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Research Paper

Response of dry season garden egg (*Solanium melongena*) to watering regime and organic mulching levels in Okigwe, Southeastern Nigeria

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Abstract. Rain fed garden egg cultivation is dominant in the farming systems of Okigwe southeastern Nigeria. Farmers seldom cultivate garden egg during dry season in the study area due to low soil moisture. This study was therefore designed to determine the level of water requirement and mulching level that could guarantee off season cultivation of garden egg in Okigwe. The dry season field experiment was laid out in a randomized block design, replicated three times in 7 × 4 factorial combinations. The factor A treatments was watering regimes (0, 500, 1000, 1500, 2000, 2500 and 3000 L/ha) while the factor B was four organic (sawdust) mulching levels (0, 5, 10 and 15 t/ha). Data collected were subjected to analysis of variance. Results showed significant differences ($P<0.05$) in all the weed infestation, growth and yield parameters. The result also showed increase in mulching levels with significant reduction in weed density and biomass. The application of 1500 L/ha produced 19.13 and 18.93 t/ha fruits respectively. The least fruit yield 9.56 and 9.11 t/ha respectively, was from the control (no irrigation) treatment. The application of 3000 L/ha of irrigation water produced 1-53% and 2-56% more fruit yield than other irrigation water levels in 2013 and 2014 cropping seasons, respectively. The result also indicated significant fruit yield of 22.05 and 22.62 t/ha from application of 15 t/ha sawdust while the least fruit yield; 9.80 and 9.29 t/ha, respectively was from control (no mulching) treatment. The interaction effect between irrigation water and mulching levels on fruit yield varied significantly different in both cropping seasons. The highest fruit yield, 25.86 and 26.80 t/ha, in both cropping seasons were observed between 3000 L/ha and 15t/ha sawdust while the least, 5.16 and 3.75 t/ha, was obtained from the interaction of no irrigation water and no mulching. The 1500 L/ha irrigation water and 10t/ha organic mulching (sawdust) were recommended for off season cultivation of garden egg in Okigwe southeastern Nigeria.

Keyword: Irrigation water, mulching, garden egg, growth, yield.

INTRODUCTION

Garden egg (*Solanum melongena*) belongs to the family *Solanaceae*, which include other economically important crops such as tomatoes, pepper, Irish potato etc. Garden egg is one of the leading fruits and leafy vegetables in the farming systems of southeastern Nigeria that is grown in all seasons for both its leaves and immature fruits. In Nigeria, the production of garden egg is almost throughout the country only that varieties and species differ in different areas and zones. Garden egg production is one of the major sources of income to rural women and their household in all the agricultural zones of the country. The garden egg plays central role of tradition

and cultural of people in sub-Saharan Africa (Chinedu *et al*., 2011). It is offered as dessert fruit in traditional ceremonies such as marriage, child naming, thanksgiving services and other socio-cultural gathering. In southeastern Nigeria where cola nut are usually celebrates, garden egg is becoming an alternative to cola nut due to high content of *caffine* and its health implications. Garden egg or cola nut is the first edible food offers to a visitor or strangers. The most elderly person especially men always bless the cola nut or garden egg be could be serve to the strangers, visitors or in a social or religious gathering. The

In 2013, global production of garden egg was 49.4 million tons more than 1,600,000 hectares devoted to the cultivation of garden egg in the world (FAOSTAT, 2015). The 57% of world output comes from China alone while India produced 27% (FAOSTAT, 2015). Garden eggs produce higher yield in a moist soil, but often much less for traditional varieties grown without supplementary irrigation. In Nigeria, Ibia and Udo (2009) reported that they tolerate high soil moisture and does best under irrigation in the warm months of the year.

