

Effect of Different Fermented Fruit Juices as Foliar spray on the Growth and Yield of Maize (*Zea mays* L.)

Aye Aye Thwe¹

Abstract

In order to study the effect of different types of fermented fruit juices as a foliar spray on the growth and yield of maize (*Zea mays* L.) were conducted at Vegetables and Fruits Research Development Center (VFRDC), Hlegu Township, Yangon Division from January 2017 to May 2018. Fermented fruit juices made from a combination of different kinds of ripe fruits. The fruits were collected from North Dagon (Myothit) market. All of these fruits were unmarketable. The fruits were prepared for fermented fruits juices. Three types of fermented fruit juices (FFJ) were prepared from Grape + Persimmon + Pear (GP + PSM + PR), Apple + Orange + Pineapple (AP + OG + PA) and Papaya + Watermelon + Banana (PPY + WM + BNN). The experiment was laid out in Randomized complete block design (RCBD) with four treatments. The four treatments were T₁ (Grape + Persimmon + Pear), T₂ (Apple + Orange + Pineapple), T₃ (Papaya + Watermelon + Banana) and T₀ control (water only). The amount of fermented fruit juice (FFJ) foliar spray was 9ml / L each treatment. Among the treatment T₃ (Papaya + Watermelon + Banana) was the best performance of cob quality and yield.

Keywords: Fermented Fruit Juices, FFJ, Foliar spray

Introduction

Maize (*Zea mays* L.) is a grain crop belonging to the grass family Poaceae (Paliwal, 2000) and it originated from the domestication of the wild grass teosinte (*Zea mexicana*), which is native Mexico. (IITA & CIMMYT, 2007). Maize is the third most important crop in the world, after rice and wheat. It is one of the most important crops in the tropical and subtropical regions of the world (Harris *et al.*, 2007).

Maize grain has greater nutritional value as it contains 72 % starch, 10 % protein, 4.8 % oil, 8.5 % fiber, 3.0 % sugar and 1.7 % ash (Hauque, 2003). Maize grain is extensively used for the preparation cake, lactic acid and acetone which are used by various industries such as textile, foundry, fermentation and food industries. In developed countries, maize is consumed mainly as second-cycle produce, in the form of meat, eggs and dairy products. In developing countries, maize is consumed directly and serves as a staple diet for some 20 million people. Most people regard maize as breakfast (Miracle, 1988).

Fermented fruit juice is a nutritional activation enzyme and is very effective in natural farming. It is used to revitalize crops, livestock and humans. As the main fruit ingredients, banana, papaya, mango, grape, melon, apple etc. can be used. Fermented fruit juice (FFJ) can be used to increase the fruiting process of plants as well as to increase yield. It can be used as a foliar spray as well as an indirect application to the soil, where it feeds the microbiome and increases soil health (Reickenberg and Pritts, 1998).

Fermented fruit juice (FFJ) is used as foliar Fertilizer, to increase and improve the yield and quality of the maize. The foliar application becomes promptly available

¹ Lecturer, Dr., Department of Botany, Dagon University

to the crops because the form of nutrient application is better than direct fertilization (Naz *et al.*, 2011).

Application of foliar fertilizer is an effective way of correcting soil nutrient deficiencies when plants are unable to absorb them directly from the soil (Liang and Silberbush, 2002).

Foliar applied fertilizers provide a quicker response and are more effective for some nutrients than soil applied fertilizers (Reickenberg and Pritts, 1996; Jamal *et al.*, 2006).

Materials and Methods

Experiment Site and Treatments

This experiment was conducted at the Vegetable and Fruit Research and Development Center, Hlegu Township from September to December 2017. Maize variety used in this experiment was 702; a commercial sweet corn variety from Agro International Co. Ltd. Randomized complete block design with four replicates was used in this experiment. Soil type at the field site has been classified as loamy-sand. Treatments in this experiment were 4 in total; three different kinds of fermented fruit juices (FFJ) and water spray were used as control. These FFJs were prepared for 2 months before this experiment.

