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Research Paper

Influence of Cropping Systems and Time of Introduction of Component Maize on Yield and Antioxidant Components of Garden egg

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Abstract: *Field experiments were conducted to study possible influence of cropping system on the antioxidant component of Garden egg fruits during the wet and dry seasons of year 2014 and 2015 at Ejiba, Southern Guinea savannah agro-ecological zone of Nigeria. The treatments consisted of time of introduction of component Maize (2 weeks before transplanting (WBT), same time as transplanting (STT) and 2 weeks after transplanting (WAT) of Garden egg) and population ratios of Maize and Garden egg (100% M:100% G, 100% M:75% G, 100% M:50% G, 100% M:25% G, 100%:0% G, 0% M:100% G, 25% M:100% G, 50% M:100% G, 75% M:100% G) where M and G represented maize and garden egg respectively. The treatments were arranged in a randomized complete block design in a split plot arrangement and replicated three times. Time of introduction was assigned at the main plot while population density ratios were allotted at the sub plot treatments.*

Population ratio had significant effects on both the number of Garden egg fruits/plot and fruit yield with the values significantly deceasing linearly as Maize population increases in the crop mixtures. Number of fruits/plant and fruit yield were highest in both seasons in sole crop with values being superior to other population ratios in the crop mixtures.

The effects of cropping system under different population ratios on the antioxidant components of Garden egg fruits varied appreciably depending on the antioxidant component under study. Increasing the population densities of both crops to full population increases the phenolic content of Garden egg fruits while sole Garden egg gave the lowest phenolic content. The reverse was the case in flavonoid component. Plants under the population ratio 100M: 25G had the highest value of 2.2 diphenyl-1- picrylhydrazyl (DPPH) at both growing seasons.

Key Words: *Population ratio, Time of introduction, Antioxidant, Cropping system*

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I. INTRODUCTION

"Garden egg" is an edible vegetable crop belonging to the family *Solanaceae.* It is the most important of the vegetable families which are essentially tropical in origin (Nwanna *et al*., 2013). Most species are wild but some of them such as *S. aethiopicum, S. macrocarpon, S. kumba* and *S.gilo* bear edible fruits in West African origin (Nwanna *et al*., 2016). The fruits may be consumed freshly raw, dry or cooked. It is one of the most important vegetable crops in West Africa mostly in Nigeria as it is consumed daily and remains a source of income for many rural dwellers (Chioma *et al*., 2011). Like many other fruits and vegetables, Garden egg fruits are very good sources of antioxidants. Umesh *et al* (2015) reported that Garden egg (*Solanum melongena* L.) fruit contain 25.17-40.35% radical scavenging activity (DPPH), comparable amount of flavanoids (7.42-13.25 mg.100g-1) and anthocyanine content along with total phenol (32.89-39.12 mg.100g-1), ascorbic acid (9.43-16.75 mg.100g-1), protein (0.92-1.39 %) and titrable acidity (0.20-0.32%).

Antioxidants are an inhibitor of the process of oxidation, even at relatively small concentration and thus have diverse physiological role in the body. Antioxidant constituents of the plant materials like fruits act as radical scavengers and helps in converting the radicals to less reactive species (Aleksandra Duda-Chodak *et al*

2007). Important antioxidant for plant and human health such as Glutathione and yellow pigment particularly, bitacarotene, play an important role in the antioxidative defense and stress signally (Foyer and Noctor 2005, Grostein *et al* 2007).

Cropping systems or the manner crops are grown have been discovered to affect the yield of crops positively and negatively hence cropping systems usually structured to maximize crop yields. Suitable time to introduce the component crop into the intercrop is also very important factor in intercropping system. Crops may be introduced at the same time or at different times (with considerable overlap in time) depending on farmer's preference. (Ofori and Stem, 1987). The relative time of planting of the intercrop, before, at the same time or after the main crop has both biological and practical implications. The effect of intercropping on antioxidants has been reported. According to Vesna *et al* 2017, antioxidant content was found to increase in a Maize- Soybean crop mixture. In the study, cropping system was reported to influence GSH and phenolics. In another study, poly phenol oxidase an antioxidant, was inhibited by intercropping in Galic- Pepper mixture (Imran *et al* 2013).

