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Effects of Different Types and Rates of Micronutrient Application on Growth, Fruit Yield, Nutritional Value and Phytochemical Components of Pawpaw in Ogbomoso

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Abstract
An experiment aimed at investigate the appropriate rates of boron and zinc applications required for optimum fruit yield of pawpaw was carried out at Teaching and Research farm of Ladole Akintola University of Technology, Ogbomoso, Nigeria. The experimental design used was a 2 x 5 factorial experiment in a randomized complete block design and replicated three times. The treatments involved two micro nutrients and five rates of micronutrient which gave ten treatment combinations. The micronutrients were zinc and boron and the rates were 0ml, 10mls, 15mls, 20mls and 25mls in 2021 planting seasons. Seedlings raised in the nursery were transplanted at 12 weeks old. Application of treatments was done at one week after transplanting. These rates were applied to the base of the pawpaw plant according to each treatment combinations. Data collection commenced at point of transplanting and it was carried out at every four weeks interval till twenty four weeks (24 weeks) after transplanting for vegetative growth. At maturity fruits at ripe stages were harvested according to the treatments. Fresh weight of fruits, fruit length and diameter were measured. The fruit qualities were assessed by determining the nutritional composition, mineral physiochemical and phytochemical content of the fruit. Data collected were analyzed by using analysis of variance (ANOVA) by SAS (2009) and significant means were separated using Duncan multiple range test at 5% probability level. The results indicate that boron and zinc had significant effect on the fruit yield, nutritional, and phytochemical properties of pawpaw. Boron gave highest physicochemical analysis (moisture content and pH) while TSS, and Beta carotene were influenced by Zinc application. Mineral elements were also increased by zinc application. It results indicate also that higher quantity of micronutrient produced high quality pawpaw.
Keywords: pawpaw, micronutrients, zinc, boron, nutritional, phytochemical.
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1. Introduction

Pawpaw (*Carica papaya L*) belongs to the family caricaecea. It is a major desert fruit crop in the tropics with different names attributed to it across the continent (Vijay *et al.,* 2014; Taty-sahab *et al.,* 2014). A native of topical America but later introduced to India in the 16th century. Pawpaw is a plant recognized by its weak and unbranched soft stem that produces white latex and crowned by large and long staled leaves that grows up to 20m tall (Vijay *et al.,* 2014).

Papaya has been viewed by scholars to stand out among the most profitable crops that contain beta carotene, protein, starch, vitamins and minerals (Agbowuro, 2013; Anjana, *et al* 2018). Health benefit of papaw includes the absence of cholesterol and low calories. It is a rich source of nutrient such as careteniods, vitamin C, dietary fibre, proteins, total lipid, macro nutrients such as sodium (Na), potassium (K), phosphorus (P) and micro nutrients such as iron (Fe), copper (Cu) and Zinc (Zn). All these varies from ripe to unripe pawpaw (Desmond, 1995; Elmoussaoui *et al.,* 2001.) Pawpaw fruit also contains many B-complex vitamins such as folic acid, pyridoxine (Vitamin B-6), riboflavin and thiamin, good amount of potassium (257mg/100g) and calcium (24mg/100g) (www.nutritionandyou.com, 2009). Pawpaw also has several industrial uses. Biochemically, its leaves and fruits are complex, producing several protein and alkaloids with important pharmaceutical and industrial applications (Elmoussaoui, *et al*., 2001); of these however papain is an important proteolytic enzyme that is produced in the milk latex of green unripe pawpaw fruits. The latex is harvested by scarifying the green skin to induce latex flow which is allowed to dry before collection or processing (Nakasone and Paul, 1999).

Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency (Preethi, *et al*., 2017). These trace elements also play a major role in disease resistance in cultivated crop species. Furthermore, these micro-nutrients also help in uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, hormone synthesis, nitrogen fixation and reduction etc. (Das, 2003). Nevertheless, micronutrients can tremendously boost horticultural crop yield and improve quality and post-harvest life of horticultural produce (Raja, 2009). Hence, micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants.