Despite the nutritive, social and economic significance of garden egg in southeastern Nigeria, the production of garden egg and other annual crops cannot be sustained only though rain fed agriculture. Rain fed agriculture is becoming increasing unable to meet the food needs of Nigeria. Irrigation which is artificial application of water to crops plays a vital role in ensuring continuity in production and good quality crops (Oiganji *et al*., 2013). Irrigation maintains moisture in the soil. Soil moisture and organic matter content determine the amount of water soils can hold. The soil moisture level has a positive effect on the seed germination and uptake of plant nutrients. It is essential to nutrient uptake by root interception, mass flow and diffusion. Roots intercept more nutrients especially Ca^{2+} and Mg^{2+}, in moist soil than dry soil because root growth is more extensive in moist soil. Crop response to fertilizers is also related soil moisture (Onwueme and Sinha, 1991). Soil moisture influences plant growth, flowering and maturation. It promotes activities of soil micro-organisms. It is also essential for the growth of roots and root penetration. Irrigation is necessary for absorption of mineral nutrient especially during dry season. Senyigit *et al*. (2011) reported that increasing irrigation interval enhanced garden egg yield. Senyigit *et al*. (2011) stated that irrigation is a vital importance for successful vegetable production because vegetable need irrigation water during all the growing periods. Artificial application of water has resulted to increase in yields of vegetables such as the eggplant (Chartzoulakis and Drosos, 1995; Aujla *et al*., 2007), cucumber (Yuan *et al*., 2006) and pepper (Antony and Singandhupe, 2004; Sezen *et al*., 2006) based on their traditional irrigation methods. The goal of irrigation farming is not only limited to food supply alone but also to promote income generation and employment during off season and slack or short spell period of rainfall especially between the months of October and March in the study area.

However, mismanagement of irrigation or injudicious application of excess water to crop has some adverse effects on both soil and crop. Hagan *et al*. (2008) asserted that excessive irrigation delay maturity, harvesting, encourage vine growth, and reduces the soluble solid content of tomato while insufficient moisture decreases yield and crop quality. In soils, excessive irrigation result in poor aeration of soil, surface runoff, leaching, deep percolation, and build up water table with consequent decrease in root zone depth, water logging and possibly soil salinity (Onwueme and Sinha, 1991; Udoh and Ndon, 2016).

Mulching is also another agronomic practice for conserving soil moisture and reducing the rate of evaporation (Oiganji *et al*., 2013). In using organic mulches such as sawdust, grasses, crop residue etc, the depth of organic mulch and fraction of the soil surface covered will affect the amount of reduction in evaporation from the soil surface. Mulching increases soil temperature, reduce soil compaction, fertilizer leaching, evaporation, and weed problem (Rafat and Rafiq, 2009).

In spite the nutritional values, social cultural and economic significance of garden egg, research on how to cultivate garden egg during off season in southeastern Nigeria has not received any attention. There are no irrigation facilities in the study area except rudimentary irrigation along the river coast and wetland without standardization. The tremendous increase in rudimentary irrigation was due to increase in demand and high cost of vegetable during off season. However, virtually no study have been done to establish the actual irrigation water requirement for garden egg during off dry season in the study area and appropriate level of organic mulch that would conserve soil moisture. Therefore, the objectives of this study were to assess the water and mulching requirement for off season cultivation of garden in Okigwe Southeastern Nigeria.

MATERIALS AND METHODS

Experimental site location

The field experiment was carried out at Ocha Farm Settlement in Umuowa Ibu 1 in Okigwe a kilometer away from National Horticultural Research Institute (NIHORT), Mbato Sub-Station Okigwe Local Government Area of Imo State Nigeria. Okigwe (05° 28′ N, 07° 32′ E, 127 m altitude) is located in the tropical rainforest agro-ecology of southern Nigeria. The rainforest zone receives about 2200 mm rainfall annually. The rainfall pattern is bimodal, with long (March to July) and short (September to November) rainy seasons separated by a short dry spell of uncertain length usually during the month of August.

The mean relative humidity is 75% and the atmospheric temperature is between 27 to 30°C. The mean sunshine hour is 2.5 to 6.7 h. The soil of the study area belongs to the broad group of ultisol.

The experiment was carried out on a plot that had been cultivated continuously by farmers and prior to the experiment; maize and yam were harvested on the plot two year before the experiment.

The organic matter content of the soil was 2.12%, total nitrogen was 0.91%, and available phosphorus was 33.56 mg/kg the calcium, magnesium, and potassium and Na content were, 2.44, 0.13 and 0.11 coml/kg while sodium was 0.08 cmol/kg. The soil was slightly acidic with pH value of 5.60 while particle size distribution was; sand 91.20%, silt 3.98% and clay 5.72%.