These three FFJs were

(T₁) Grape + Persimmon + Pear

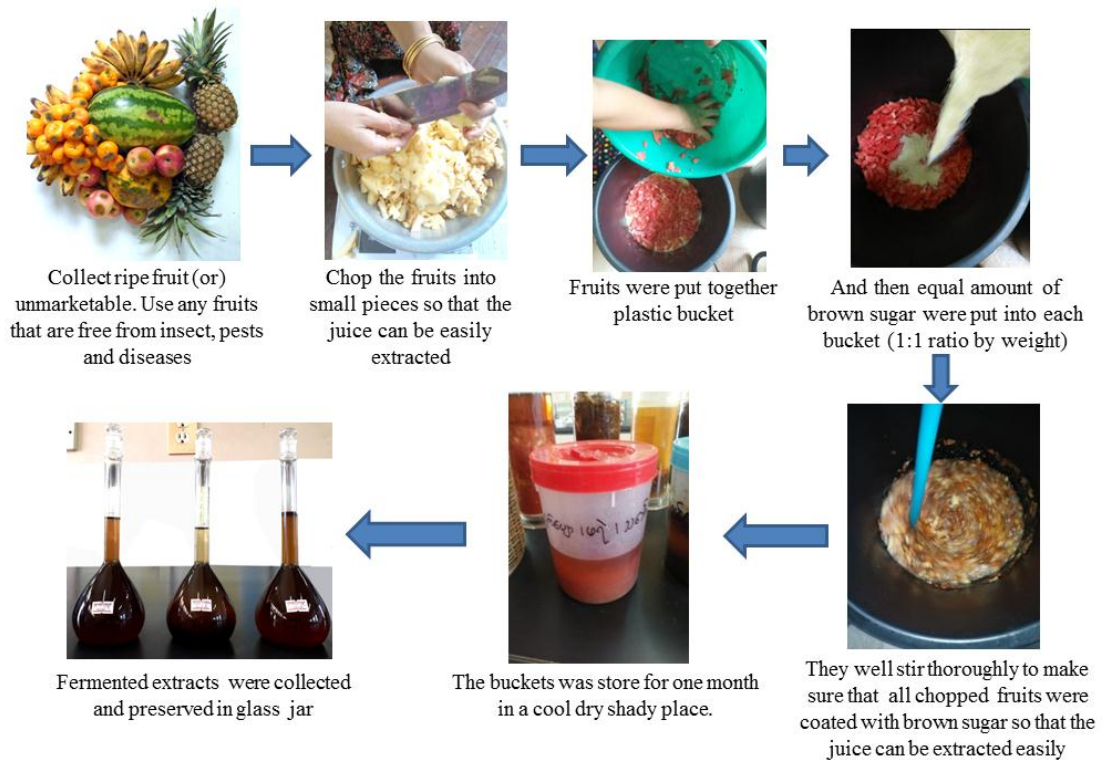
(T₂) Apple + Orange + Pineapple

(T₃) Papaya + Watermelon + Banana

Preparation of Fermented Fruit Juice (FFJ)

Collect the nine different kinds of ripe fruits. And then, three different kinds of fruits were chopped into 3.5 cm small pieces in order to extract the juice easily. The chopped materials of the (3) respective fruits were put together in a plastic bucket according to the predetermined combination. And then an equal amount of brown sugar was put into each bucket (1:1 ratio by weight) and they were mixed thoroughly to make sure that all chopped materials were coated with brown sugar so that the juice can be extracted easily. The remaining six different kinds of ripe fruits were made the same manner. All (3) buckets were covered with paper and secured with a string. The buckets were stored for one month in a cool dry shady place. Three kinds of fermented extracts were collected after one month and preserved in dark colored glass jar for further use.

