizer rates used significantly ($p<0.05$) increased cumulative number of flowers of yellow passion fruit throughout the periods of observation.

Table 1: Agro-Meteorological data for Abeokuta the location of the field experiment (2010-2011).

Months	2010			2011		
	Rainfall (mm)	Mean Temperature (^{O}C)	Sunshine Hours	Rainfall (mm)	Mean Temperature (^{O}C)	Sunshine Hours
January	4.40	28.6	5.3	0.0	26.1	6.2
February	41.2	30.6	6.4	139.8	28.5	6.2
March	58.9	28.3	3.9	23.9	29.2	6.5
April	112.7	27.8	7.0	74.5	29.1	6.5
May	169.6	28.9	7.2	73.7	28.1	6.6
June	98.3	27.4	7.1	84.5	26.9	5.7
July	327.9	25.9	5.5	349.5	25.5	3.8
August	266.6	25.2	4.4	88.7	25.3	3.1
September	257.6	26.7	5.3	204.1	26.7	5.5
October	172.3	27.3	6.2	288.1	26.9	5.0
November	94.7	27.6	6.4	3.6	27.9	6.4
December	0.0	26.8	7.2	0.0	27.0	7.4

Source: Department of Agro-Meteorology and Water Resources Management, Federal University of Agriculture, Abeokuta (FUNAAB).

Table 2: Pre-cropping physico-chemical properties of soil used for the experiments in Abeokuta and Ibadan.

Parameters	Soil (Abeokuta)
pH	6.8
Sand (%)	71.0
Clay (%)	15.4
Silt (%)	13.6
Textural Class	Sandy loam
Ca (me/100g)	3.28
Mg (me/100g)	0.75
Na (me/100g)	0.74
K (me/100g)	0.32
H + Al (me/100g)	0.03
ECEC (me/100g)	5.12
Base SAT. (%)	99.41
C (%)	3.88
N (%)	0.34
Av.P (ppm)	11.10
Cu (mg/kg)	0.47
Zn (mg/kg)	1.44
Fe (mg/kg)	1.80
Mn (mg/kg)	6.65

Table 3: Chemical properties of organic fertilizers used in the experiments.

Parameters	Poultry manure
pH	7.4
Ca (%)	5.33
Mg (%)	0.33
Na (%)	1.00
K (%)	1.34
C (%)	26.83
N (%)	3.41
P (%)	3.12
Cu (mg/kg)	30.80
Zn (mg/kg)	207.00
Fe (mg/kg)	740.00
Mn (mg/kg)	175.00

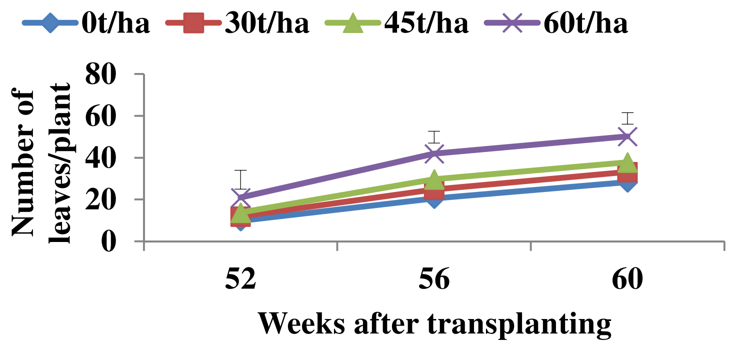

Figure 1: Effect of poultry manure rates on number of leaves of yellow passion fruit. Vertical bars are LSD at ($p<0.05$).

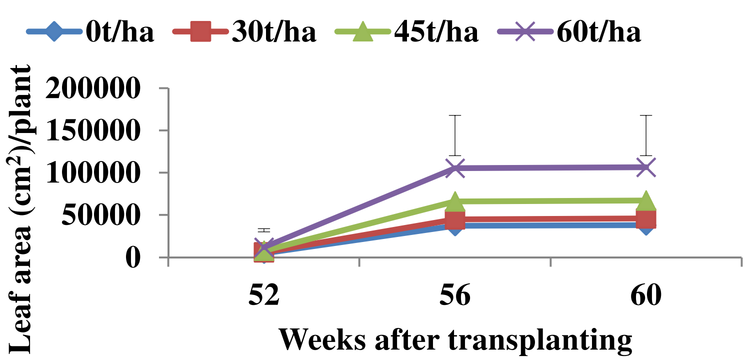

Figure 2: Effect of poultry manure rates on leaf area of yellow passion fruit. Vertical bars are LSD at ($p<0.05$).

