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Effect of Mulching on Weed, Fruit Yield and Economic Returns of Garden Egg (*Solanium melogena*) in Okigwe Southeastern Nigeria

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ABSTRACT

The experiment was carried out at Umulolo in Okigwe Imo State in 2016 and 2017 seasons. The experiment was laid in randomized complete block design, replicated three times. The treatments were mulching materials (two synthetic materials-polythene sheet, trampoline sheet) while natural or organic materials were 6/ha sawdust and grasses and control treatment (no mulching). Result showed significant difference in all the weed infestation parameters, vegetative growth and yield parameters assessed. In both cropping seasons, the control had significant higher weed density and biomass. Garden egg fruit yield as influenced by different mulching materials was also significantly different ($p<0.05$) in both cropping seasons. The highest fruit yield; 22.27 and 23.63 t/ha in 2016 and 2017, respectively was from the plot mulched with sawdust. The grasses mulched plot had 21.19 and 22.17 t/ha fruit yield, respectively. The trampoline plot produced 18.77 and 17.18 t/ha fruit, respectively. The least fruit yield was 5.43 and 6.54 t/ha in both cropping seasons in control treatment. The result showed that the plot mulched with sawdust had 7-76% and 6-72% greater fruit yield compared to the other mulching materials in both cropping seasons. The result of indicated that application of grasses and sawdust were more cost effective in weed management and higher economic returns to management compared to trampoline and polythene sheets. Farmers in the study area were advised to mulch their garden egg field during off-season with sawdust. The application of sawdust would reduce weed infestation and also enhances high fruit yield.

Introduction

Garden egg (*Solanum melongena* L.) also known as garden belongs to the family *Solanaceae*, which include other economically important crops such as tomatoes, peppers, tobacco, and Irish

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potato. Garden egg is a tropical crop and tolerates optimal night temperature of 20⁰C -27⁰C and day temperatures range of 25⁰C - 35⁰C (Udoh and Ndon, 2016). High temperature is often injurious to the root system, eggplant thrives in both wet and dry seasons, but excessive rainfall will check vegetative growth and flower formation (Udoh and Ndon, 2016). Eggplant is sensitive to cold weather; it therefore prefers subtropical conditions with humidity requirements varying according to variety (Rice and Rice, 1987). Despite the high nutritive value of garden, its production in Nigeria is less than national demand. The major constraints to garden egg production are pest and diseases, availability of improved cultivars that withstand biotic and abiotic stress, poor cropping system, soil fertility maintenance cost and availability of inorganic fertilizer etc. The low cultivation of garden egg during off season in Okigwe could due to low rainfall distribution during the second season planting, which results to soil moisture stress and also high weed infestation which require high labour demand (Ikeh and Akpan, 2018). The low yield of garden egg during off season in southeastern Nigeria could be attributed to the facts that some farmer may not have sufficient knowledge on how to conserve the soil for optimum yield of garden egg (Ikeh and Akpan, 2018). Garden egg production is one of the major sources of income to rural women and their household in Nigeria. The economic returns from garden egg production depends on some certain factors such as variety, time of planting, agronomic packages employed in production and availability of ready market (Akpabio, 2018) Therefore, this study becomes necessary to provide a means to increase garden cultivation in Okigwe, Southeastern Nigeria.

Mulching is agronomic practice use in conserving soil moisture and suppress weed. Mulch materials applied to the surface of the soil to suppress weeds, modify soil temperature, reduces water loss, protect the surface and reduce erosion (Ikeh and Akpan, 2018). There are different kinds of organic materials are used for this purpose; include straw, leaf mould, peat and compost. The organic mulches increase earthworm activity at the surface, which promote better and more stable soil structure in the top layers. Organic mulches are derived from plant bodies and animal waste. Organic mulches help in maintaining soil fertility and provide food and shelter for micro fauna such as earthworms and other desirable soil biota. Mulching reduces soil compaction by water droplets and also improves soli structure (Adam et al, 1999). According to Udoh and Ndon (2016) mulching helps to conserve soil moisture because it reduces evaporation by lowering the soil temperature and by increasing the absorption capacity of the upper layer of soil. Benefits of mulching on growth and yield of annual and perennial crops have long been recognized (Ikeh, 2010; Ikeh and Akpan, 2018). Mulching with organic or inorganic materials aims to cover soils and forms a physical barrier to limit soil water evaporation, control weeds, maintain a good soil structure, and protect crops from soil contamination (Udoh and Ndon, 2016). Mulching reduces soil erosion as a result of decreased surface runoff and shielding effect of the mulch materials to reduces kinetic energy of rain from striking the soil surface. Mulches can be composed of organic materials or they may be synthetic consisting of plastics sheets. Synthetic mulches are majorly obtained from petroleum-based materials. These products such as polyethylene and trampoline sheets have been used widely in agriculture, but challenges with these petroleum-based materials include increased runoff volume compared with living mulches (Rice et al. 2001). According to Suh and Kim (1991) Polyethylene sheet mulchhas reported to increase the yield of onion Adetunji (1994) reported that with the exception of saw dust mulch, both natural and synthetic mulches significantly enhanced vegetative growth and bulb yields of onion.