Steps in Making Fermented Fruit Juice (FFJ)



Land Preparation and Seedling Production

A basal dose of well-decomposed chicken manure was incorporated into the topsoil at the rate of 2 ton ac⁻¹, shortly prior to planting. Lime at the rate of 100 kg ac⁻¹ was incorporated into the soil during soil preparation. Plot size was 4 m x 4.5 m (18 square meters) with 90 cm spacing of between rows and 30 cm between plants. Seeds were firstly germinated in the germination tray and the plantlets were transplanted into the field at 10 days after emergence. Irrigation was done daily until one month after transplanting and it continued with 2 days intervals. Hand weeding was done weekly until two weeks before harvest. All treatments were applied with 10 days intervals since the maize plants were one month old after sowing until harvest at the rate of 9ml / 1L of (T₀ control) Water, (T₁)FFJ; Grape + Persimmon + Pear, (T₂) FFJ; Apple + Orange + Pineapple and (T₃) FFJ; Papaya + Watermelon + Banana.

Data Collection

The data were collected at the final harvest. Twenty plants from each plot were harvested from each treatment and the data were recorded for the following characters. Plant height, Number of leaves/plant, length of internodes between second and third leaves, SPAD chlorophyll meter reading (SCMR), Relative water content (%), ear length, ear perimeter, ear weight, cod length, cod perimeter, cod weight, number of row/cod, number of seed/row, 100 seed weight, sweetness (°Brix) and cod yield (ton/acre). Relative water content (RWC) was used to evaluate plant water status and it was measured at harvest. It was measured at the second top leaf of 5 plants for each plot at 10:00-12:00 am (Clavel *et al.*, 2006; Girdthai *et al.*, 2010). Leaf discs of 2.5 x 2.5 cm² were cut from the central area of the leaves avoiding the midribs. These five leaf discs were put into a vial with a rubber stopper and the vial was sealed with parafilm. The vials were suddenly kept inside the icebox to prevent moisture loss. After measuring the field weights, the leaf discs were soaked in the distilled water for 8 hours and turgid weights were determined again. Then, these leaf discs were dried

in an oven at 80°C for 48 hours or until the dry weight became constant. Finally, RWC was determined as follows: $RWC (\%) = [(FW-DW) / (TW-DW)] \times 100$, Where, FW is sample field weight, TW is sample turgid weight (saturated weight) and DW is sample dry weight.

Statistical Analysis

The data were subjected for analysis of variance according to an RCBD design and all calculation was performed using Duncan's multiple range tests (DMRT).

Results

Growth Parameters

The growth parameters of each treatment are represented in Table. 1. The result of the field experimented fruit juice (FFJ) as a foliar spray on maize plants had significantly affected in vegetative growth. The plant growth parameter of maize as shown by plant height, Number of leaves, length of internodes, chlorophyll content and relative water. The finding showed that T₃ (PPY + WM + BNN) gave the best plant growth followed by T₁ (GP + PSM + PR). However, the lowest value was obtained from control plants (water). The result of statistical analysis. Indicated that all the T₃ (PPY + WM + BNN) treated plants were significant difference $P < 0.05$ in growth characters.

Plant Height

The results showed that Fermented Fruit Juice (FFJ) has a significant effect on plant height. The result of the highest plant height - 235.03 cm occurred in T₁ (Grape + Persimmon + Pear) treated plants followed by 231.95 cm in T₃ (Papaya + watermelon + Banana). In contract to the shorted in plant height, 218.27 cm obtained in control (water) plants. It can be noted that all the treated plants were significantly similar to one another but significantly different at 5% level DMRT from the T₀ (water).

Number of Leaves

The results of the experiment indicated that the maximum number of leaves 12.52 in T₃ (Papaya + Watermelon + Banana) and followed by T₁ (Grape + Persimmon + Pear) 11.92 cm and T₂ (Apple + Orange + Pineapple) obtained 11.77 cm. There was no significant difference on all the treatments.

Length of Internodes

The longest length of the internode 19.82 cm T₁ (Grape + Persimmon + Pear) treated plants and the shorted length of the internode in T₀ (Water) had 19.00 cm. There was no significant difference in all the treatments.