Several studies in crop mixture involving Garden egg have carried out (Ngbede and Nworie (2011), Anyaegbu *et al.*, 2013), there is dearth of information on the effects of the system on composition of antioxidants as influenced by time of introduction of component Maize. This study was therefore carried out to study the influence the different cropping systems on yield of Garden egg and the antioxidant activity of the fruits as affected by antioxidant components in the fruits.

II. MATERIALS AND METHODS

The field trials were carried out at the Lower Niger River Basin Development Authority, Kampe/Omi irrigation project, Ejiba (Lat 8^0 18^1 N; Long 5^0 39^1E; 246 m above the sea level) in the southern Guinea savannah agro – ecological zone of Nigeria, during the wet and dry seasons of year 2014 and 2015.

The trial was laid as a randomized complete block design (RCBD) in a split-plot arrangement replicated thrice. The main plots were time of introduction of Maize [2weeks before transplanting (WBT), same time with transplanting (STT) and 2 weeks after transplanting (WAT)] while 9 plant population ratios were the sub plots (100M: 100G, 100M: 75G, 100M: 50G, 100M: 25G 100M: 0, 0:100G, 25M: 100G, 50M: 100G, 75M: 100G).

The Garden egg seedlings were raised in the nursery for two weeks before transplanting to the field. Prior to transplanting, the field was ploughed and harrowed. The Garden egg seedlings were transplanted the same day while the component Maize (SAMMAZ 28) seeded according to treatment allotted. Pre emergence application Pendimethalin at the rate of 2.0 kg a.i ha^{-1} and supplemented by hand weeding at 8 and 12 weeks after planting (WAP). NPK 20:10:10 fertilizer was applied in split application to Maize at 3WAP at the rate of 200 kg ha^{-1} and 100 kg ha^{-1} at 8WAP. Chlorpyriphos 20% was applied to the Garden egg plants to control hoppers and sucking insects at the rate of 30 ml per 20 litres of water using knap sack sprayer.

Garden egg fruits were harvested at five days interval and the necessary data were taken from the harvested fruits.

2.2: Number of fruits per plot

This was taken by counting the number of fruits taken from the five randomly selected and tagged plants at each harvest and the average multiplied by the number of stands per plot.

2.3: Fruit yield per plot (t/ha)

The total fruits harvested in each plots were taken and weighed to get the fruit yield per plot.

2.4: Preparation of Plant Materials

The Garden egg fruits per plot were washed, chopped into pieces and dried at 60◦C in the oven. The dried fruits were milled into fine powder, and stored in plastic bags at −20◦C prior to extraction.

2.5: Preparation of Methanolic Extracts

Twenty grams of dried milled powder of the Garden egg fruit was immersed in 100 ml methanol for 3 days at room temperature. The mixture was shaken at intervals and filtered after 3 days. The extraction procedure was repeated three times and filtrates were pooled. Organic solvents in pooled filtrates were removed under reduced pressure in a rotary evaporator at 40◦C. (Ademoyegun *et al*. 2013)

2.6: Determination of Plant Extract Yield

The yield of evaporated dried extracts based on dry weight was calculated as:

Yield (%) = $(W1 \times 100)/W2$

where $W1$ is the weight of extract after evaporation and $W2$ is the dry weight of the fresh plant sample.

2.7: Determination of Total Phenol, Total Flavonoid, and Flavonol Content

Total phenolic content was determined using the Folin-Ciocalteu reagent, as described by Singleton and Rossi (1965), using gallic acid as a standard phenolic compound. Total flavonoid contents were measured according to

a colorimetric assay (Zhishen *et al*., 1999). A 1-mL aliquot of standard solutions of catechin at different concentrations, or appropriately diluted samples, was added to a 10-mL volumetric flask containing 4 mL double-distilled water. At zero time, 0.3 mL of 5% $NaNO_2$ was added to the flask. After 5 min, 0.3 mL of 10% $AlCl_3$ was added. After 6 min, 2 mL of 1 M NaOH was added to the mixture; the solution was immediately diluted to volume (10 mL) with double-distilled water and thoroughly mixed. Absorbance was read at 510 nm with a spectrophotometer (model 6400/6405, Jenway, Missouri City, Tex.). The distribution of gallic acid along a line produced an $r2$ value of 0.9955 and a regression equation between absorbance (y) and gallic acid content (x) was y =
$0.0068x - 0.01$. Flavonol concentrations were determined by the method of Yermakov *et al*.
(1987) with modification. The catechin calibration curve was prepared by mixing 2 mL of various concentrations of methanolic solutions of catechin with 2 mL (20 mg・mL−1) aluminum trichloride and 6 mL (50 mg・mL−1) sodium acetate. Absorbance was read at 440 nm after 2.5 h. The same procedure was used for 2 mL of extracts instead of catechin solution. All determinations were carried out in triplicate. The content of flavonols was calculated using a standard curve obtained from various concentrations of catechin.