The demand for sustainable weed management and control approaches has resulted from increasing energy, labour and material costs associated with weed control practices in conventional cropping systems (Clements et al. 1995; Feldman et al. 2000). Degraded herbicide compounds have also been detected in surface and ground waters at amounts exceeding maximum contamination levels established by the USEPA (Goolsby et al. 1991; Kolpin et al. 1997) generating an interest in alternative strategies for weed control especially in the tropical countries. Economically and environmentally sustainable weed control alternatives, such as non-synthetic or "natural" mulches, can provide many benefits, including weed suppression and delayed weed seed emergence (Teasdale and Mohler, 1993); soil moisture conservation and improved water infiltration (Hoyt and Hargrove, 1986); enhanced soil stabilization, soil porosity, water holding capacity, microbial population activity, and cation exchange capacity and decreased plant disease (Feldman et al. 2000). Despite of sufficient research on other vegetable and arable crops in Nigeria and other tropical countries, reports on mulching in garden egg during off season cultivation in Okigwe southern Nigeria is rare. This study was, therefore, conducted to observe the effectiveness of natural and synthetic mulching materials on weed severity, vegetative traits, yield attributes and economic returns to management during off-season cultivation. This study was design to evaluate the effect of organic and synthetic mulching on garden egg fruit yield and economics returns to management.

Materials and Methods

This study was conducted during the early cropping season of 2016 and 2017 at School Farm of Boys' Secondary School Umulolo, Okigwe which is less than a kilometer from National Horticultural Research Institute (NIHORT) Sub-Station, Okigwe Imo State Nigeria. The mean annual rainfall was 2500.00 mm with a mean monthly relative humidity of 75% while the mean monthly atmospheric temperature ranges is about 26.80^{0}c. The experimental site use had been under continuous cropping for the past 20 years to various arable crops such as cassava, maize, cowpea, and cassava.

Before this study was carried out in both cropping seasons, the experimental site was left to fallow for one year.

The entire experimental site was 26 m x 18 m. Each plot was 3.0 m x 3.0 m, replicates were demarcated by 1m paths. The plots were also demarcated by 1m paths respectively. The treatments were of polyethene, trampoline, sawdust, grasses and control (no mulching). The experimental site was manually cleared on last week of August of 2016 and 2017. The garden egg seedlings were raised in a nursery bed of 4.3mx1.3m dimension. The seeds were sown on bed by drilling. The bed was lightly covered with dried grasses mulch and watered until seedlings emerged. The mulching materials were removed gradually as seedling emerged; the garden egg variety used was *Anara Ngwa* (Popular local cultivar in the study area). The seedlings were transplanted from the nursery bed to the permanent site field on the same day. Transplanting was done in the evening just after rainfall. Only healthy seedlings and equal size were transplanted on seedbed of 3m x 3m at spacing of 90cm x 60cm. The polythene and trampoline material of 3m x 3m were spread on treatment basis with small holes of 13cm circumference were the seedling were transplanted through while 10 t/ha of sawdust and grasses were spread evenly on treatment basis.

The inorganic fertilizer (200kg/ha NPK 15.15.15) was applied to the crop two weeks after transplanting and top dressed with urea (25 kg/ha) during flowering. Stem and fruit borer attack were observed, it was controlled by spraying Deices (3-4 m/lit) at fortnightly intervals. Weed density was determined with aid of 1m x 1m quadrat at 1, 2 and 3 months after planting (MAP). Number of weeds appeared in each quadrat were counted and recorded. Weed uprooted from each quadrat (1m x 1m) were enveloped and oven dried at constant temperature of 75^0C for the period of 5 hours. The dried weights were determined using sensitive electronic weighing balance.