SPAD Chlorophyll Meter Reading (SCMR)

According to SPAD chlorophyll meter reading, the highest chlorophyll content was observed in T₃ (Papaya + Watermelon + Banana) 53.75 followed by T₁ (Grape + Persimmon + Pear) 50.85 and T₂ (Apple + Orange + Pineapple), 50.26. The lowest content of chlorophyll was 44.22 in T₀ (water). The different fermented fruit juice treated plant was significantly similar to one another but the T₀ (water) at 5% level was significantly different.

Relative Water Content (RWC)

The results showed that the relative water content was highest in T₃ (Papaya + Watermelon + Banana) 96.15, T₂ (Apple + Orange + Pineapple) 93.80, T₁ (Grape + Persimmon + Pear) 93.50 and the lowest relative water content in T₀ (Water) 90.01.

As presented in Table 1, (Grape + Persimmon + Pear) T₁ and (Apple + Orange+ Pineapple) T₂ are significantly similar but all FFJ treated plants were highly significantly different between the T₀ (Water).

Table.1 Responses of Maize to Different Types of Fermented Fruits Juices (FFJ) on Maize Plants

Treatment	Plant Height (cm)	Leaf Number/ plant	Length of internodes (cm)	SPAD chlorophyll meter reading (SCMR)	Relative water content (RWC)
T₀ (Water)	218.27 ^b	10.17 ^a	19.00 ^a	44.22 ^b	90.01 ^c
T₁(GP + PSM + PR)	235.03 ^a	11.92 ^a	19.82 ^a	50.85 ^a	93.50 ^b
T₂ (AP + OG + PA)	230.80 ^a	11.77 ^a	19.22 ^a	50.26 ^a	93.80 ^b
T₃ (PPY + WM + BNN)	231.95^a	12.52^a	19.50^a	53.75^a	96.15^a
(LSD)	9.21	0.95	0.84	3.94	2.25

PPY = Papaya, WM = Watermelon, BNN = Banana, AP = Apple, OG = Orange, PA = Pineapple, GP = Grape, PSM = Persimmon, PR = Pear, Different letters adjacent to data in the same column show significant difference at P < 0.05 by Duncan's multiple range tests (DMRT)