2.8: Determination of Antioxidant Activity

Antioxidant activity was determined by the 2,2,-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity (RSA) method of Zhang and Hamauzu (2004) with some modifications. The methanol extracts of fresh leafy vegetables used was 10 mg・mL−1 (dry weight), chosen as an appropriate concentration for assessing antioxidant activity based on preliminary studies.

An aliquot of 3.9 mL of 0.1 mM DPPH radical in methanol was added to a test tube containing 0.1 mL of vegetable extract at 10 mg・mL−1. Instead of methanolic extract of plants, pure methanol was used as the control. The reaction mixture was vortexed and left to stand at room temperature in the dark for 1 hr before absorbance at 517 nm was measured. Pure methanol was used to calibrate the spectrophotometer. Antioxidant activity was expressed as percentage inhibition to the DPPH radical determined by:

$\%RSA = (1 - AC/AD) \times 100$

where AC is the absorbance of the solution when the extract was added at a particular level, and AD is the absorbance of the DPPH solution. The extract concentration providing 50% inhibition (EC50) was calculated from the graph of RSA percentage of DPPH against extract concentration.

Data collected on yield and the antioxidant components of the fruits were subjected to analysis of variance at $p \leq 0.05$.

III. RESULTS AND DISCUSSION

3.1: Fruit yield of Garden egg

The result showed that number of fruit/plot and fruit yield were superior in 2015 rainy season than in 2014. The reverse was the case in dry season as the values obtained in 2014 were significantly higher than those of 2015 (Table 1).

Number of fruit/plot and fruit yield in crop mixtures when Maize was introduced into the mixture 2 WAT of Garden egg was higher than other period of introduction of Maize except for fruit number where the value did not differ significantly from plots with the component Maize introduced at the same time with Garden egg in the rainy season.

Population ratio had significant effects on both traits i.e. the number of Garden egg fruits/plot and fruit yield with the values deceasing linearly significantly with the increased Maize population in the crop mixtures. Number of fruits/plot and fruit yield were highest in both seasons in sole crop with values being superior to other population ratios in the crop mixtures. This was followed by values obtained in respect of crop mixture 25M: 100G, decreasing in that order. Number of fruit/plot and fruit yield were also significantly higher in the dry season in Maize introduced simultaneously with Garden egg compared to Maize introduction 2 WBT of Garden egg.

The results of the interaction effects of year of planting, time of introduction of component Maize and population ratio on the number of fruit/plot are presented in table 2. The result show that the number of fruits/plot varied significantly among the population ratios irrespective of the times of introduction of component Maize in both years in the dry season. Sole Garden egg had the highest number of fruits/plot with the values obtained in 2014 significantly higher than in 2015 regardless of the period of introduction of component Maize into the mixtures. Values obtained in 25M: 100 G crop mixtures were also significantly higher in 2015. Number of fruits/plot was lowest in both years at crop mixtures of 100M: 25 G.

Fruit yield in the rainy season (Table 3) varied significantly among the population ratios at all times of introduction in both years with sole Garden egg having the highest fruit yield. Fruit yields were generally higher at all times of introduction and crop mixture in 2015 than in 2014.

3.2: Phenolic and Flavonoid Content

The results show that antioxidant components, phenolic and flavonoid were significantly affected by cropping system under different population ratios tested in both growing seasons (Table 4). Crops mixture of 100M: 100G resulted in the highest value of phenolic content of Garden egg in the two seasons. However the value in the rainy season did not differ significantly from those of 100M: 75G and 100M: 50G respectively. All plants in the intercropped plots have higher phenolic content than sole plots. This agreed with the findings of Adeniyi *et al* (2018) who reported that the sole cropping of tomato resulted in lower value of phenolic content than in intercropped tomatoes. Similarly, Aliyeh Salehi *et al* (2019) reported that fenugreek seeds harvested in the intercropped treatments had higher antioxidant activity (total phenolic content, vitexin, isovitexin, orientin, and isoorientin) when compared with the sole. Garden egg fruits higher in phenolic content are preferable to those with lower phenolic contents as dietary phenolic acids intake is epidemiologically correlated with diminished risk of esculentum cancer that has been found to be superior to carotenoid in inhibiting cell proliferation in various human epithelial cancer lines (Cao *et al.*,1996).