For garden egg growth and yield parameters, five (5) plants were randomly tagged per net plot and the following parameters were taken at monthly interval of 1, 2 and 3 MAP. The height of the crop was determined by measuring the crop from the base to the growing point using a meter rule. Number of leaves of plants was counted per sampled plant. Number of branches was counted per sampled plant. Number of fruit per plant was counting the number of fruits per plot. Fruit yield was determined by weighing the harvested fruits with aid top load weighing balance and then converted to t/ha. All the growth and yield data were subjected to analysis of variance and means that show significant difference were separated using least significant difference (LSD) at 5% probability levels.

Results and discussion

Table 1 shows the number of garden egg leaves per plant as influenced by mulching materials. The number of leaves per varied significantly different ($p<0.05$) at 6 and 9 weeks after transplanting (WAT) in both cropping seasons (Table 1). The highest number of leaves per plant was observed from the sawdust mulching plots (83 and 120) and (78 and 118) at 6 and 9 WAT in 2016 and 2017 cropping seasons, respectively. The plots mulched with grasses had 81.45 and 119.40 leaves at 3 and 9 WAT in 2016 while 77.81 and 118.59 leaves per plant, respectively, was recorded from grasses mulch plots in 2017. The result indicated no significant difference between the treatments of sawdust and grasses in both cropping seasons. The polyethene sheet mulched plot produced 101.45 and 99.41 leaves per plant at 9 WAT in both cropping seasons. The plots mulched with trampoline sheet had 108.75 and 101.51 leaves per plant at 9 WAT. The least number of leaves per plant, 43.40 and 73.40 in 2016 and 51.12 and 68.41 in 2017) was recorded from the control treatment plots. The result of the study indicated that mulching with sawdust enhanced production of a greater number of leaves per plant with 1-39% and 2-44% more than other mulching at 9 WAT in both cropping seasons.

Table 1. Number of Leaves per plant as Influenced by Mulching Materials.

Treatment	2016			2017		
	Weeks After Transplanting			Weeks After Transplanting		
	3	6	9	3	6	9
Polythene sheet	22.61	54.34	101.45	28.28	68.01	99.41
Trampoline sheet	21.75	63.33	108.75	29.03	68.75	101.51
Sawdust	23.40	83.40	120.14	28.45	78.95	121.25
Grasses	22.53	81.85	119.40	27.47	77.81	118.59
Control	21.45	43.40	73.40	26.97	51.12	68.41
LSD(p<0.05)	NS	2.78	3.17	Ns	3.23	5.90

NS=Not Significant

The effect of mulching materials on the height of garden egg differed significantly ($p<0.05$) in both cropping seasons (Table 2). The plots mulched with sawdust and grasses had the significant taller plants at 6 and 9 WAT in both cropping seasons. The mean plant heights recorded from polythene and trampoline plots were not significantly different when they were compared in both cropping seasons (Tables 2). The tallest plant at 9 WAT; 83.40 cm and 86.39 cm in both cropping seasons was from the plots mulched with sawdust while 82.99 cm and 85.40 cm both cropping seasons was from plots mulched with grasses. The shortest plant at 9 WAT, 59.22 cm and 58.99 cm in 2016 and 2017 cropping seasons was from the control treatment. At 9 WAT, eggplant mulched with sawdust had plant height of 1-29% and 1-32% more than other mulching materials in both cropping seasons.

Table 2. Egg Plant Height (cm) as Influenced by Mulch Material.

Treatment	2016			2017		
	Weeks after Transplanting			Weeks after Transplanting		
	3	6	9	3	6	
Polythene sheet	31.40	53.36	77.80	35.32	59.67	75.17
Trampoline sheet	31.25	50.78	75.45	33.84	55.73	73.16
Sawdust	35.41	69.40	83.40	38.77	74.18	86.39
Grasses	34.60	65.81	82.99	37.68	73.22	85.40
Control	34.60	49.77	59.22	31.55	42.14	58.99
LSD(p<0.05)	NS	3.09	3.11	1.75	3.77	4.06

*NS =Not Significant

Leaf area of garden egg as influenced by mulching materials were significantly different ($p<0.05$) in both cropping seasons when compared to leaf area recorded from the control treatment (Table 3). The largest leaf area; 33.40 and 36.92 cm^2 at 6 and 9 WAT in 2016 was from the plots mulched with sawdust. In 2017, the leaf area from sawdust plots was 35.40 and 37.55 cm^2 at 6 and 9 WAT, respectively.

