

Full Length Research Paper

A contrast between fish offal's fertilizer, chemical fertilizer and manure applied to tomato and onion

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Fertilizer is a critical input for improving production and increasing crop yields. The effect of chemical fertilizer, fish offal's fertilizer and manure on marketable yield and other parameter of tomato (*Lycopersicon esculentum*) and Adama red onion (*Allium cepa*) were compared. The experiment was laid as a randomized complete block design (RCBD), with three treatments; chemical fertilizer (T₁), fish offal's fertilizer (T₂) and manure (T₃). Treatments encompassed 0.24 kg diammonium phosphate (DAP) of chemical fertilizer, 2 kg of ground fish offal's fertilizer and 10 kg of unfermented (fresh) manure for tomato. Similarly, 0.12 kg DAP of chemical fertilizer, 1 kg of ground fish offal's fertilizer and 5 kg of unfermented manure for Adama red onion. 3 × 4 m plot size was used for tomato and 2 × 3 m plot size was used for Adama red onion. The results indicated that there is significant difference ($p < 0.05$) in tomato height at first harvesting with the maximum height of 80.33 ± 3.97 cm from plot treated with fish offal's fertilizer. There is significant difference ($p < 0.05$) in onion bulb weight. The maximum bulb weight was 112.51 ± 16.4 g recorded from plot treated with chemical fertilizer. Tomato fertilized with fish offal's fertilizer grew better than those fertilized with chemical fertilizer at later stages. Fish offal's fertilizer boosted the production at the later age and concluded that it can be used as an alternative to chemical fertilizer for tomato. The use of fish offal's fertilizer for different crops, application time and amounts should be further studied.

Key words: Fish offal's fertilizer, chemical fertilizer, manure, onion, tomato.

INTRODUCTION

Low soil fertility is one of the bottlenecks to sustain agricultural production and productivity in Ethiopia. Fertilizer is a critical input for improving production and increasing crop yields. Over the past decades of years, chemical fertilizers have been the primary means of enhancing soil fertility in small-farm agriculture. A benefit of chemical fertilizers is that they work quickly and supply the exact needs of the crop. However, chemical fertilizers are expensive, leached before the nutrients are taken up and washed into the river and lakes cause excess algal growth which can damage the ecology (<http://www.ghsonlinesupport.org/fertilisers.pdf>, 26 August, 2012).

Organic matter is one of the most important components

of soil and is relevant to plant health (Magdoff and Weil, 2004). Over the last 50 years, there has been severe depletion in soil organic matter content of many agricultural soils due to intensive cultivation. This has resulted in degradation of soil structure. There is a need to revitalize these soils with practices such as addition of organic amendment (Magdoff and Weil, 2004). Fish emulsion (sometimes called fish fertilizer or liquid fish emulsion) is an organic, liquid fertilizer made from byproducts of the fish industry. It is particularly useful for lawns and leafy green vegetables, having a high level of nitrogen (http://www.ehow.com/about_6327673_fish-emulsion-tomatoes.html). Soil amendments of various by-products of fish industry are routinely used as fertilizers for crop production. Fish meal, the dried protein obtained from processed fish, has been used as a soil amendment with great success in vegetable production systems (Blatt and McRae, 1998).

Fish offal's fertilizers are excellent sources of nutrition

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for soils and plants, as fish contains the full spectrum of nutrients found in the planets' waters. Fish offal's fertilizers contain significant quantities of protein Nitrogen as well as a healthy balance of all 18 nutrients known to be significant for crops growth. Nitrogen-phosphorous-Potassium ratio of fish fertilizer is 10-6-2 (Gaskell, 1999). Plants rapidly respond to and grow vigorously when regularly fertilized with fish fertilizers. Fish offal's fertilizers are suitable for all fruits plants, flowers and vegetables, and are applied through foliar or soil application methods (www.greatpacificbioproducts.com/.../Harris_Ranch_Napa_Valley, 26 August, 2012).

Compared to synthetic fertilizer, organic fertilizer contains relatively low concentrations of actual nutrients, but they perform important functions which the synthetic do not. They improve the physical structure of soil which allows more air to get into plants roots, increase bacterial and fungal activities in the soil. Organically derived fertilizers do not leach from the soil making them less likely to contribute to water pollution than synthetic fertilizers (www.econutrients.com/product_fish.html, 26 August, 2012). Therefore, greater effort is needed to find an alternative source of fertilizer to synthetic fertilizers. This project was initiated with the objective to compare growth response, marketable and unmarketable yield of tomato and onion fertilized using inorganic (chemical) fertilizer, fish offal's fertilizer, and manure.

MATERIALS AND METHODS

Description of the study area

The field experiment was conducted at Zeway Fisheries Resources Research Center, 160 km south of Addis Ababa starting from January 2009 to July 2009 under irrigation condition. The center is located at an altitude of 1636 m.a.s.l and longitude of 7° 56' 0" North, 38° 43' 0" East. The average rainfall of the area is 688 mm and the maximum and minimum temperature are 27 and 14°C, respectively.