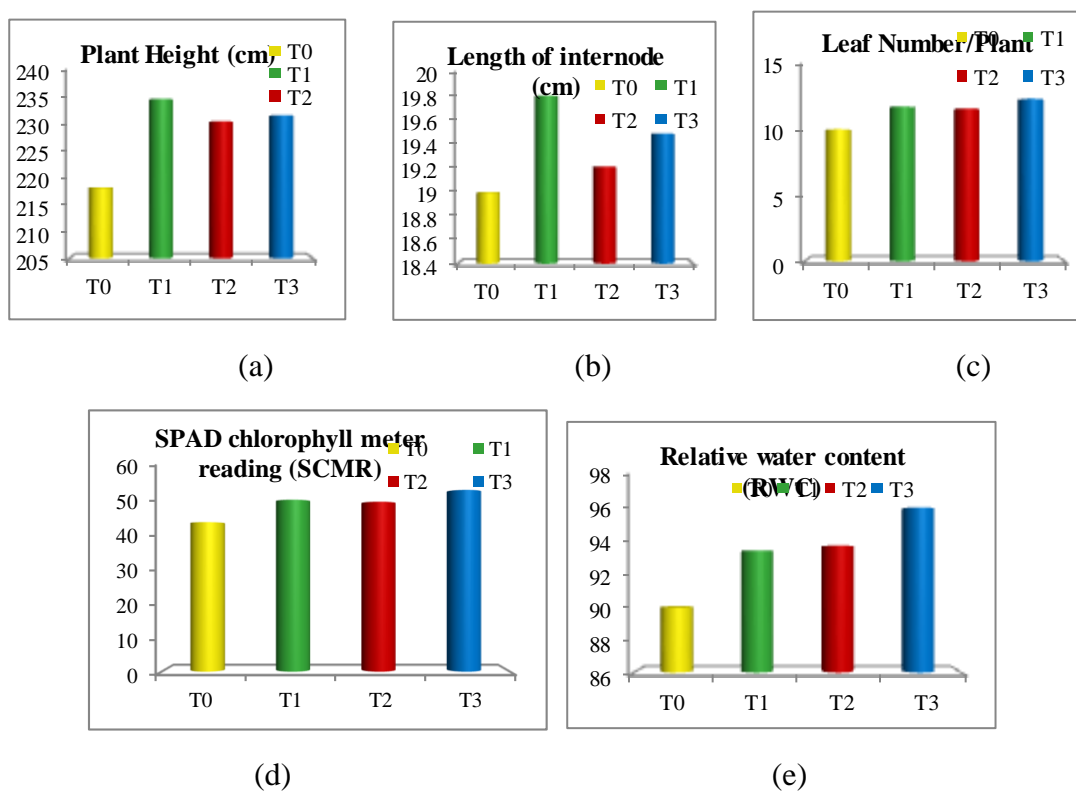


Figure (1) Responses of Maize to Different Types of Fermented Fruits Juices (FFJ) on (a) Plant Height, (b) Length of Internode (cm), (c) Number of Leaf, (d) PSAD Chlorophyll Meter Reading (SCMR) and (e) Relative Water Content (RWC)

Yield and Yield Components

Yield and yield components of each treatment are represented in Table. 2. Fermented Fruit Juice (FFJ) foliar application had a significant effect on yield and yield significant effect on yield and yield components of a maize plant. Fermented fruit juice (FFJ) foliar spray gave better results enhancing yield and yield components of FFJ treated plants than control. Within the different types of fermented fruit juice, the highest values of yield and yield components in T₃ (PPY + WM + BNN) treated plants. According to the analysis of variation, all treatments were highly significant.

Ear length and Ear Perimeter

In this result, there are the ear length in T₁ (Grape + Persimmon + Pear) 27.87 cm, T₃ (Papaya + Watermelon+ Banana) 27.85 cm, T₂ (Apple+ Orange + Pineapple) 27.67 cm and T₀ (Water) 26.32 cm. All the fermented fruit juice treated plants were similar significant but T₀ (water) was significantly different at 5% level DMRT.

The experiment showed that the highest ear perimeter was 21.49 cm in T₁ (Grape + Persimmon + Pear) and the lowest was 19.85 cm in T₀ (Water). All treatments were no significant difference.

Cod length and Cod Perimeter

In this result, the highest with a mean value of 21.85 cm was observed in T₃ (Papaya + Watermelon+ Banana) while 21.65 cm was similar in T₁ (Grape + Persimmon + Pear) and T₂ (Apple+ Orange + Pineapple) respectively. The shorted cod length of 21.50 cm was found in T₀ (Water) treated plant. All treatments were no significant difference.

The maximum mean value of Cod perimeter, T₃ (Papaya + Watermelon+ Banana) had 19.37 cm and the least value 18.26 cm was observed in T₀ (Water). Analysis of variance revealed a significant difference between the treatments.

Ear Weight and Cod Weight

The highest value of ear weight, T₃ (Papaya + Watermelon+ Banana) had 522.20 g and followed 516.53 g and 510.95 g in T₁ (Grape + Persimmon + Pear) and T₂ (Apple+ Orange + Pineapple). The lowest value of 460.23 g also observed in T₀ (Water).

The maximum cod weight was 411.23 g in T₃ (Papaya + Watermelon+ Banana) and followed by 404.57 g in T₂ (Apple+ Orange + Pineapple) and 404.40 g in T₁ (Grape + Persimmon + Pear). The least value of 378.57 g also observed in T₀ (Water).

The different fermented fruit juice treated plants were significantly similar to one another but the T₄ (water) at 5% level was significantly different.