Experimental design, treatment and layout

The field experiment was laid out in randomized complete block design (RCBC), replicated three times in 7 × 4 factorial combinations. The factor A treatments were seven (7) watering regime (0, 500, 1000, 1500, 2000, 2500 and 3000 L/ha) whereas four (4) organic mulching levels (control (no mulch), 5, 10 and 15 t/ha) constituted the factor B treatment. The entire experimental plot site occupied 142 m × 18 m. Each replication measured 142 m × 4 m while each plot size was 4 m × 4 m. The replications were separated by 2 m path while plots were demarcated by 1 m path way. The actual rate of water applied to each plot of 4 m × 4 m were zero for control, 0.8 L for 500 L/ha plot, 1.6 L for 1500 L/ha, 2.4 L for 1500 L/ha, 3.2 L for 2000 L/ha, 4 L for 2500 L/ha and 4.8 L for 3000 L/ha. The irrigation interval was fortnightly for three months after transplanting (MAT). The actual weight of organic mulch (sawdust) applied per plot basis were: 0, (control), 8 kg/plot for 5t/ha sawdust, 16 kg/plot for 10t/ha sawdust and 24 kg/plot for 15 t/ha sawdust.

The garden egg seeds were raised in nursery. The garden egg variety used was locally known as *Ngwa* large. Farmers in Ndikpa farm settlement in Okigwe were the custodian of the *Ngwa* large. The garden egg seedlings were raised in a nursery bed of 4.3 m × 1.3 m dimension. The seeds were sown on bed by drilling and the bed was lightly covered with dried grass mulch and watered until seedlings emerged. The mulching materials were removed gradually as seedling emerged. A week before transplanting to the permanent field, the seedling were exposed to sunlight to be harden.

Transplanting was done in the permanent field when the seedlings were up to 15 cm high at 40 days after sowing. The seedlings were watered adequately for maximum water uptake before transplanting. Transplanting was done in the evening and the seedlings were watered immediately to avoid transplanting shock. Method of transplanting used was ball of earth. Seedlings were transplanted at spacing of 75 cm inter row × 60 cm intra row. Compound fertilizer (NPK 15: 15: 15) was applied at rate of 200 kg/ha at 10 days after transplanting.

Artificial water was applied at interval of 14 days (2 weeks) on treatment basis with of knapsack sprayer (Model: BIKY Deluxe Agro 3WBS - 20). The application was done during evening period. Water was carefully sprayed on soil and vegetative parts of the plants which drained to the soil. The application of water to vegetative parts before flower was carried out to reduce dust particles and also imitate the natural rainfall pattern. The source of water used was from a stream known as *Ugbi,* which is the closest source of water to the farmers in the farm settlement. The chemical composition of Ugbi River was analyzed at Department of Crop and Soil Science Laboratory University of Uyo, Akwa Ibom State, Nigeria. The pH value of *Ugbi* was 7.50 while the HCO^-, Cl^- and SO_4^- were 7.25, 0.28 and 0.50, respectively.

Manual weeding was carried out three times at 4, 8, and 12 weeks after transplanting (WAT) with the aid of native weeding hoe.

Stem and leaves attack were controlled by spraying Delthrin (Karto 2.5 EC lambdacyhalothrin). The formulation was 50 ml in 20 L of clean water contained in a 20 L-capacity Knapsack Sprayer (Model: BIKY Deluxe Agro 3WBS - 20). The fruit borer was controlled by spraying a fungicide, Z-Force Carbamate (powder) using 250 g dissolved in 20 L of water at fortnightly intervals. Whenever the plants were sprayed, harvesting of fruit was delayed for 2 days. Harvesting was done every 5 to 6 days.

Data collection

The following weed infestation, growth, yield and yield components were determined: Weed density (m^2); The population of weeds per plot was determined by counting the number of weeds (m^2) with aid of 1 m × 1 m quadrat thrown two times at random in each garden egg plot. Dry weed biomass (g/m^2): The weeds collected were air dried for 5 days in the field. The final weight (dry biomass) was determined with aid of electronic weighing balance (g). Growth and Yield Data: The following growth and yield parameters were assessed; Plant height (cm): Plant height was determined by measuring the crop from the soil surface level to the growing point using measuring tape. Number of leaves: Number of leaves per plant was counted per tagged plant. Number of branches per plant: Number of branches per plant was counted per tagged plant. Leaf area (cm^2): The leaf area was determined using a product of length and width and multiplying same with a correction factor of 0.65 (Mohammed and Krishnamurthy, 2001).Thus leaf area = L × W × 0.65; L = length of leaf, **W**= width (cm) or breadth of the leaf. Stem girth (cm): This was determined with aid of Vernier Caliper (Model: Helios Extra, Stainless Steel Mitutoyo

530 -312. Made in Japan).