In spite of these important, there is dearth of information on the effect micronutrients in pawpaw production. Also, as papaya grows and sets flowers and fruits continuously, there is a need to generate information regarding requirement of quantity of micronutrient require for proper fruit yield. Hence there is a need determine the appropriate type and rate of micronutrients required for optimum fruit yield and quality of pawpaw

2. Materials and methods

An experiment aimed at investigate the appropriate rates of boron and zinc applications required for optimum fruit yield of pawpaw was carried out at Teaching and Research farm of Ladole Akintola University of Technology, Ogbomoso, Nigeria. The experimental design used was a 2 x 5 factorial experiment in a randomized complete block design and replicated three times.

The treatments involved two micro nutrients and five rates of micronutrient which gave ten treatment combinations. The micronutrients were zinc and boron and the rates were 0ml, 10mls, 15mls, 20mls and 25mls.

Seedlings raised in the nursery were transplanted at 12 weeks old. Holes were dug at a depth of 45cm prior to transplanting to accommodate the seedling with ball of earth. The polythene bags were torn off at the bottom before placing inside the hole, transplanted seedlings were covered firmly with soil, and water was applied lightly.

Application of treatments was done at one week after transplanting using calibrated syringe to apply different rates of micronutrients. These rates were applied to the base of the pawpaw plant according to each treatment.

Data collection commenced at point of transplanting and it was carried out at every four weeks interval till twenty four weeks (24 weeks) after transplanting for vegetative growth. The parameters taken were:

Plant height**:** This parameter was collected by using a flexible tape rule to measure the height of the plant in centimeter (cm)

Stem Girth**:** This parameter was also collected by using a flexible tape rule to measure the circumference of the plant in centimeter (cm)

Number of leaves/plant**:** This was done by counting the number of leaves per plant and recorded.

Matured fruits at ripe stages were harvested according to the treatments. Fresh weight of fruits obtained taking using a Camry manual scale. Fruit diameter and diameter were measured using measuring tape

Ripe fruits were harvested per stand based on treatment applications to give total number of fruits. Three plants were tagged randomly from each treatment to determine average number of fruits. Nutritional composition of the fruits were accessed by determining, the presence of elements such as Na^+, Mg $^+$, Vit. C, Ca^+, Fe^{2+} , K+, Available P was determined by venadomolybdate yellow calometric method, C^+ and K^+ were determined by atomic spectrometric method. Also the following nutritional and phytochemical were determine moisture content, TTA, TSS, reducing sugar, beta-carotene, lycopene, alkaloids, saponin, tannins, phenol and flavonoids.

Data collected were analyzed by using analysis of variance (ANOVA) by SAS (2009) and significant means were separated using Duncan multiple range test at 5% probability level.

3. Results

The effect of two types of micronutrients application had significant effect on pawpaw plant height throughout the experimental period (Table 1). The highest plant height was observed in boron application from 4WAT – 24WAT (ranging from 39.03cm, 56.74cm; 64.52cm; 71.59cm, 82.02cm, and 91.83cm) respectively, while least plant height of (33.65cm, 56.05cm, 59.62cm, 66.12cm, 75.93cm and 83.69cm) were recorded in plants that received zinc application. The values were significantly different at $p \leq 0.05$.

The effect of the rates of application was only significant ($p \leq 0.05$) at 12WAT and 16WAT. At 12 weeks the rate of application of 15mls produced tallest plant of 64.63cm which was significantly different ($p \leq 0.05$) from shortest plant height of 58.06cm, recorded at no application of micronutrient. At 16WAT, tallest plant was recorded at 25mls of application of micronutrient (71.81cm), this was significantly different ($p \leq 0.05$) from shortest plant (64.06cm) at no micronutrient application.

There were increases in stem girths of pawpaw from 4WAT – 24WAT, although significant differences ($p \leq 0.05$) were observed from 4WAT – 8WAT, for both micronutrient types (boron and zinc). Boron gave highest stem girth of 5.06cm at 4WAT and 8.45cm at 8WAT. These values were significantly different ($p \leq 0.05$) from least value observed for zinc at 4.3cm (4WAT) and 7.63cm (8WAT) (Table 2).

Micronutrient rates had significant effect ($p \leq 0.05$) in stem girth from 8WAT – 24WAT. At 8WAT, the highest stem girth value of 8.5cm was observed at 15mls of application of micronutrient while least value of stem girth of 7.4cm was observed for plant that was not treated with micronutrients. The highest stem girth of 10.75cm (12WAT), 11.83cm (16WAT), 12.86cm (20WAT) and 15.12cm (24WAT) were observed at 25mls of application of micronutrients, these values were significantly different ($p \leq 0.05$) from the least value recorded at 9.5cm (12 WAT), 10.66cm (16 WAT) 11.62cm (20WAT) and 12.93cm (24WAT) (Table 2).