Table.2 Responses of Maize to Different Types of Fermented Fruits Juices (FFJ)

Treatment	Ear	Ear	Cod	Cod	Ear	Cod
	length	Perimeter	length	Perimeter	weight	weight
9 ml/ L	(cm)	(cm)	(cm)	r (cm)	(g)	(g)
T₀ (Water)	26.32 ^b	19.85 ^a	21.50 ^a	18.26 ^b	460.23 ^b	378.57 ^b
T₁ (GP + PSM + PR)	27.87 ^a	21.49 ^a	21.65 ^a	19.27 ^a	516.53 ^a	404.40 ^a
T₂ (AP + OG + PA)	27.67 ^a	21.08 ^a	21.65 ^a	18.67 ^b	522.50 ^a	404.57 ^a
T₃(PPY + WM + BNN)	27.85^a	21.11^a	21.85^a	19.37^a	510.95^a	411.23^a
(LSD)	1.31	0.77	0.38	0.53	27.45	22.54

PPY = Papaya, WM = Watermelon, BNN = Banana, AP = Apple, OG = Orange, PA = Pineapple, GP = Grape, PSM = Persimmon, PR = Pear Different letters adjacent to data in the same column show significant difference at $P < 0.05$ by Duncan's multiple range tests (DMRT)

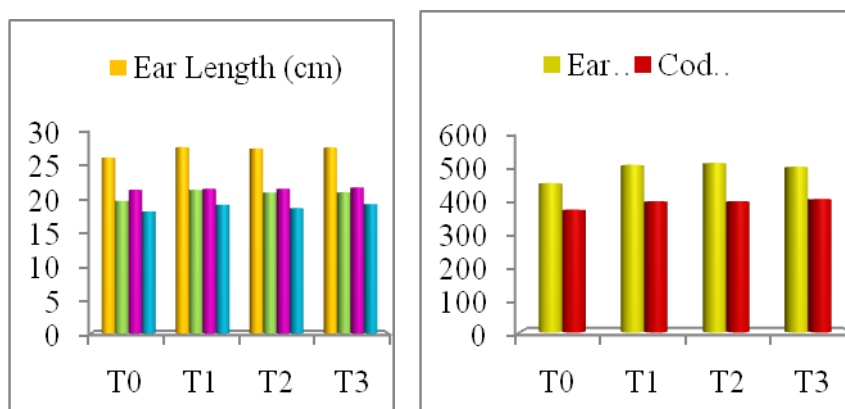


Figure (2) Responses of Maize to Different Types of Fermented Fruits Juices (FFJ) (a) Ear Length (cm), Ear Perimeter (cm), Cod Length (cm), Cod Perimeter (cm) and (b) Ear Weight (g) and Cod Weight (g)

Number of Row per Cod, Number of Seed per Row and Number of Seed per Cod

The result of a number of row per cod was the highest in T₃ (Papaya + Watermelon+ Banana) which had 19.35 and 19.30 in T₁ (Grape + Persimmon + Pear) and 19.25 in T₂ (Apple+ Orange + Pineapple). The least value was 17.70 in T₀ (water). The different fermented fruit juice treated plant was significantly similar to one another but the T₀ (water) at 5% level significantly different.

The number of seed per row on maize plant had the highest value of 42.95 in T₃ (Papaya + Watermelon+ Banana) and T₁ (Grape + Persimmon + Pear) had 42.55 and T₂ (Apple+ Orange + Pineapple) had 42.47. The lowest value was 39.25. Analysis of variation on all the treatments was highly significant.

In this experiment, the highest number of seed per cod was 831.08 in T₃ (Papaya + Watermelon+ Banana) and the lowest was 695.45 in T₀ (water). Analysis of variation on all the treatments was highly significant

100 Seeds Weight (g), Sweetness and Cod Yield

The result showed that 100 seeds weight was 17.74 g in T₃ (Papaya + Watermelon+ Banana) and followed by 17.24 g in T₁ (Grape + Persimmon + Pear).