Yield and yield components parameter

Number of fruits per plant: This was counted on the tagged plants per plot. Length of the fruits: The length of fruit was determined by measuring tape. Circumference of the fruit: The circumference was determined by aid of Vernier Caliper (Model: Helios Extra, Stainless Steel Mitutoyo 530-312. Made in Japan). Weight of fruits per plant: The fruits per plant were weighed using a sensitive top load weighing balance (Model: Adventurer Pro AS3101, Made in Switzerland) and then converted to tones per hectare.

Statistical analysis

All the growth and yield data were subjected to statistical analysis of variance and means that showed significant difference were compared using Least Significant Difference (LSD) at 5% probability level.

RESULTS

Weed density per m^2 as influenced by watering regime and mulching in garden egg field differed significantly (P<0. 05) in all the weeks under observation. At 4 weeks after planting (WAP) increase in litre of water per hectare resulted to increase in weed density in both cropping seasons while from 8-12 WAP, the result indicated significant decrease in weed density with increase in water level. At 8 WAP, the highest weed density 62.40 and 60.20 weeds per m^2 in 2013 and 2014 cropping seasons respectively recorded in the treatment of 500 L/ha. At 12 WAP, the highest weed density of 33.75 and 35.18 weeds per m^2 in 2013 and 2014 cropping seasons respectively was recorded in control treatment (no irrigation), compared to lowest weed density of 23.33 and 17.16 respectively recorded in the treatment of 3000 L of water per hectare.

The result of organic mulch level on weed density in garden egg field differed significantly (P<0.05) from 4 to 12 WAP in both cropping seasons. The result showed that increase in organic mulch level resulted to significant reduction in number of weeds per plot. Control (no mulch) had highest weed density; 75.01, 59.49, 47.17 at 4, 8 and 12 WAP respectively in 2013 cropping season. In 2014 cropping season, the following weed density; 98.57, 60.55 and 50.81 weeds per m^2 at 12 WAP respectively was recorded in control treatment. The application of 15 t/ha of organic mulch resulted to the lowest density of 2.55 and 3.40 at 8 and 12 WAP in 2013 trial with the following; 5.00 and 4.22 corresponding mean weed density in 2014 trial. The result of interaction effect between watering regime and organic mulch level on weed density per m^2 showed no significant difference (P>0.05) in all the weeks under investigation irrespective of cropping season.

Weed biomass (gm^2) as influenced by watering regime and mulching in garden egg field differed significantly (P<0.05) and maintain a similar pattern as in weed density (Table 1 and 2). At 4 WAP in both cropping seasons application of 3000 L of water per hectare resulted in significant increase in weed biomass, 74.65 and 75.75 g in 2013 and 2014 cropping seasons respectively, whereas 45.11 and 56.81 g respectively was recorded in control (no irrigation) treatment. At 8 and 12 WAP, the highest weed biomass (60.41 and 45.66 g) and (63.50 and 47.50 g) in 2013 and 2014 trial respectively was recorded in control (no irrigation) compared to the least weed biomass (31.07 and 10.56) and (28.66 and 10.01 g) respectively recorded in treatment of 3000 L/ha application. The result indicated that control (no irrigation) treatment had the highest weed biomass accumulation of 6-49 and 53-77% at 8 and 12 WAP respectively in 2013 trial above other other treatments. In 2014 trial, control still had the highest weed biomass accumulation of 17-55% and 35-79% respectively above other water level treatments.

The effect of organic mulch level on weed biomass in garden egg field indicated significant effect (Table 3), the increase in organic mulch level resulted in significant decrease in weed biomass plot. The highest weed biomass; 90.70, 59.20 and 33.43 gm^2 at 4, 8 and 12 WAP respectively in 2013 was from recorded in control treatment (no mulching). In 2014 cropping, the following corresponding weed biomass of 75.60, 42.68 and 25.60 gm^2 was also recorded in control treatment. The least weed biomass 0.99, 0.15 and 0.12 gm^{-2} at 4, 8 and 12 WAT in 2013 trial was recorded in treatment of 15t/ha of organic mulch. In 2014, the weed biomass of 5.22, 1.55 and 0.10 gm^{-2} at 4, 8 and 12 WAT respectively was also recorded in treatment of 15 t/ha of organic mulch. The result of interaction effects between watering regime and organic mulch level on weed biomass showed no significant difference (P<0.05) in all the weeds under study.