The effect of types and rate of micronutrient was not significant ($p \leq 0.05$) for number of number of leaves/plant throughout the experiment. (Table 3)

Boron produced the highest total number of fruit (38) while least total number of fruit (31) was obtained from pawpaw treated with zinc application. The highest value for total fruit weight (40.65kg), total fruit diameter(1627.33cm), total fruit length (834.71cm), average number of fruit (13), average fruit diameter (40.4cm) and average fruit length, (20.24cm) were observed for boron application, and the values were significantly different ($p \leq 0.05$) from the least values produced by zinc application. Average fruit weight (1.01kg) produced by Boron application was highest but not significantly different ($p \leq 0.05$) from (0.93kg) produced by zinc application (Table 4). The highest total numbers of fruits (41.3) were observed from plots where no micronutrient was applied while least value of total number of fruits (36) was observed at 25mls of application of micronutrients. Total fruit weight was highest at 25ml of application (41.60kg), this was not significantly different ($p \leq 0.05$) from the value of 10mls and 20mls. Total fruit length was highest at 20mls of application (894.53cm) while control gave 818.1cm. There were no significant differences ($p \leq 0.05$) between these two rates however the least value of Total fruit length gave 399.5cm which was significantly different ($p \leq 0.05$). The highest AVNF was observed at 20mls (15) while control gave14 fruits, the two rates were not significantly different ($p \leq 0.05$) from each other but different from the least value of average number of fruits produced at 15mls of application. Average fruit weight (1.24kg) was highest at 25mls of application, this was significantly different from the least average fruit weight (0.74kg) observed in plots where no micronutrient was applied.

Total Soluble Solid (TSS) which gave higher values for fruits treated with zinc (0.472g/100ml) and least values of TSS in boron (0.448g/100ml), were significantly different ($p \leq 0.05$)Table 5. Application of micronutrients types had no significant difference ($p \leq 0.05$) in lycopene while the application of micronutrient had significant effect on reducing sugar and beta carotene. Application of zinc gave higher Beta-carotene level of (0.705mg/100g) which was significantly different ($p \leq 0.05$) from boron application that had least value of β-carotene (0.444mg/100g) Table 5. The highest moisture content (86.35%) was recorded on plot where no micronutrient was applied while least moisture content of 84.74% was observed at 20mls application level. pH of pawpaw fruit was 6.5 on plots with no application of micronutrients while the pH of 6.2 was observed at 25mls of micronutrient application, which significantly different ($p \leq 0.05$). TTA (0.57g/100ml) was highest in fruits collected from plots that received no application of micronutrient, this was significantly different ($p \leq 0.05$) from the least value observed 10mls application of micronutrient. The highest TSS (0.52g/100ml) at 20mls of application was significantly different ($p \leq 0.05$) from the least value of TSS (0.42g/100ml) observed at 25ml of application. Micronutrient rate applied at 25mls/plant gave highest reducing sugar (39.66 g/100g) while least value was obtained from 20mls of application (23.66g/100g). Highest lycopene was obtained at 20mls of application at (0.58mg/100g), this value is significantly different ($p \leq 0.05$)from the least value (0.24mg/100g) that was observed at 10mls of application, however this value was not significantly different ($p \leq 0.05$) from other rates at 0, 15mls and 25mls with values of 0.30mg/100g, 0.33mg/100g and 0.33mg/100g respectively. The highest beta-carotene was observed at 20mls of application (0.74mg/100g), this was not significantly different ($p \leq 0.05$) from 25ml of micronutrient application (0.70mg/100g) but these two values were significantly different from the least value beta-carotene of 0.44mg/100g observed at 15mls of application (Table 5).