High population Maize intercropped with low population of Garden egg (100M: 25G) had a significantly higher flavonoid value in the two seasons than other crop mixtures.

The results showed that time of introduction of the component Maize had significant effect on the phenolic and flavonoid content of Garden egg in this experiment. Garden egg with its component Maize planted at two weeks after transplanting of Garden egg had the highest value of phenolic content in the two growing seasons while the least was recorded when Maize was introduced into the mixture two weeks before transplanting.

Garden egg plants with the component Maize introduced at two weeks before transplanting the Garden egg had the highest value of flavonoid at the two seasons while Maize introduced at the same time with Garden egg recorded the lowest value.

There were no significant differences in the interaction effect on phenolic content of Garden egg among the population ratio but Garden egg plants whose component Maize were introduced 2 WAT had the highest phenolic content in all the population ratio with the exception of 100M: 25G and 50M: 100G in the raining season (table 5). In the dry season, phenolic content varied appreciably with the 100M: 100G introduced 2 WBT, 100M: 50G introduced STT and 100M: 100G introduced 2 WAT presenting the highest phenolic content of Garden egg fruits (table 6) .

The results also showed that flavonoid content of the Garden egg fruits were higher in all the population ratios when the component Maize was introduced 2 WBT of Garden egg with the exception of 100M: 100G and 100M: 50G. Flavonoid was also higher in 100M: 75G, 100M: 25G, 25M: 100G and in the sole plot when the component Maize was introduced same time as transplanting and 100M: 100G, 100M: 50G, 100M: 25G and sole plot when the component Maize was introduced 2 weeks after transplanting of Garden egg in the rainy season (Table 7).

In the dry season, flavonoid content varied appreciably among the population ratios at all times of introduction in both years. The result showed that there was no particular trend in the value of flavonoid between the years in the dry season trials. The highest flavonoid content was recorded for 100M: 25G when Maize was introduction into the mixture was done simultaneously with Garden egg in the dry season. However, this value did not differ significantly from those obtained at other periods of Maize introduction at the crop mixture in both years and other crop mixtures involving introduction of Maize two weeks after transplanting in 2014, 100M: 50G two weeks after transplanting (both years) and 50M: 100G two weeks before transplanting in 2014 (Table 8).

The results (Table 4) also showed that population ratio had significant effect on 2.2- diphenyl-1-picrylhydrazyl (DPPH) component. This trait, however was not affected by year of evaluation as well as time of introduction. The intercropped Garden egg fruits in100M: 25G plots had the highest value of DPPH at both growing seasons (48.47 and 48.07 respectively), and the values were significantly different from those of other population ratios and sole plots (44.81 and 44.42 respectively). This is in agreement with Aliyeh Salehi *et al* (2019) who reported that the seeds of fenugreek plants harvested from the intercropped plots had higher DPPH values, on average compared to Sole plots. Aliyeh Salehi *et al* (2019) also reported that the antioxidant activity increased with an increasing share of fenugreek plants in the intercrop system which is in disagreement with this study where antioxidant activity increased with an decreased share of Garden egg plants in the intercrop system (100M:25G).

The interaction effect on DPPH (2.2- diphenyl-1-picrylhydrazyl) values of Garden egg fruits varied significantly and was similar in both the rainy and dry seasons. 100M: 50G with the component Maize introduced 2 weeks before Garden egg, 100M: 25G with the component Maize introduced same time with Garden egg and 50M: 100G with the component Maize introduced 2 weeks after transplanting of Garden egg were significantly superior in both seasons (Tables:9 and 10).