Plant height as influenced by watering regime and organic mulch level showed significant difference (P < 0.05) irrespective of cropping season (Table 3). The result showed increase in garden egg height with increase in watering level. The result further indicates no significant difference in plant height when the height recorded from application of 1500 L/ha to 3000 L/ha were compared in both cropping seasons. The shortest garden egg height 7.50, 16.05, 27.60 and 32.11 cm at 2, 4, 6 and 8 WAT respectively was recorded in control treatment in 2013 trial. In 2014 trials, the same trend; 8.12, 18.25, 26.88 and 34.18 cm respectively was recorded in the control treatment. The tallest garden egg; 69.50 and 71.95 cm was recorded in treatment of 3000 L/ha in 2013

Table 1. Weed density (Weeds/m^2) in garden egg farm as influenced by watering regime and mulching.

Treatment	2013			2014		
	Weeks after transplanting			Weeks after transplanting		
	4	8	12	4	8	12
Watering regime (L/ha)						
0	65.30	45.20	33.75	68.75	52.16	25.18
500	80.40	62.40	26.40	91.75	60.20	28.13
1000	85.00	41.30	26.45	101.25	48.18	22.40
1500	98.00	40.40	28.75	112.30	47.40	21.09
2000	99.75	32.47	25.40	119.20	48.01	18.77
2500	101.30	32.50	23.40	119.80	45.20	18.60
3000	108.40	31.09	23.33	122.70	45.26	17.16
LSD (P<0.05)	5.78	3.81	2.70	7.15	3.60	3.11
Organic mulching (t/ha)						
0	75.01	59.47	42.17	98.57	60.55	50.81
5	47.50	24.18	18.20	41.68	28.16	25.40
10	20.40	10.70	9.72	18.17	9.89	11.20
15	7.34	2.55	3.40	8.55	5.00	4.22
LSD (P<0.05)	3.69	6.01	4.12	7.09	5.18	3.67
Interaction	Ns	Ns	Ns	Ns	Ns	Ns

Ns = not significant

Table 2. Weed biomass (g/m^2) in garden egg farm as influenced by watering regime and mulching.

Treatment	2013			2014		
	Weeks after transplanting			Weeks after transplanting		
	4	8	12	4	8	12
Watering regime (L/ha)						
0	45.11	60.41	45.66	56.81	63.50	47.50
500	60.30	56.60	21.40	62.77	52.44	30.70
1000	62.14	51.00	18.70	61.80	50.70	21.14
1500	70.88	45.00	14.25	71.45	41.30	14.75
2000	71.45	41.09	13.14	72.80	39.40	11.25
2500	74.60	33.43	11.75	74.12	31,07	11.22
3000	74.65	31.07	10.56	75.75	28.66	10.01
LSD (P<0.05)	5.31	5.81	2.42	4.85	3.75	2.71
Organic mulching (t/ha)						
0	90.70	59.20	33.45	75.60	42.68	25.60
5	31.40	19.40	4.75	39.45	15.40	3.77
10	18.25	7.55	0.70	25.01	6.50	0.61
15	0.99	0.15	0.12	5.22	1.55	0.10
LSD (P<0.05)	3.30	2.75	2.35	3.82	2.16	2.20
Interaction	Ns	Ns	`Ns	Ns	ns	Ns

ns = not significant

and 2014 cropping season at 8 WAT. The result showed that irrigating up to 3000 L/ha resulted in 2-54% and 1-53% increase in garden egg height in 2013 and 2014 cropping seasons respectively above other irrigation treatments.

Effect of mulching on garden egg height differed significantly (P<0.05) (Table 3). Application of organic mulch up to 10 and 15 t/ha resulted in significant increase

Table 3. Plant height (cm) as influenced by watering regime and mulching.

Watering regime (L/ha)	2013				2014			
	Weeks after transplanting				Weeks after transplanting			
	2	4	6	8	2	4	6	8
0	7.50	16.05	27.60	32.11	8.12	18.25	26.88	34.18
500	10.40	20.20	32.40	67.40	11.33	22.30	35.12	60.01
1000	13.41	25.12	38.12	63.40	14.91	29.40	36.55	62.50
1500	15.08	26.81	41.14	65.10	15.50	30.12	42.60	68.36
2000	15.15	26.85	42.30	67.75	15.90	30.90	43.70	71.40
2500	15.22	27.01	42.90	68.11	16.01	31.20	43.90	71.55
3000	15.25	27.50	42.91	69.50	16.20	31.26	43.95	71.95
LSD (P<0.05)	2.11	3.25	3.60	5.31	2.69	2.95	4.18	4.87
Organic mulching (t/ha)								
0								
5	10.87	21.75	39.51	69.01	9.75	23.40	32.60	71.25
10	16.14	27.40	46.40	71.25	15.33	29.91	45.60	71.66
15	16.83	28.12	46.70	72.40	15.51	30.75	45.60	72.12
LSD (P<0.05)	3.16	2.44	3.12	4.12	2.90	3.23	2.84	3.68
Interaction	*Ns	Ns	Ns	Ns	Ns	ns	Ns	ns