Significant differences were observed in the phyto-nutrients present in pawpaw fruits that were treated with Boron and Zinc. Highest amount of Saponin (30.56mg/100g) was recorded when zinc was applied, while least quantity of (24.1mg/100g) was recorded for boron application. These two rates were significantly different at $p \leq 0.05$. Tanin and flavonoid were highest at (3.32mg/100g) and (76.4mg/100g) respectively when boron was applied, these two were significantly different from least quantities of Tanin and flavonoid recorded for zinc application at (2.90 mg/100g) and (72.23mg/100g). However, phenolic (39.43mg/100g) and alkanoid (43.50mg/100g) were highest in fruits treated with Zn and significantly different from the least values of the same phyto-nutrients recorded at boron application as these two types of phyto-nutrients had least values of (30.1mg/100g) and (42.92mg/100g) Table 6 The highest Saponin (31.91mg/100g) was observed at 25mls of micronutrient application (Boron and Zinc), this rate was significantly different ($p \leq 0.05$) from the least value that was observed at 10mls of application rate. Tanin (4.60 mg/100g) was highest in fruits where no application of micronutrient was carried out. This was significantly different ($p \leq 0.05$) from the least value of tannin (1.8mg/100g) at 25mls of micronutrient application. The highest value of flavonoid (90.66mg/100g) was observed at 20mls of application of micronutrients (Boron and Zinc) while least value observed at 25mls of application was 35.2mg/100g, these two values were significantly different ($p \leq 0.05$). 20mls of micronutrient of Boron and Zinc application gave the highest value for phenolic (41.7mg/100g), this was significantly different ($p \leq 0.05$) from the least rate observed at 15mls application (27.9mg/100g). The Alkanoids in fruits had 20mls of application of Boron and Zinc with the highest value of 43.53mg/100g, this was significantly different ($p \leq 0.05$) from the least value of 41.52mg/100g at 15ml rate of application (Table 6)

The value of sodium was highest in fruits treated with Boron at (3.33ppm) while the least value (2.82) was observed in fruits treated with zinc, which were significantly different ($p \leq 0.05$). There was no significant difference ($p \leq 0.05$) between the value of potassium (K) present in pawpaw fruits treated with Boron (26.4ppm) Zinc (26.43ppm). the value of calcium was highest (9.28ppm) in fruits treated with zinc which was significantly different ($p \leq 0.05$) from least vale observed for b boron (8.96ppm), likewise magnesium (6.36ppm) value was higher when zinc was applied which was significantly different ($p \leq 0.05$) from boron application (6.200ppm).(Table 7) There was significant different in the highest value of sodium (Na) (4.36ppm) at 10mls of application of micronutrients while least value of sodium (2.61ppm) was observed at 15mls of application of micronutrients. Potassium was highest at 10mls of application of micronutrient (27.82ppm) while least value was recorded at 25mls of micronutrients application (25.66ppm). Calcium was highest at no application of micronutrient (10.25ppm) while least amount of calcium was observed at 25mls of application rate (8.57ppm). The two rates were significantly different from one another. The highest amount of magnesium (Mg) (6.46ppm) was observed at 20mls, this was not significantly different ($p \leq 0.05$) from other rates of application however, these values were significantly different ($p \leq 0.05$) from the least value observed for magnesium at 10mls (6.02ppm) (Table 35).

4. Discussion

Application of nutrients (Boron and Zinc) to pawpaw seedlings had no significant effects on vegetative growth of pawpaw seedlings. Agbowuro (2013) reported that were there was no significant differences in the treatment effect of using boron and zinc fertilizers on plant height, number of leaves per plant and leaf area. This result also confirmed the earlier findings of Preethi *et al*., (2017) when he treated pawpaw seedlings with application of zinc, boron, and iron to determine the effect on red lady cultivar of pawpaw, the result revealed that there were no significant difference in plant height, stem girth and number of leaves produced after 8 months after transplanting.

An increase in total fruit weight recorded at 25mls of application may be attributed to function of micronutrients in playing a pivotal role in flowering and development of plants and they are directly involved in the process of photosynthesis which means there may not be a possibility of increasing yield (Tamboli *et al*., 2015).

Pawpaw fruits contain highest percentage of water in the pulp that is why result showed that moisture content of pawpaw is the highest physicochemical properties of pawpaw (Daagema *et al*., 2020). An evaluation of nutritional component of pawpaw at different stages of ripening revealed that pulp of unripe mature 81.39% moisture content, hard ripe 86.68% and very ripe 89.21% Chukuka and Ufere 2013, this report was in line with the result of the experiment that gave 85.95% Boron and 83.89% Zinc. Highest moisture content of pawpaw was recorded at control level, this was also in line with the finding of Ahuja *et al* (2008), QECD (2010), Olanrewaju (2012) also reported 100g edible portion of fresh and ripe pawpaw fruits contains approximately 88% water.