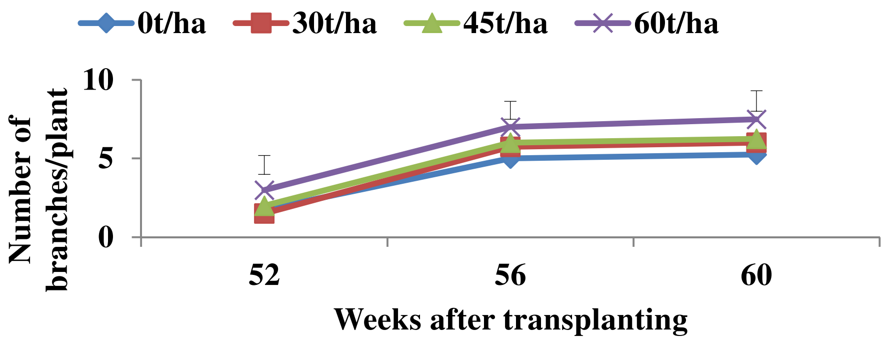

Figure 3: Effect of poultry manure rates on number of branches of yellow passion fruit. Vertical bars are LSD at (p<0.05).

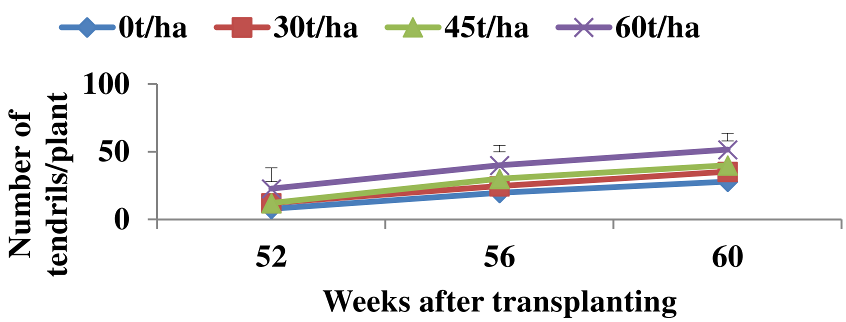

Figure 4: Effect of poultry manure rates on number of tendrils of yellow passion fruit. Vertical bars are LSD at (p<0.05).

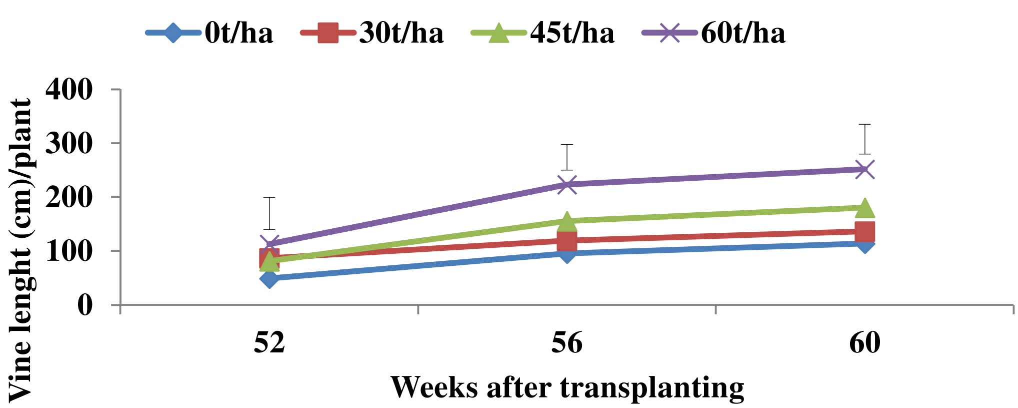

Figure 5: Effect of poultry manure rates on vine length of yellow passion fruit. Vertical bars are LSD at (p<0.05).

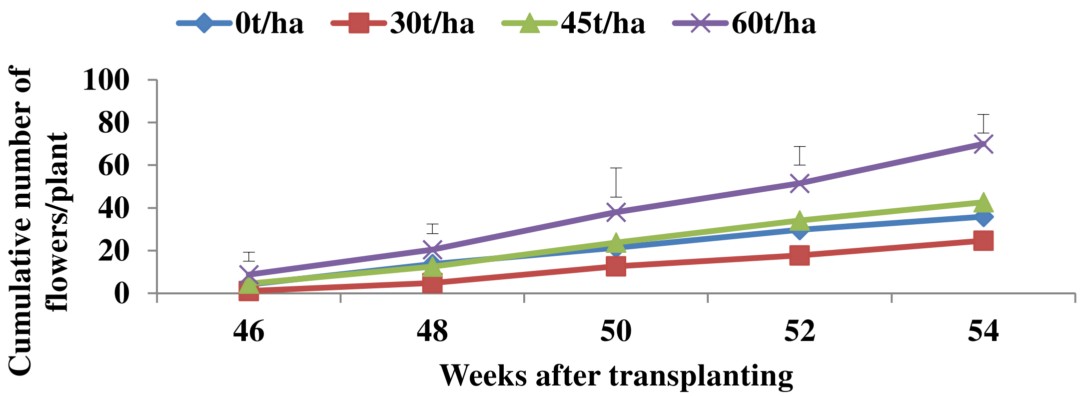

Figure 6: Effect of poultry manure rates on cumulative flower production of yellow passion fruit. Vertical bars are LSD at (p<0.05).