ns = not significant

Table 4. Number of garden egg branches per plant as influenced by watering regime and mulching.

Treatment	2013			2014		
	Weeks after transplanting			Weeks after transplanting		
	4	8	12	4	8	12
Watering regime (L/ha)						
0	2.70	5.16	7.45	2.90	5.09	7.95
500	6.86	9.75	12.30	5.75	8.99	12.90
1000	7.75	11.30	17.40	8.10	12.40	18.45
1500	7.25	11.40	18.15	8.19	12.70	19.80
2000	7.60	11.77	18.24	8.20	12.80	20.40
2500	7.67	11.90	18.77	8.21	12.82	20.45
3000	7.69	11.92	18.79	8.25	12.90	20.66
LSD (P<0.05)	1.22	1.93	2.33	2.58	2.78	3.01
Organic mulching (t/ha)						
0	3.60	5.99	9.25	2.55	6.28	11.20
5	6.75	11.29	15.70	6.44	12.40	16.50
10	8.45	12.08	19.70	8.77	13.75	20.15
15	8.75	12.15	22.40	8.92	12.80	22.80
LSD (P<0.05)	2.30	2.15	3.15	2.55	1.98	2.80
Interaction	*Ns	0.12	0.35	Ns	0.41	0.70

NS = not significant

in garden egg height compared to mean height recorded in control treatment. The result of interaction between watering regime and mulching indicated significant difference (P<0.05) only at 6 and 8 WAP in both cropping seasons (Table 3).

Numbers of garden egg branches per plant as influenced by watering regime showed significant difference (P<0.05) (Table 4). The least number of branches per plant; 2.70, 5.16 and 7.45 branches are 4, 6 and 8 WAT respectively in 2013 trial was recorded in control treatment. In 2014 trial, the least number of branches per plant; 2.90, 5.09 and 7.95 at 4, 6 and 8

Table 5. Number of garden egg leaves per plant as influenced by watering regime and mulching.

Treatment	2013				2014			
	Weeks after transplanting				Weeks after transplanting			
	2	4	6	8	2	4	6	8
Watering regime (L/ha)								
0	8.22	15.21	25.18	32.60	7.51	14.08	28.17	39.16
500	17.14	25.15	39.81	50.01	13.98	26.81	40.88	52.68
1000	17.50	27.81	50.14	68.33	17.81	28.81	58.75	71.09
1500	17.65	28.70	58.41	72.60	18.20	28.99	58.90	71.80
2000	17.68	29.81	61.30	72.81	18.22	30.12	61.60	72.60
2500	17.70	31.09	61.45	72.90	18.40	30.19	61.75	72.77
3000	17.80	31.12	61.65	72.98	18.42	30.40	61.88	73.81
LSD (P<0.05)	2.08	4.25	4.33	4.81	2.11	2.91	3.82	3.60
Organic mulching (t/ha)								
0	5.30	11.25	19.65	29.39	7.34	12.92	20.61	30.60
5	16.70	26.70	39.30	50.16	15.30	27.30	40.12	52.40
10	18.75	31.30	48.70	69.80	20.11	35.11	51.09	71.50
15	19.40	34.31	60.30	72.17	20.81	35.60	62.70	71.70
LSD (P<0.05)	3.12	3.75	5.67	5.91	3.25	4.30	5.08	5.88
Interaction	*Ns	Ns	1.55	1.75	Ns	ns	0.92	1.82

*ns = not significant

WAT was also recorded in control. Compared to 18.79 and 20.66 branches recorded at 8 WAT in 2013 and 2014 cropping seasons respectively. The mean number of branches per plant recorded among the treatments of 1000, 1500, 2000, 2500 and 3000 L/ha showed no significant difference (P<0.05) when the values were compared in all the weeks under investigation irrespective of year of trial.