There is a variation in the amount of physicochemical properties of pawpaw based on the two types of micro-nutrients application. TTA content was highest in boron application, and significantly different from the least quantity that was present in Zinc application, the figure was synonymous to non-application of micronutrient in guava Rajkumar and Shant (2014). They reported that Zinc sulphate and borax acid or iron combination increased the quality of guava fruits, this was also in conformity with the work of Rajput and Chand (1976) in guava, boron is reported to be responsible for the improvement of fruit quality as reported in this present work with pawpaw this was also in accordance with the findings of several workers (Kumar and Satyabhishan, 1980) in grapes.

TSS and reducing sugar present in pawpaw treated with zinc and boron is in line with the findings of RajKumar and Shant (2014), where he reported combinations of $ZnSO_4$ and boric acid at 1% each to have shown a positive effect on TSS (12.99%) TSS 9.87%, reducing sugar 5.93% and NRS 3.94% in guava. Higher rate of reducing sugar in pawpaw treated with Boron is an evidence of boron participation in sugar translocation in higher plants. They reported that boron have the ability to make complexity with sugars (sugar bivate complex), this facilitated the transport of sugar in plants. Deficiency of Boron is observed to result in changes in starch and sugars in many plants.

However zinc act as a catalyst in the oxidation and reduction process and has great importance in sugar metabolism RajKumar *et al*., (2014). Highest TTA was recorded in untreated trees of pawpaw, this was significantly different from other rates of micronutrient application. TSS was highest at 20mls of application, this was significantly different from other levels.

According to the results of the experiments, some phytonutrients determined (saponin, tannin, flavoid, phenolic and alkanoid), were significantly different based on the two types of micro-nutrients used. Tanin and flavonoid are higher with boron application while zinc exhibited a characteristic of producing higher quantity saponin, phenolic, and alkaloid.

An increase in micronutrient rate of application increased saponin, this was observed at 25ml of application, 20mls produced highest quantity of flavonoid, and phenolic, the control rate of micronutrient produced highest tannin and alkaloid these values were greater than results of Chukwuika and Ufere (2013) on an evaluation of nutritional components of *Carica papaya* at different stages of ripening. The variation in level of phytochemicals produced as against the rate of micronutrient can be ascribed to the function of micronutrients in acting as an enzyme or precursor in the production of phytochemicals present in pawpaw fruit.

Mineral composition of pawpaw fruits treated with Boron and Zinc are lower than those reported by Anitha *et al* (2018) , this was contrary to the result of the experiment where (Mg) was higher in quantity and others were lower, the variation could be as a result of varietal differences in the types of pawpaw analyzed. It is believed that different varieties of pawpaw may likely contain varying degree of mineral elements and also time of collection of fruits, can also be factor to the reduced quality of mineral elements.

Phosphorus was highest at 20mls of application, this is in line with report of Chukwuka and Ufere (2013) who in an experiment to evaluate mineral component of pawpaw at different stages of ripening, a very ripe pawpaw has higher values of P than unripe pawpaw. The results of the research recorded the highest P at 20mls of both B and Zn however there is significant interaction between types and rate of micronutrient.

5. Conclusion

It was concluded that zinc and boron had no significant effect on the vegetative growth but had significant on fruit yield, nutritional, fruit quality and phytochemical component of pawpaw and 20ml of seem appropriate for the production of pawpaw in Ogbomoso.