The effects of cropping system employed in this work on the antioxidant contents of the Garden egg fruits i.e increase or decrease in value could be as a result of Allelophaty induced by effect of intercropping on Garden egg plants. This is in agreement with the work of Imran Ahmad *et al(2013)* in a Galic/Pepper intercrop where he reported that Polyphenol oxidase (PPO) activity is significantly decreased in all the intercropped treatments as compared to the control and he suggested that it might be due to allelochemicals released by garlic which caused oxidative damage through an increase in reactive oxygen species (ROS) and modification of PPO. It is also in line with the findings drawn by Lixuan *et al*., (2007), that the activities of defense enzymes such as polyphenol oxidase (PPO) in leaves and roots of watermelons in the intercropping system were significantly lower than those in the mono-cropped system.

IV. CONCLUSION

4.1: Fruit yield

Intercropping did not have positive effect on Garden egg fruit yield as this was significantly depressed by Maize population. Garden egg did not respond positively to increase in the population of the component Maize as the increase in the population of the component Maize result in reduction of Garden egg yield while fruit yield was highest under sole cropping. However, apart from the sole crops plots, Garden egg fruit yield also did well in population ratio of 25M: 100G.

Time of introduction of the component Maize influenced Garden egg fruit yield as seen in introducing Maize two weeks after transplanting Garden egg significantly increased Garden egg fruit yield.

4.2: Antioxidant Components

The effects of cropping system under different mixed population ratios of Maize and Garden egg on the antioxidant components of Garden egg fruits varied appreciably. Increasing the population densities of both crops to full population increases the phenolic component of Garden egg fruits while sole Garden egg gave the lowest phenolic content. The reverse was the case in flavonoid component.

The effect was also seen to have significance on DPPH (2.2- diphenyl-1-picrylhydrazyl) while neither year of evaluation nor time of introduction had any significant effect on this trait. Plants under the population ratio 100M: 25G (intercropped Garden egg plants) had the highest value of DPPH at both growing seasons, and the values were significantly higher than those of sole plants and other population ratio.

Table 1: Effects of population ratio and time of introduction of component Maize on number of fruits/plot and fruit weight/plot of Garden egg

	Rainy Season		Dry Season	
Treatment	**No. of Fruit/plot**	**Fruit yield (t/ha)**	**No. of Fruit/plot**	**Fruit yield (t/ha)**
Year				
2014	190.03[b]	11.17[b]	437.13[a]	47.91a
2015	371.47[a]	36.019[a]	284.64[b]	30.63b
SED	20.63	0.6726	1.0933	0.1516
LSD (0.05)	88.76	2.8939	4.7039	0.6523
Time of Introduction of component Maize (TI)				
2 WBT	256.33[b]	23.03[b]	346.35[c]	37.79[c]
STT	283.88[a]	22.38[b]	361.52[b]	39.06[b]
2 WAT	302.06[a]	25.50[a]	374.77[a]	40.96[a]
SED	8.4155	0.7308	3.1220	0.3465
LSD (0.05)	19.4062	1.6851	7.1993	0.7989
Population Density (PD) Ratio				
M : G				
100:100	271.50[c]	21.05[c]	350.67[c]	30.75[e]
100:75	215.78[ef]	18.16[d]	304.72[e]	35.43[d]
100:50	252.11[cd]	21.48[c]	251.22[f]	27.29[f]
100:25	198.50[f]	14.61[e]	162.39[g]	16.43[g]
75:100	241.89[de]	21.31[c]	326.78[d]	37.74[c]
50:100	249.72[cd]	22.82[c]	353.61[c]	38.45[c]
25:100	320.17[b]	25.64[b]	504.00[b]	56.52[b]
0: 100	496.39[a]	44.00[a]	633.67[a]	71.54[a]
SED	14.3719	0.9695	3.6693	0.5250
LSD (0.05)	28.5801	1.9280	7.2968	1.0439
Year x TI	ns	ns	Ns	*
Year x PD	**	**	**	**
TI x PD	ns	*	**	ns
Year x TI x PD	ns	**	**	ns

Means followed by the same letters are not significantly different from each other at 5% probability level $LSD_{0.05}$ = least Significant Difference at 5% probability level. SED = Standard Error of Difference. ns = not significant. ** denotes significant means at 1% probability. * denotes significant means at 5% probability. WBT = weeks before transplanting. STT =same time as transplanting. WAT = weeks after transplanting

Table 2: Interaction effects of Year, time of introduction of component Maize and population ratio on Number of Fruits/plot of Garden egg (Dry season)