Table 3. Leaf Area (cm^2) as Influenced by Mulching Materials

Treatment	2016			2017		
	Weeks after Transplanting			Weeks after Transplanting		
	3	6	9	3	6	
Polythene sheet	23.56	30.56	34.90	24.78	33.56	36.45
Trampoline sheet	23.90	30.19	35.67	24.06	33.88	35.99
Sawdust	26.18	33.23	36.91	25.91	34.23	37.01
Grasses	26.89	33.40	36.92	26.23	35.40	37.55
Control	24.01	24.36	22.16	23.90	23.17	23.90
LSD(p<0.05)	Ns	4.21	4.55	Ns	3.74	4.81

*NS =Not Significant

The least leaf area; 24.36 and 22.16cm^2 in 2016 and 23.17 and 23.90 cm^2 in 2017 at 6 and 9 WAT, respectively, was from the control treatment. Numbers of branches per plant as affected by different types of mulching materials were significantly different in both cropping seasons (Table 4). At 9WAT, the highest number of branches per plant; 13.40 and 15.70 in 2016 and 2017, respectively was from sawdust treatment. This was followed by 12.45 and 15.18 branches recorded from the plots mulched with grasses. The plots mulched with trampoline had 8.93 and 9.77 branches respectively. The plots with polythene sheet had 8.93 and 9.77 branches respectively. The least number of branches per plant at 9 WAT, 5.11 and 5.40 in 2016 and 2017, respectively was from control plots.

Table 4. Number of Branches per Plant.

Treatment	2016			2017		
	Weeks after Transplanting			Weeks after Transplanting		
	3	6	9	3	6	9
Polythene sheet	2.33	5.12	9.78	2.45	5.67	9.85
Trampoline sheet	1.90	4.45	8.93	2.11	5.33	9.77
Sawdust	5.01	8.45	13.40	5.32	10.01	15.70
Grasses	4.81	7.55	12.45	5.30	8.81	15.18
Control	1.01	2.14	5.11	1.22	3.01	5.40
LSD(p<0.05)	1.78	1.91	2.77	1.53	2.86	3.11

Weed density per m^2 as affected by different mulching materials varied significantly among the treatments in both cropping seasons (Table 5). In 2016, the highest weed density per plot; 119.59, 125.18 and 138.66 at 1, 2 and 3 months after transplanting (MAT) was recorded from control plots. These corresponding weed densities; 122.01, 150.80 and 159.75 was recorded in 2017. In 2016, the least weed density; 1.12, 0.11 and 0.21 in 2016 and 0.00, 0.03 and 1.05 in 2017 was from the plots mulched with trampoline.

Table 5. Weed Density (M^2) as Affected by Different Mulching Materials

Treatment	2016			2017		
	Months After Planting			Months After Planting		
	1	2	3	1	2	3
Polythene Sheet	1.25	0.52	0.33	0.00	0.31	1.30
Trampoline sheet	1.12	0.11	0.21	0.00	0.03	1.05
Sawdust	9.45	14.81	28.40	12.60	20.40	31.84
Grasses	22.40	15.68	32.40	18.30	24.50	30.42
Control	119.59	125.18	138.66	122.01	150.80	159.75
LSD(p<0.05)	5.89	7.22	8.60	4.95	6.32	9.33

Weed biomass as affected by different mulching materials varied significantly (p<0.05) when the biomass obtained from the control plots was compared to the other mulching treatments (Table 6). The control plots had the largest weed biomass while trampoline and polythene sheet had the least weed biomass (Table 6). Number of fruits per plant as affected by mulching materials differed significantly in both cropping seasons (Table 7). The highest number of fruits per plant; 26.56 and 25.90 in both cropping seasons was from the plots mulched with sawdust. This was followed by 24.37 and 23.90 fruits per plant recorded from the plots mulched with grasses. The plots with trampoline had 21.98 and 20.08 fruits per plant, respectively while 21.16 and 19.65, respectively was from polythene sheet plot. The least number of fruits per plant; 4.67 and 6.23 in 2016 and 2017 were recorded from the control treatment.