Application of organic mulch in garden egg field indicated significant difference (P<0.05). The increase in organic mulch level resulted in significant increase in number of branches per plant. The result also revealed no significant effect between 10 and 15 t/ha treatment in all the weeks under observation irrespective of year of trial (Table 4). At 4 and 6 WAP in both years of trial, the mean number of branches per plant recorded in the treatment of 10 t/ha of organic mulch was not significantly above the mean number of branches per plant recorded in treatment of 5 t/ha in all the weeks under study. The result of interaction effect between watering regime and organic mulch level indicated significant response at 6 and 8 WAT in both years under trial.

Number of garden egg leaves per plant as influenced by watering regime and mulching showed significant difference (P<0.05) in each of the factor in all the weeks under observation irrespective of year under trial, increase in rate of application led to increase in leaves production. Application of 3000 L/ha led to production of highest number of leaves per plant in all the weeks under study, although, the mean number of leaves per plant recorded in 3000 L/ha treatment was not significant when compared to the mean number of leaves per plant recorded in treatments of 1000, 1500, 2000, and 2500 L/ha in both cropping seasons. In 2013 and 2014 trials, the highest number of leaves per plant 72.98 and 73.81 at 8 WAP respectively was recorded in treatment of 3000 L/ha whereas the least; 32.60 and 39.16 respectively was recorded in control treatment. The result showed that application of 3000 L/ha of water resulted in 0-55% and 1-50% increase in number of leaves per plant higher than other treatments.

Application of organic mulch also resulted in significant increase in number leaves per plant (Table 5). Application of 15 t/ha had higher number of leaves on average; 19.40, 34.31, 60.30 and 72.17 at 2, 4, 6 and 8 WAT respectively in 2013 trial while 20.81, 35.60, 62.70 and 71.70 respectively was recorded in control (no organic mulch) treatment. In 2014 trial, the same trend of low number of leaves per plant was recorded in control with the corresponding mean values of 7.34, 12.92, 20.61 and 30.60 respectively. The result showed that application of 15 t/ha of mulch results in increase in number of leaves per plant of percentage difference of 3-59% and 0-57% above other treatments at 8 WAT in 2013 and 2014 trials respectively. The interaction between both factors on number of leaves per plant indicated significant positive respond at 6 and 8 WAT in both years under study (Table 5).

Table 6 shows the interaction effect between watering regime and mulching on number of garden egg fruit per plant. The result showed that increase in levels of watering regime and organic mulch led to significant increase in number of fruits per plant. In treatment of 3000 litres t/ha under 15 t/ha of organic mulch had average 24.73 and 25.50 fruits in 2013 and 2014 trials respectively. The least number of fruits per plant 4.20 and 4.75 was recorded on the treatment interaction between the two control treatments in 2013 and 2014 trials

Table 6. The interaction effect of watering regime and mulching on number of garden egg fruits per plant in 2013 and 2014.

Watering regime (L/ha)	2013					2014				
	Organic mulch (t/ha)					Organic mulch (t/ha)				
	0	5	10	15	Mean	0	5	10	15	Mean
0	4.20	8.45	8.75	8.89	7.57	4.75	6.75	9.25	9.87	7.66
500	6.31	10.40	12.30	12.55	10.39	6.82	11.42	13.47	18.33	12.51
1000	9.30	13.77	14.70	15.66	13.36	9.45	11.42	18.75	18.99	16.46
1500	13.40	18.70	20.20	22.45	18.69	12.88	18.66	21.68	22.45	19.43
2000	13.50	18.90	21.66	24.40	19.62	13.75	20.70	22.45	25.17	20.71
2500	13.55	18.92	22.70	24.60	19.94	14.20	21.45	22.80	25.41	21.04
3000	13.69	18.98	22.75	24.75	20.04	14.25	21.75	22.40	25.50	21.00
Mean	8.64	15.45	17.58	19.04		10.87	21.82	18.69	20.82	
	LSD (P<0.05) = 2.51					LSD (P<0.05) =2.33				

Table 7. Interaction between watering regime and mulching on garden egg fruit yield in tonnes per hectare.