Year	Time of Introduction	Population Ratios							
		100:100	**100:75**	**100:50**	**100:25**	**75:100**	**50:100**	**25:100**	**0:100**
2014	2 WBT	397.33^{c}	326.33^{d}	247.33^{e}	171.67^{f}	380.33^{c}	397.33^{c}	682.67^{b}	797.33^{a}
	STT	418.67^{c}	349.67^{e}	253.00^{f}	184.67^{g}	394.00^{d}	401.67^{cd}	693.00^{b}	808.33^{a}
	2 WAT	428.67^{d}	363.00^{f}	261.00^{g}	190.00^{h}	397.67^{e}	449.33^{c}	695.33^{b}	802.67^{a}
2015	2 WBT	261.33^{c}	233.00^{d}	212.67^{e}	126.33^{f}	264.33^{c}	274.67^{c}	294.33^{b}	474.67^{a}
	STT	295.00^{c}	261.67^{d}	244.67^{d}	147.33^{e}	258.33^{d}	298.67^{c}	317.67^{b}	458.00^{a}
	2 WAT	303.00^{c}	294.67^{c}	288.67^{c}	154.33^{e}	266.00^{d}	300.00^{c}	341.00^{b}	461.00^{a}
SED					8.99 (Rows)				
LSD					17.87 (Rows)				

The means followed by the same letter do not differ statistically between each other. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 3: Interaction effects of Year, time of introduction of component Maize and population ratio on fruit yield of Garden egg (Rainy season)

Year	Time of Introduction	Population Density Ratio							
		100:100	100:75	100:50	100:25	75:100	50:100	25:100	100:0
2014	2 WBT	10.77^{bc}	4.56^{d}	8.26^{cd}	14.11^{b}	9.013^{cd}	7.49^{cd}	9.31^{c}	20.77^{a}
	STT	7.38^{cd}	5.14^{cd}	16.82^{b}	4.88^{cd}	3.27^{d}	6.59^{cd}	8.32^{c}	27.21^{a}
	2 WAT	11.43^{bcd}	8.68^{d}	15.23^{b}	13.65^{bc}	10.28^{cd}	10.86^{bcd}	12.47^{bcd}	21.61^{a}
2015	2 WBT	30.67^{d}	28.93^{d}	27.63^{d}	17.20^{e}	35.60^{c}	38.33^{bc}	41.33^{b}	64.43^{a}
	STT	30.93^{cd}	29.67^{d}	29.27^{d}	17.36^{e}	33.00^{cd}	35.40^{c}	41.67^{b}	61.10^{a}
	2 WAT	35.10^{cde}	32.00^{de}	31.67^{e}	20.49^{f}	36.67^{bcd}	38.27^{bc}	40.77^{b}	68.87^{a}
SED					2.38 (Rows)				
LSD					4.72 (Rows)				

The means followed by the same letter do not differ statistically between each other. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 4: Effects of population ratio and time of introduction of component Maize on Phenolic, Flavonoid and DPPH contents of Garden egg

	Rainy Season			Dry Season		
Treatment	**Phenolic**	**Flavonoid**	**DPPH**	**Phenolic**	**Flavonoid**	**DPPH**
Year						
2014	26.63	9.41	42.74	27.24	10.57	42.62
2015	27.26	10.69	42.38	27.11	10.45	42.27
SED	0.8800	0.3496	1.6835	0.0552	0.0428	0.1408
LSD (0.05)	ns	ns	ns	ns	ns	0.6059
Time of Introduction of component Maize (TI)						
2 WBT	24.79^{c}	11.19^{a}	43.39	24.40^{c}	11.85^{a}	42.87
STT	26.94^{b}	8.83^{c}	42.41	27.20^{b}	9.11^{c}	42.11
2 WAT	29.10^{a}	10.14^{b}	41.88	29.93^{a}	10.57^{b}	42.34
SED	0.5192	0.2443	1.1048	0.2648	0.0918	0.3271
LSD (0.05)	1.1973	0.5635	ns	0.6107	0.2118	ns
Population Density (PD) Ratio						
M : G						
100:100	30.50^{a}	9.86^{bc}	39.84^{d}	31.88^{a}	10.47^{c}	39.60^{d}
100:75	28.08^{abc}	9.67^{bc}	36.37^{e}	29.32^{b}	9.84^{de}	35.35^{e}
100:50	28.80^{ab}	9.64^{bc}	43.86^{bc}	29.23^{b}	10.06^{d}	45.31^{b}
100:25	25.59^{cd}	12.02^{a}	48.47^{a}	24.73^{e}	12.68^{a}	48.07^{a}
75:100	28.03^{abc}	9.22^{c}	44.18^{b}	27.56^{c}	9.75^{e}	44.62^{b}
50:100	25.56^{cd}	9.36^{bc}	42.20^{bcd}	25.65^{d}	9.84^{de}	42.30^{c}
25:100	26.09^{bc}	10.52^{b}	40.76^{cd}	25.60^{d}	10.87^{b}	39.87^{d}
0: 100	22.91^{d}	10.11^{bc}	44.81^{b}	23.42^{f}	10.58^{c}	44.42^{b}
SED	1.4849	0.6186	1.6454	0.2600	0.1189	0.5248
LSD (0.05)	2.9528	1.2302	3.2720	0.5171	0.2365	1.0437
Year x TI	ns	ns	ns	ns	ns	ns
Year x PD	ns	ns	ns	ns	**	ns
TI x PD	**	**	**	**	**	**