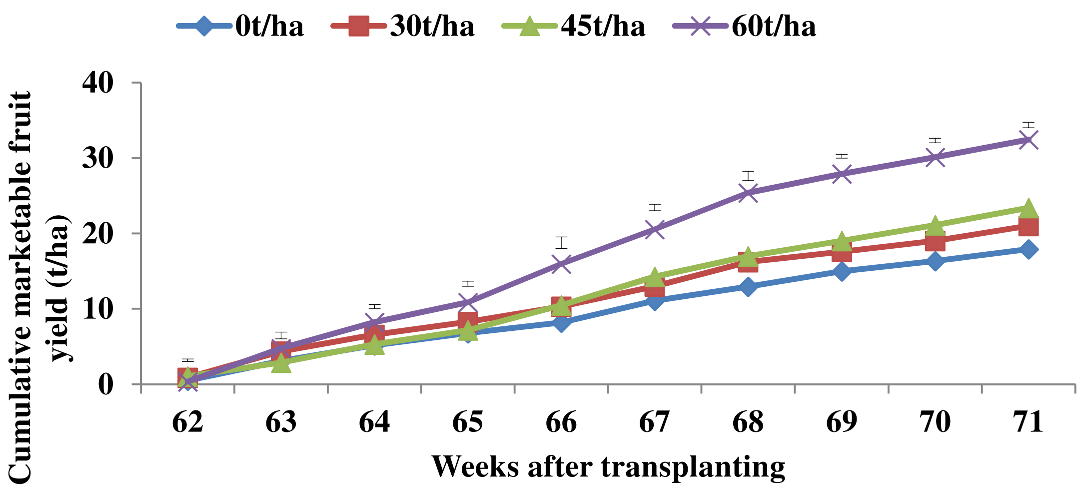

Figure 7: Effect of poultry manure rates on cumulative marketable fruit yield of yellow passion fruit. Vertical bars are LSD at (p<0.05).

Discussion

Passion fruit juice was acidic in nature and the fertilizer rates and control used had similar effect on brix and vitamin A content of the juice. Also, the vitamin C, total solid and ash content were significantly affected by poultry manure (PM). The consistent low values recorded by the control treatment for all the parameters assessed were a confirmation that fertilizer had positive influence on growth of yellow passion fruit. This is in agreement with Aiyelaagbe *et al.*, (2005); Aiyelaagbe and Abiola, (2008); Fagbayide and Joseph-Adekunle, (2002); Abiola, (2007); Abiola and Aiyelaagbe, (2011) findings. Superiority of 60 t/ha of poultry manure applied to passion fruit in field trials confirmed the earlier view that lower rates delivered insufficient amount of nutrient required for growth and development. Based on foliar nutrient content, the major nutrients demanded during the vegetative phase of yellow passion fruit are N, K, and Ca while during the reproductive phase they are P, Ca, Mg, and Fe. This has to be taken into consideration in articulating fertilizer recommendation for the production of organic yellow passion fruit. Besides the absolute amount of nutrients, the nutrient ratio also counts. The 60 t/ha of poultry manure which produced the highest fruit yield gave an N, P, K, Mg, Ca ratio of 2046, 1872, 804, 3198, 198kg/ha respectively. The fact that, organic fertilizers are protected by the binding and absorptive property of organic matter component, leading to a gradual release of nutrients in the soil and to a reduction of nutrient losses could also be responsible (FAO, 2002). This is another possible reason for the enhanced response in the mineralization of P and reduced leaching (loss of N and K) which lead to gradual increased in growth parameters assessed. Passion fruit being a shallow root feeder possibly took advantage of this (Wu and Saise, 1989). Also, response could be due to the postulation by Powell and Valentin (1998) that the nutrient demand of crops and the supply potential of manure are not well marched in terms of N and P; but if sufficient manure is applied to supply the crop N requirements, the P will be sufficient. The yields of passion fruit reported here are similar to those reported by Ferraira *et al*., (1984) but lower from the yield of up to 40t/ha reported by Joy, (2010). The highest cumulative fruit yield (27.0 t/ha) was produced by plants that received 60 t/ha of poultry manure. The plants grown with 60 t/ha were precocious, so they made the best out of the growing season. Their larger leaf area also translated to higher photosynthetic capacity and production of more photosyntates that could be translocated to the reproductive organs. Since passion fruit is a perennial crop, it benefited from the slow rate of nutrient mineralization in poultry manure (FAO, 2002).

Conclusion

Organic fertilizers significantly enhanced the growth and fruit yield of yellow passion fruit. Based on the result of this experiment 60t/ha of poultry manure is optimum for growth and fruit yield of yellow passion fruit in south western Nigeria.

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