Watering regime (L/ha)	2013					2014				
	Organic mulching (t/ha)					Organic mulching (t/ha)				
	0	5	10	15	Mean	0	5	10	15	Mean
0	5.16	9.20	11.59	12.30	9.56	3.75	8.74	11.20	12.75	9.11
500	7.50	12.30	15.30	18.70	13.45	6.12	11.36	13.60	19.26	12.59
1000	9.70	14.70	18.20	21.75	16.09	8.55	13.75	19.53	22.80	16.16
1500	11.25	18.55	22.40	24.30	19.13	10.25	18.98	21.80	24.70	18.93
2000	11.60	19.59	22.50	25.66	19.84	11.66	19.40	21.99	25.60	19.66
2500	11.70	19.74	23.06	25.75	20.06	11.89	19.45	22.70	26.40	20.19
3000	11.81	19.80	23.45	25.86	20.23	12.80	19.80	22.80	26.80	20.55
Mean	9.80	16.25	19.50	22.05		9.29	15.97	19.02	22.62	
	LSD (P<0.05) =					LSD (P<0.05) =				

respectively.

Table 7 shows the interaction effect between watering regime and organic mulch level. The result indicated significant increase in yield of garden egg fruit. The increase in both factors led to increase in fruit yield. Comparing the fruit yield obtained at interaction of 3000 L/ha and 15 t/ha of organic mulch; 25.86 and 26.80 t/ha in 2013 and 2014 trials respectively was not significantly (P<0.05) when compared to the yield obtained in watering regime of 1000 to 2500 L/ha at 15 t/ha of organic mulch in both trials. The results also showed that fruit yield obtained from 3000 L/ha of water and 15 t/ha were not significant when compared to treatment interaction of 1500 L/ha and 10 t/ha in both trials.

DISCUSSION

The result vegetative characteristics and yield of garden egg as influenced by watering regime and organic mulching level showed significant difference (P < 0.05) in number of leaves per plant, plant height, number of branches per plant, number of fruits per plant as well as fruit could be due to the ability of those treatment plots that received water to maintain high moisture level that could sustain the plants for growth and development. Availability of moisture encourages bio-decomposition of organic matter, increases mineralization and also encourages nutrient absorption by the plant roots, also watering at weekly interval could equally resulted to cooling and temperature regulation which led to garden egg growth on the treatments to be health and grow vigourous. The availability of moisture in irrigated plots could also led to better biochemical and physiological process compared to control treatment where low soil moisture could have resulted in low rate of biochemical and physiological activities.

Result of mulching effect also indicated significant difference (P < 0.05) with increase in organic mulch level resulting to increase in growth and yield parameters. This could be as a result of organic mulch protecting the soil from direct sunlight thereby reducing evaporation The application of organic mulch could also reduce weed growth on those treatment that received organic mulch, which invariably reduced competition for nutrient and space as well as being alternative host of pest and diseases vectors. The treatment that received organic mulch also performed better than control could be that

organic mulch material could have also served as organic fertilizer, which invariably supplies nutrients as organic manure. This observation agreed with the findings of Mark (2015) that covering the soil surface with suitable mulch can reduce weed seed germination, shade and physical hinder emerging weeds; enhanced crop growth and competitiveness.

The weed density and biomass as influenced by watering regime and mulching showed significant difference ($P < 0.05$). At 4 WAT the highest number of weeds per m^2 observed in irrigated plots compare to non-irrigated plot (control) could be that high moisture concentration in the irrigated plots stimulated weed seed germination especially when garden egg canopy spread were not sufficient to shade the weeds. At 8 and 12 WAT, the study indicated higher weed density and biomass in non-irrigated plot compared to irrigated plots, this would be as a result of garden egg to form a well developed canopy spread through higher number of leaves per plant and more number of branches per plant which invariably covers light penetration to the weeds, this agreed with report of Akobundu (1997), that higher plant significantly reduces weed infestation. Mulching also resulted to significant reduction in weed density and biomass. The low density recorded in mulched plot could be due to the ability of the mulch material to smoother the ground cover, therefore preventing weed germination and growth. This agreed with report of Gbadamosi *et al*. (2003) that mulching is used in controlling weeds. Onyegbule *et al.* (2014) reported that mulching generally prevents the seed germination of light sensitive weeds.

Conclusion

The results of the field experiment have shown that garden egg could be cultivation in the study area during off-season through judicious soil conservation of irrigation and mulching. The results of the study had shown that irrigating garden egg field once in every two weeks with 1500 L/ha and application of 10 t/ha of organic mulch would guarantee dry season production of garden egg in the study area and also help to reduce high weed infestation which is one of the major threats to garden production in Okigwe southeastern Nigeria.

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