Yr x TI x PD	ns	ns	ns	ns	**	ns

Means followed by the same letters are not significantly different from each other at 5% probability level $LSD_{0.05}$ = least Significant Difference at 5% probability level. SED = Standard Error of Difference. ns = not significant. ** denotes significant means at 1% probability. * denotes significant means at 5% probability. WBT = weeks before transplanting. STT =same time as transplanting. WAT = weeks after transplanting

Table 5: Interaction effects of time of introduction of component Maize and Population ratio on Phenolic content of Garden egg Fruit (Rainy season)

Time of Introduction	Population Density Ratio							
	100:100	100:75	100:50	100:25	75:100	50:100	25:100	0:100
2 WBT	29.32^{bA}	28.34^{bAB}	22.38^{bCD}	26.96^{aABC}	24.40^{bABCD}	23.55^{bBCD}	23.42^{bBCD}	19.96^{bD}
STT	25.48^{bBCD}	20.41^{cD}	30.95^{aA}	28.54^{aABC}	30.53^{aAB}	30.89^{aA}	25.21^{abCD}	23.52^{abCD}
2 WAT	36.70^{aA}	35.50^{aA}	33.08^{aAB}	21.27^{bD}	29.15^{abBC}	22.25^{bD}	29.64^{aBC}	25.24^{aCD}
SED	2.461 (columns)				2.572 (Rows)			
LSD	4.8895 (columns)				5.1143 (Rows)			

Superscripts in small letters give comparison along the columns while those in capital letters give comparison along the rows. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 6: Interaction effects of time of introduction of component Maize and Population ratio on Phenolic content of Garden egg Fruit (Dry season)

Time of Introduction	Population Density Ratio							
	100:100	100:75	100:50	100:25	75:100	50:100	25:100	0:100
2 WBT	30.5167^{bA}	28.3083^{bB}	20.5983^{cF}	25.1950^{bC}	22.3333^{bE}	23.6333^{bD}	24.0500^{bD}	20.5333^{bF}
STT	24.9667^{cD}	21.3333^{cF}	34.3333^{aA}	28.1300^{aC}	30.3567^{aB}	30.9817^{aB}	22.4833^{cE}	25.0383^{aD}
2 WAT	40.1667^{aA}	38.3283^{aB}	32.7700^{bC}	20.8783^{cG}	29.9833^{aD}	22.3433^{cF}	30.2733^{aD}	24.7000^{aE}
SED	0.4976 (columns)				0.4504 (Rows)			
LSD	0.9946 (columns)				0.8956 (Rows)			

Superscripts in small letters give comparison along the columns while those in capital letters give comparison along the rows. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 7: Interaction effects of time of introduction of component Maize and population ratio on Flavonoid content of Garden egg (Rainy season)