Table 6. Weed Biomass Affected by Different Mulching Materials.

Treatment	2016			2017		
	Months After Planting			Months After Planting		
	1	2	3	1	2	3
Poly ethane Sheet	0.008	0.03	0.001	0.00	0.001	0.03
Trampoline sheet	0.003	0.001	0.003	0.00	0.001	0.001
Sawdust	2.05	6.11	8.09	6.60	10.01	14.80
Grasses	5.90	6.90	11.90	3.38	12.78	12.99
Control	49.89	78.90	101.34	77.01	94.81	125.01
LSD(p<0.05)	6.11	8.75	12.19	5.45	11.12	17.01

Garden egg fruit yield as influenced by different mulching materials was also significantly different (p<0.05) in both cropping seasons (Table 7). The results maintain similar pattern as in number of fruits per plant. The highest fruit yield; 22.27 and 23.63 t/ha in 2016 and 2017 respectively was from the sawdust mulched plot. The grasses mulched plot had 21.19 and 22.17 t/ha fruit yield, respectively (Table 7). The trampoline plot produced 18.77 and 17.18 t/ha fruit, respectively. The least fruit yield; 5.43 and 6.54 t/ha in both cropping seasons, was from the control treatment. The result showed that the plot mulched with sawdust had 7-76% and 6-72% greater fruit yield compared to the other mulching materials in both cropping seasons.

The cost of production and economic returns to management is presented in Table 8. The highest cost of production (₦ 236,800 and ₦ 229,960 in both cropping seasons) was recorded in control treatment. The treatment of trampoline had the cost of production of ₦ 217,800 and ₦ 225, 560 in 2016 and 2017 cropping seasons, respectively while ₦190,200 and ₦ 186,460 was recorded from the treatment of polythene. The total cost of production of 149,300 and 154,860 was recorded in the treatment of grasses while 155,800 and 159,400 was recorded in the treatment of sawdust in both cropping seasons. Among the garden egg production systems, the highest net revenue was recorded in the treatment of grasses as mulching material, ₦119,1770 and ₦1,215,680 in both cropping seasons (Table 8). This was followed by ₦ 1094,410 and ₦ ₦1, 215,680 recorded from the treatment of sawdust. The treatment of trampoline had the net revenue of ₦ 889,630 and ₦ 770,880, respectively. The least net revenue, ₦ 93570 and ₦ 154360 in both cropping seasons was from the control treatment.

Table 7- Yield and Yield Components of Garden egg as Affected by Different Mulching Materials

Treatment	2016		2017	
	Number of Fruits/Plant	Fruit Yield (t/ha)	Number of Fruits/Plant	Fruit Yield (t/ha)
Polythene Sheet	21.16	19.32	19.65	19.98
Trampoline sheet	21.98	18.77	20.08	17.18
Sawdust	26.56	22.73	25.90	23.63
Grasses	24.37	21.19	23.90	22.17
Control	4.67	5.43	6.23	6.54
LSD(p<0.05)	2.99	3.17	2.87	3.94

Comparing the cost/benefit ratios from different treatments, the highest cost/benefit ratio 7.98 and 7.85 in 2016 and 2017 was recorded from the plots mulched with grasses. This was followed by 7.03 and 7.07, respectively recorded in the treatment of sawdust. The treatment of trampoline had 4.09 and 3.42 cost/benefit ratio. The least cost benefit ration, 0.35 and 0.69, respectively was from the control treatment. These cost /benefit ratios indicated the amount released by the farmer for each ₦ 1.00 spent for the cultivation of garden egg during dry season in the study area.

Result of the study shows that the control plot (not mulched) had significant higher weed density and biomass when compared to both organic and inorganic mulched plots. The significant lower weed densities and biomass in mulched plots could be that the mulching materials shaded the weed seeds therefore making seed germination difficult. This observation agrees with the recent report of Ikeh and Akpan (2018) that organic mulch material especially at higher dosage hinders weed seeds germination. The low weed density and biomass observed in mulched plots compared to the control plots could be that organic and inorganic mulching materials were able to shade and smother some weeds. This agrees with the findings at Ikeorgu et al (2006) who reported that covering the soils with cover crops, straws, grasses or even synthetic materials could effectively suppress weeds growth and prevents them from receiving sun light.