The sweetness of maize seeds was highest 11.37 in T₃ (Papaya + Watermelon+ Banana) and the lowest sweetness was 10.57 in T₀ (Water).

The maximum yield was obtained from T₃ (Papaya + Watermelon+ Banana) which had 11.94, T₁ (Grape + Persimmon + Pear) and T₂ (Apple+ Orange + Pineapple) had 11.66. The minimum yield was from T₀ (Water), 10.99.

Analysis of variation says all the treatments were highly significant.

Table. 3 Responses of Maize to Different Types of Fermented Fruits Juices (FFJ)

Treatment 9 ml/ L	No. Row/ Cod	No. Seed/ Row	No. Seed/ Cod	100 Seed weight (g)	Sweetness ° (Brix)	Cod Yield (ton/ac)
T ₀ (Water)	17.70 ^b	39.25 ^c	695.45 ^c	15.31 ^c	10.57 ^c	10.99 ^b
T ₁ (GP + PSM + PR)	19.30 ^a	42.55 ^a	821.95 ^a	17.24 ^a	11.10 ^{ab}	11.74 ^a
T ₂ (AP + OG + PA)	19.25 ^a	42.47 ^b	817.55 ^b	16.90 ^{ab}	10.84 ^{bc}	11.66 ^a
T ₃ (PPY + WM + BNN)	19.35^a	42.95^a	831.08^a	17.74^a	11.37^a	11.94^a
(LSD)	0.43	1.57	37.82	1.59	0.46	0.65

PPY = Papaya, WM = Watermelon, BNN = Banana, AP = Apple, OG = Orange, PA = Pineapple, GP = Grape, PSM = Persimmon, PR = Pear Different letters adjacent to data in the same column show significant difference at P < 0.05 by Duncan's multiple range tests (DMRT)

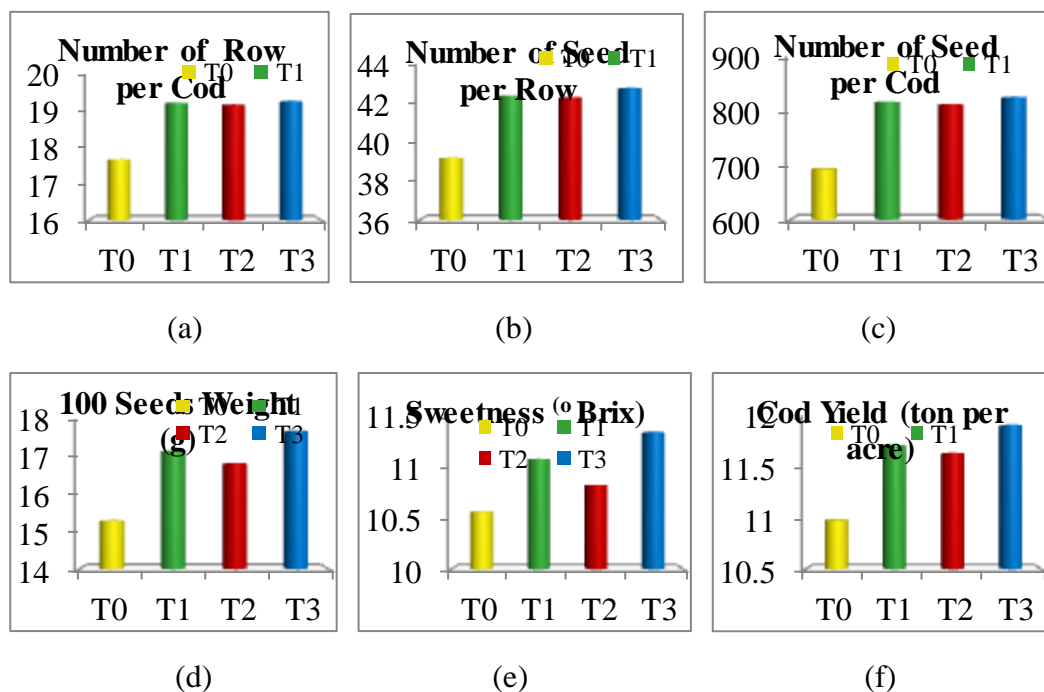


Figure (3) Responses of Maize to Different Types of Fermented Fruits Juices (FFJ) on (a) Number of Row per Cod, (b) Number of Seed per Row, (c) Number of Seed per Cod, (d) 100 Seeds Weight (g), (e) Sweetness (° Brix) and (f) Cod Yield (ton per acre)