Time of Introduction	Population Density Ratio							
	100:100	100:75	100:50	100:25	75:100	50:100	25:100	0: 100
2 WBT	9.5767^{bC}	11.5083^{aABC}	9.7883^{bBC}	11.9883^{aA}	12.2217^{aA}	11.8783^{aAB}	12.8233^{aA}	9.7033^{aC}
STT	7.8917^{bBC}	9.7917^{aAB}	6.7400^{cC}	11.8467^{aA}	5.8167^{cC}	6.5400^{cC}	11.8133^{aA}	10.1650^{aA}
2 WAT	12.1217^{aA}	7.7033^{bCD}	12.3933^{aA}	12.2350^{aA}	9.6233^{bBC}	9.6517^{bBC}	6.9350^{bD}	10.4467^{aAB}
SED	1.032 (columns)				1.071 (rows)			
LSD	2.0492 (columns)				2.1307 (rows)			

Superscripts in small letters give comparison along the columns while those in capital letters give comparison along the rows. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 8: Interaction effects of Year, time of introduction of component Maize and population ratio on Flavonoid content of Garden egg fruit (Dry season)

Year	Time of Introduction	Population Density Ratio							
		100:100	100:75	100:50	100:25	75:100	50:100	25:100	0:100
2014	2 WBT	10.37^{c}	12.76^{b}	10.33^{c}	13.00^{ab}	13.37^{a}	13.08^{ab}	12.96^{ab}	10.32^{c}
	STT	8.45^{c}	9.00^{c}	6.80^{d}	12.65^{a}	5.00^{e}	7.04^{d}	12.67^{a}	11.17^{b}
	2 WAT	13.00^{a}	8.41^{d}	13.19^{a}	13.23^{a}	10.33^{b}	9.53^{c}	7.00^{e}	10.00^{bc}
2015	2 WBT	10.00^{c}	11.51^{b}	10.13^{c}	12.00^{b}	13.14^{a}	13.01^{a}	13.29^{a}	10.33^{c}
	STT	8.65^{c}	9.10^{c}	6.90^{d}	12.00^{a}	5.96^{e}	7.08	12.00^{a}	11.33^{b}
	2 WAT	12.33^{b}	8.27^{e}	13.00^{a}	13.23^{a}	10.67^{c}	9.27^{d}	7.33^{f}	10.33^{c}
SED		0.291(Rows)							
LSD		0.579 (Rows)							

The means followed by the same letter do not differ statistically between each other. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 9: Interaction effects of time of introduction of component Maize and population ratio on DPPH of Garden egg (Rainy season)

Time of Introduction	Population Density Ratio							
	100:100	100:75	100:50	100:25	75:100	50:100	25:100	0: 100
2 WBT	45.14^{aB}	41.44^{aBC}	53.10^{aA}	44.70^{bB}	40.72^{bBC}	38.68^{bC}	39.54^{aBC}	43.77^{abBC}

STT	40.49^{aBC}	31.69^{bD}	36.85^{bBCD}	53.35^{aA}	50.15^{aA}	36.04^{bCD}	41.82^{aB}	48.92^{aA}
2 WAT	33.90^{bE}	35.99^{abDE}	41.63^{bCD}	47.37^{bAB}	41.68^{bC}	51.89^{aA}	40.91^{aCD}	41.73^{bBC}
SED		2.886 (columns)				2.850 (rows)		
LSD		5.7345 (columns)				5.6671 (rows)		

Superscripts in small letters give comparison along the columns while those in capital letters give comparison along the rows. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

Table 10: Interaction effects of time of introduction of component Maize and population ratio on (DPPH) of Garden egg (Dry season)

Time of Introduction	Population Density Ratio							
	100:100	100:75	100:50	100:25	75:100	50:100	25:100	0: 100
2 WBT	44.05^{aB}	40.43^{aC}	56.12^{aA}	44.42^{cB}	40.16^{cC}	36.45^{bD}	37.92^{bD}	43.42^{bB}
STT	41.21^{bC}	32.41^{bE}	34.97^{cD}	52.13^{aA}	50.30^{aB}	35.85^{bD}	40.67^{aC}	49.33^{aB}
2 WAT	33.54^{cE}	33.20^{bE}	44.84^{bC}	47.67^{bB}	43.40^{bC}	54.60^{aA}	41.00^{aD}	40.50^{cD}
SED	0.911 (columns)				0.909 (rows)			
LSD	1.8099 (columns)				1.8077 (rows)			

Superscripts in small letters give comparison along the columns while those in capital letters give comparison along the rows. 2 WBT = 2 Weeks before transplanting; STT = same time as transplanting; and 2 WAT = 2 Weeks after transplanting

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