Table 8. Cost of Off Season Garden Egg Production and Economic Returns To Management as Influenced by Organic and Synthetic Mulching in 2016 and 2017.

Cost of Production (₦)	2016					2017				
	Trampoline	Poly thene	Grasses	Sawdust	Control	Trampoline	Poly thene	Grasses	Sawdust	Control
Land preparation	83,000	83,000	83,000	83,000	83,000	85,000	85,000	85,000	85,000	85,000
Soil Analysis	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Mulching Material	90,000	63,000	18500	25,000	00,000	93,000	59,000	16,900	27,000	00,000
Planting/Planting Material	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500
Weeding (2x)	2,500	2,900	6,500	6,500	106,000	2,600	3,000	8,000	8,000	100,000
Insect pest control	2,100	2,100	2,100	2,100	2,100	2400	2400	2400	2400	2400
Harvesting	5,200	5,200	5,200	5,200	5,200	5060	5060	5060	5060	5060
Miscellaneous	15,000	15,000	15,000	15,000	15,000	17,000	17,000	17,000	17,000	17,000
Total Cost of Production (₦)	217,800	190,200	149,300	155,800	226,800	225,560	186,460	154,860	159,400	224,960
Fruit Yield (tha^{-1})	18.77	19.92	22.73	21.19	5.43	17.18	19.98	23.63	22.17	6.54
Gross Revenue (₦)	1107430	11398	1341070	1250210	320370	996,440	1158,840	137,540	1285,860	379320
Net Revenue(₦)	889630	949680	1191770	1094410	93570	770,880	972,380	1215680	112646	154360
Cost/Benefit Ratio	4.09	4.99	7.98	7.03	0.35	3.42	5.21	7.85	7.07	0.69

The significant growth parameters observed in the mulched plots over control plot could be due to weed competition for nutrients and space with the garden plants planted in the plots. Also, the could higher rate of evaporation in the control plot compared to the mulched plots. The soil moisture stress could have affected the growth and development of the crop. Moisture stress has been reported as one of the major factors affecting the growth and development of vegetable crops. This finding is in conformity with the observation of Ikeh and Akpan (2018) mulching regulates soil moisture and temperature and also provides favourable environmental conditions for plant growth. Organic mulching reduces weed infestation and enhances growth and yield of crops. This observation is in consonance the report with the finding of Dilipkumar et al. (1990) that increase in yield as a result of reduced crop-weed competition due to weed suppression by organic mulching.

The plot mulched with sawdust had significant higher fruit yield, followed by the fruit yield from the grasses mulched plot. It could be that both mulching materials were able to serve as organic fertilizer to the soil. The soil fertility status of the experimental site before planting showed that the soil was low organic matter and total nitrogen, also the soil was slightly acidic. Sawdust and grasses could have been supplemented the nutrient requirement of the soil. This observation was in line with the report of Ikeh and Akpan (2018) and Ikeorgu et al. (2006) that organic mulching is source of organic manure to soil. Udoh and Ndon (2016) also revealed that organic mulching is not only to check evaporation but also help to add organic matter to the soil. The result also in line with the report of Yang et al. (2006) that organic mulches such as sawdust, dry grass, maize cobs, water hyacinth, rice and wheat straw have enhanced vegetative growth and yield through improving water content of soil, heat energy and addition of some organic nitrogen and other minerals to improve nutrient status of the soil. The superiority of grasses mulching material over the other materials had been reported by Nkansah et al. (2003) that grass straw, rice straw, rice husk and saw dust mulches significantly reduced fresh weed weight and improve fruit yield. They also stated that grass straw mulch significantly reduced fresh weed weight while the highest fresh weed weight was observed in the control. According to Norman et al. (2011), dry grass and sawdust mulches suppressed weed growth significantly.

Conclusion

The result of the study revealed that mulching garden egg with grasses and sawdust during off season, could enhanced high fruit yield and more income generation to farmers in the study area. Farmers in the study area were advised to adopt grasses and sawdust mulching for cost effective in weed management, high fruit yield and net revenue returns to management.

Conflict of interest

Authors declare no conflict of interest.

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