Figure (4) Applying with Fermented Fruit Juices (FFJ) on cultivation maize plants

Discussion and Conclusion

The different Fermented Fruit Juices (FFJ) had a very significant effect on the maize plants in terms of final plant height, number of leaf, length of internode, chlorophyll content, relative water content (RWC), ear length, ear perimeter, and length, cod perimeter, ear weight cod weight, number of row per cod, 100 seeds weight, sweetness and cod yield.

The result of the field experiment showed that the application of different fermented fruit juice (FFJ) as a foliar spray on maize plants had significantly affected vegetative and reproductive growth during the growing period. The best performance of fermented fruit juice on maize plants found in T₃ (Papaya + watermelon + Banana) because of the high yields of marketable maize cobs production.

Naz *et al.*, 2011, reported that the fermented fruit juice is organic fertilizer composed of banana, watermelon, papaya, apple and pineapple, grape, etc. Papaya, watermelon and Banana have certain properties that can make our plants stronger and healthiest. The banana is packed with potassium, which encourages fruiting and papaya and watermelon are rich in chlorophyll and chromoplast in plants. Fermented fruit juice helps plants because of its capability of dissolving the chlorophyll in a short period to be readily absorbed by the plants due to its natural enzymes.

Reickenberg and Pritts, 1998 stated that fermented fruit juice can be used to increase the fruiting process of plants as well as to increase yield. The foliar spray fertilizers provide a quicker response and are more effective for some nutrients than soil applied fertilizer. It can be used as a foliar spray as well as an indirect application to the soil, where it feeds the microbiome and increases soil health.

The result of the experiment showed that fermented Fruit Juice (FFJ) has a significance effect on plant height. The mean values of the highest plant height 235.03

cm occurred in T1 (Grape + Persimmon + Pear). The maximum number of leaves was 12.52 in T3 (Papaya + Watermelon + Banana). The longest length of internode was 19.82 cm in T1 (Grape + Persimmon + Pear) treated plants. The maximum mean values of chlorophyll content were 53.75 and the highest value of relative water content (RWC) was 96.15 in T3 (Papaya + watermelon + Banana).

In addition, the result of yield and yield components indication that fermented fruit juice (FFJ) as foliar spray had significant effect on maize plants. The longest ear length had 27.85 cm and the biggest perimeter had 21.11 cm in T₃. The maximum cod length and cod perimeters were 21.85 cm and 19.37 cm in T₃. Moreover, the highest cod weight was 411.23g in T₃. However, the highest ear weight had 522.50 g in T₂.

According to the results of maize cods, T₃ (Papaya + watermelon + Banana) was the best performance of number of row per cod, number of seed per row, number of seed, 100 seed weight and sweetness (Brix). Among all the treatments, the highest yield in T₃ had 11.9.4 t/ac. The results indicated that the highest chlorophyll and relative water content had a direct role in photosynthesis and hence closely related to the capacity of photosynthesis, development and cob yield.

Present findings suggested fermented fruits Juice (FFJ) as foliar spray give better results in enhancing the vegetative growth and reproductive growth of maize plants, while FFJ T₃ (Papaya + watermelon + Banana) gave the highest yield and cob quality.

In conclusion, the findings of this research work have a number of important application for future practice especially providing information in producing fermented fruits juice, unmarketable waste of fruits organic fertilizer form in order to move forward in achieving sustainable agriculture.

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