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Table 1: **Effect of micronutrients on plant height of pawpaw**

	4WAT	8WAT	12WAT	16WAT	20WAT	24WAT
Types (T)						
Boron	39.03 ^{A}	56.74 ^{A}	64.52 ^{A}	71.59 ^{A}	82.02 ^{A}	91.83 ^{A}
Zinc	33.65^{A}	56.05 ^{A}	59.62 ^{A}	66.12 ^{A}	75.93 ^{A}	83.69 ^{A}
Rates (R)						
0ml	36.41^{A}	52.01 ^{A}	58.06 ^{B}	64.06 ^{B}	75.60 ^{A}	80.43 ^{B}
10mls	36.97 ^{A}	53.57 ^{A}	63.34 ^{AB}	69.44 ^{AB}	79.26 ^{A}	89.47 ^{A}
15mls	36.54 ^{A}	56.83 ^{A}	64.63 ^{A}	70.98 ^{A}	81.47 ^{A}	90.84 ^{A}
20mls	35.27 ^{A}	55.36 ^{A}	60.54 ^{AB}	67.97 ^{AB}	78.10 ^{A}	88.62 ^{A}
25mls	36.49 ^{A}	89.21 ^{A}	63.47 ^{AB}	71.81 ^{A}	80.49 ^{A}	89.49 ^{A}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 2: Effect of micronutrients on stem girth of pawpaw

	4WAT	8WAT	12WAT	16WAT	20WAT	24WAT
Types (T)						
Boron	5.06 ^{A}	8.45 ^{A}	10.39 ^{A}	11.35 ^{A}	12.50 ^{A}	14.52 ^{A}
Zinc	4.30 ^{A}	7.63 ^{A}	9.99 ^{A}	11.25 ^{A}	12.53 ^{A}	14.54 ^{A}
Rates (R)						
0ml	4.80 ^{A}	7.40 ^{B}	9.50 ^{A}	10.66 ^{A}	11.62 ^{A}	12.93 ^{A}
10mls	4.92 ^{A}	8.25 ^{AB}	10.19 ^{AB}	11.28 ^{AB}	12.66 ^{AB}	14.69 ^{A}
15mls	4.53 ^{A}	8.50 ^{AB}	10.22 ^{AB}	11.30 ^{AB}	12.70 ^{A}	14.95 ^{A}
20mls	4.36 ^{A}	8.00 ^{AB}	10.26 ^{AB}	11.35 ^{A}	12.75 ^{A}	14.94 ^{A}
25mls	4.70 ^{A}	7.97 ^{AB}	10.75 ^{A}	11.83 ^{A}	12.86 ^{A}	15.12 ^{A}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 3: Effect of micronutrients on number of leaves/plant of pawpaw

	4WAT	8WAT	12WAT	16WAT	20WAT	24WAT
Types (T)						
Boron	12.9^{A}	15.0 ^{A}	17.4 ^{A}	19.7 ^{A}	21.4 ^{A}	23.9 ^{A}
Zinc	12.5 ^{A}	14.9 ^{A}	17.3 ^{A}	19.6 ^{A}	21.0 ^{A}	23.4 ^{A}
Rates (R)						
0ml	13.00 ^{A}	15.08 ^{A}	17.25 ^{A}	19.41 ^{A}	21.16 ^{A}	23.83 ^{A}
10mls	12.50 ^{A}	14.25 ^{A}	16.75 ^{A}	19.08 ^{A}	20.75 ^{A}	23.00 ^{A}
15mls	12.75 ^{A}	15.41 ^{A}	17.50 ^{A}	19.66 ^{A}	21.25 ^{A}	23.50 ^{A}
20mls	13.08 ^{A}	15.50 ^{A}	18.00 ^{A}	20.41 ^{A}	22.0 ^{A}	24.41 ^{A}
25mls	12.25 ^{A}	14.66 ^{A}	17.25 ^{A}	19.75 ^{A}	21.08 ^{A}	23.33 ^{A}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 4: Effect of micronutrients on fruit yield of pawpaw

	TNF	TFW	TFDM	TFL	AVNF	AVFW	AVFDM	AVFL
Types (T)								
Boron	38.00 ^{A}	40.65 ^{A}	1627.33 ^{A}	834.71 ^{A}	13.16 ^{A}	1.01 ^{A}	40.39 ^{A}	20.24 ^{A}
Zinc	31.30 ^{B}	28.39 ^{B}	1144.62 ^{B}	631.96 ^{B}	10.43 ^{B}	0.93 ^{A}	36.51 ^{B}	19.90 ^{B}
Rates (R)								
0ml	41.25 ^{A}	31.58 ^{B}	1516.0 ^{B}	818.05 ^{AB}	13.92 ^{AB}	0.744 ^{C}	39.93 ^{A}	19.18 ^{A}
10mls	39.0 ^{B}	40.01 ^{A}	1457.93 ^{B}	800.70 ^{B}	12.17 ^{B}	0.983 ^{B}	37.26 ^{A}	20.23 ^{A}
15mls	20.25 ^{E}	18.41 ^{C}	767.95 ^{C}	399.50 ^{C}	6.75 ^{C}	0.908 ^{B}	38.30 ^{A}	19.80 ^{A}
20mls	37.25 ^{C}	41.01 ^{A}	1810.7 ^{A}	894.53 ^{A}	14.50 ^{A}	0.954 ^{B}	41.76 ^{A}	19.72 ^{A}
25mls	35.50 ^{D}	41.60 ^{A}	1377.95 ^{B}	753.90 ^{B}	11.66 ^{B}	1.235 ^{A}	38.99 ^{A}	21.16 ^{A}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 5: Effect of micronutrients on physico- chemical properties of pawpaw

	MC %	pH	TTA g/100ml	TSS g/100ml	Red- Sugar g/100g	Lycopene mg/100ml	β-Caro g/100ml
Types (T)							
Boron	86.95^{A}	6.34A	0.312^{A}	0.448^{B}	27.52^{B}	0.344^{A}	0.444^{B}
Zinc	83.89^{A}	6.23B	0.158^{B}	0.472^{A}	0.325^{A}	0.705^{A}	0.705^{A}
Rates (R)							
0ml	86.35^{A}	6.45^{A}	0.57^{A}	0.45^{C}	28.33^{D}	0.30^{B}	0.46^{B}
10mls	84.87^{B}	6.30^{B}	0.10^{B}	0.46^{B}	31.49^{C}	0.24^{B}	0.51^{B}
15mls	85.73^{AB}	6.31^{B}	0.16^{B}	0.43^{D}	34.73^{B}	0.33^{B}	0.44^{B}
20mls	84.78^{B}	6.20^{BC}	0.18^{B}	0.52^{A}	23.66^{E}	0.58^{A}	0.74^{A}
25mls	85.33^{AB}	6.18^{C}	0.15^{B}	0.42^{D}	39.66^{A}	0.33^{B}	0.70^{A}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 6: Effect of micronutrients on phyto nutrient of pawpaw in mg/100g

	Saponin	Tanin	Flavonoid	Phenolic	Alkanoid
Types (T)					
Boron	24.08^{B}	3.319A	76.35^{A}	30.07^{B}	42.92^{B}
Zinc	30.56^{A}	2.893^{B}	72.23^{B}	39.43^{A}	43.50^{A}
Rates (R)					
0ml	29.16^{C}	4.59^{A}	83.31^{C}	35.02^{C}	41.19^{D}
10mls	19.82^{E}	2.61^{D}	85.21^{B}	31.02^{D}	43.39^{B}
15mls	25.58^{D}	3.37^{B}	77.12^{D}	27.87^{E}	41.52^{C}
20mls	30.11^{B}	3.02^{C}	90.66^{A}	41.65^{A}	43.53^{A}
25mls	31.91^{A}	1.79^{E}	31.15^{E}	37.79^{B}	43.40^{B}

Means in the column with different superscripts are significantly different at $P<0.05$.

Table 7 : Effect of micronutrients on mineral elements of pawpaw in ppm

	Na	K	Ca	Mg	Fe	P
Types (T)						
Boron	3.33^{A}	26.36^{A}	8.96^{B}	6.20^{B}	1.070^{A}	3.59^{A}
Zinc	2.82^{B}	26.43^{A}	9.28^{A}	6.36^{A}	1.073^{A}	3.54^{A}
Rates (R)						
0ml	2.91^{B}	26.44^{B}	10.25^{A}	6.35^{A}	0.95^{BC}	3.66^{A}
10mls	4.36^{A}	27.82^{A}	9.03^{B}	6.02^{B}	0.83^{C}	3.34^{B}
15mls	2.61^{B}	26.17^{BC}	8.95^{B}	6.30^{A}	1.19^{AB}	3.56^{AB}
20mls	2.66^{B}	25.87^{BC}	8.79^{BC}	6.46^{A}	1.29^{AB}	3.70^{AB}
25mls	2.81^{B}	25.66^{C}	8.57^{C}	6.28^{A}	1.07^{ABC}	3.56^{AB}

Means in the column with different superscripts are significantly different at $P<0.05$.