Preparation of fish offal fertilizers

Fish offal, fish visceral, head, trimmings and intestine of Nile Tilapia (*Oreochromis niloticus*) are the fish products used. The offal was cooked in 50 kg cooking capacity barrel, left over night to settle in the barrel to separate the oil, water and solid components. Press liquor removed, the press cake spread on the laminated tin and dried in open air for 3 to 5 days as indicated in Abera et al. (2008). Chemical fertilizer was purchased from local market. Manure was obtained from Adami Tullu Agricultural Research Center.

Experimental design

The experiment was laid as a randomized complete block design (RCBD), with three treatments; chemical fertilizer (T₁), Fish offal's fertilizer (T₂) and manure (T₃). The treatments were applied to plots measuring 3 x 4 m for tomato and 2 x 3 m for Adama red onion. Each treatment was replicated three times. The ratio of Nitrogen, Phosphorus and Potassium (N-P-K) was taken into consideration

then the amount of fertilizer required for each plots were calculated. Tomato was fertilized three times with 0.24 kg DAP (Diammonium Phosphate) of chemical fertilizer, 2 kg of ground fish offal fertilizer and 10 kg of unfermented (fresh) manure. Similarly, onion was fertilized 0.12 kg DAP (Diammonium Phosphate) of chemical fertilizer, 1 kg of ground fish offal fertilizer and 5 kg of unfermented manure for Adama red onion. The amounts of fish offal fertilizer and cow manure added were based on recommendation of their nutrient contents. Irrigation was done three times per week until the plants were established. Once the plants were established, watering was done twice per week.

Statistical analysis

The collected data was subjected to general linear model of statistical analysis system (SAS) versions 9.0 (SAS, 2002). Means were compared using analysis of variance (ANOVA). Least significant difference (LSD) test was used to separate means and differences were considered significant at $p < 0.05$. The results were expressed as mean \pm standard error.

RESULTS

Malka shola (*Lycopersicon esculentum*)

Table 1 indicates that tomato heights at 1st harvesting were significantly different at $p < 0.05$, the highest height (80.333 \pm 3.97 cm) was obtained from plots treated with fish offal's fertilizer. Marketable yield in quintals per hectare were significantly different the maximum marketable yield (721.1 \pm 48.1). Quintal per hectare was obtained from plots treated with fish offal's fertilizer.

The highest average fruit weight was recorded at 1st harvesting of plot treated with fish offal's fertilizer which was 75.91 g per fruit (Figure 1). The minimum average fruit weight was 33.65 g recorded from plots treated with chemical fertilizer at 7th harvesting. The average weight of fruit was decreased as harvesting stage proceeded for all treatments. Even though the averages weight of fruits was decreased as harvesting stage proceeded for all treatments, the average weight of fruits treated with fish offal's fertilizer show slightly constant weight as compared to other treatments (Figure 1).

Adama red onion (*Allium cepa*)

There is significance difference ($p < 0.05$) in bulb weight. The maximum bulb weight (112.51 \pm 16.4 g) was recorded from plots treated with chemical fertilizer and the minimum bulb weight (88.24 \pm 8.816 g) was recorded from plots treated with manure (Table 2).

DISCUSSION

Tomato (*L. esculentum*)

The height of tomato at first harvesting was affected by

Table 1. Effects of chemical fertilizer, fish offal's fertilizer and manure fertilization on plant height, number of cluster per plant, number of fruit per cluster marketable and Unmarketable yield of tomato.

Treatment	Plant height at 1 st harvesting (cm)	No. of cluster per plant	No. of fruit per cluster	Marketable yield (Q/ha)	Unmarketable yield (Q/ha)	Total yield (Q/ha)
T ₁	80.267±1.65 ^a	30.1±8.703 ^a	3.3817±0.1397 ^a	643.4±133.3 ^a	82.02±14.29 ^a	725.5±121.2 ^a
T ₂	80.333±3.97 ^a	29.067±2.74 ^a	3.551±0.10 ^a	721.1±48.1 ^a	105.99±31.0 ^a	826.8±43.99 ^a
T ₃	72.022±3.25 ^b	25.471±3.350 ^a	3.0617±0.212 ^b	417.8±17.39 ^b	86.27±29.689 ^a	504.7±15.94 ^b
CV (%)	6.938	34.471	8.31	27.37	44.62	20.819
LSD	7.04	12.6	0.32	212.8	53.3	186.8

Means in the same column with different letter are significantly different (p<0.05).

Table 2. Effects of chemical fertilizer, fish offal's fertilizer and manure fertilization on bulb size, bulb diameter, marketable yield and unmarketable yield of onion.

Treatment	Bulb size (cm)	Bulb diameter (cm)	Bulb weight (gram)	Marketable yield (Q/ha)	Unmarketable yield (Q/ha)
T ₁	5.3527±0.394 ^a	5.747±0.2598 ^a	112.51±16.4 ^a	364.91±42.31 ^a	197.78±97.78 ^a
T ₂	5.018±0.1398 ^a	5.467±0.2080 ^a	89.6±9.824 ^d	391.53±48.12 ^a	56.47±2.762 ^a
T ₃	5.1073±0.338 ^a	5.3513±0.336 ^a	88.24±8.816 ^b	315.44±22.62 ^a	125.9±41.23 ^a
CV (%)	6.535	6.7794	14.49	17.1532	19.539
LSD	0.4	0.4	18.3	80.2	151.7

Means in the same column with different letter are significantly different (p < 0.05).

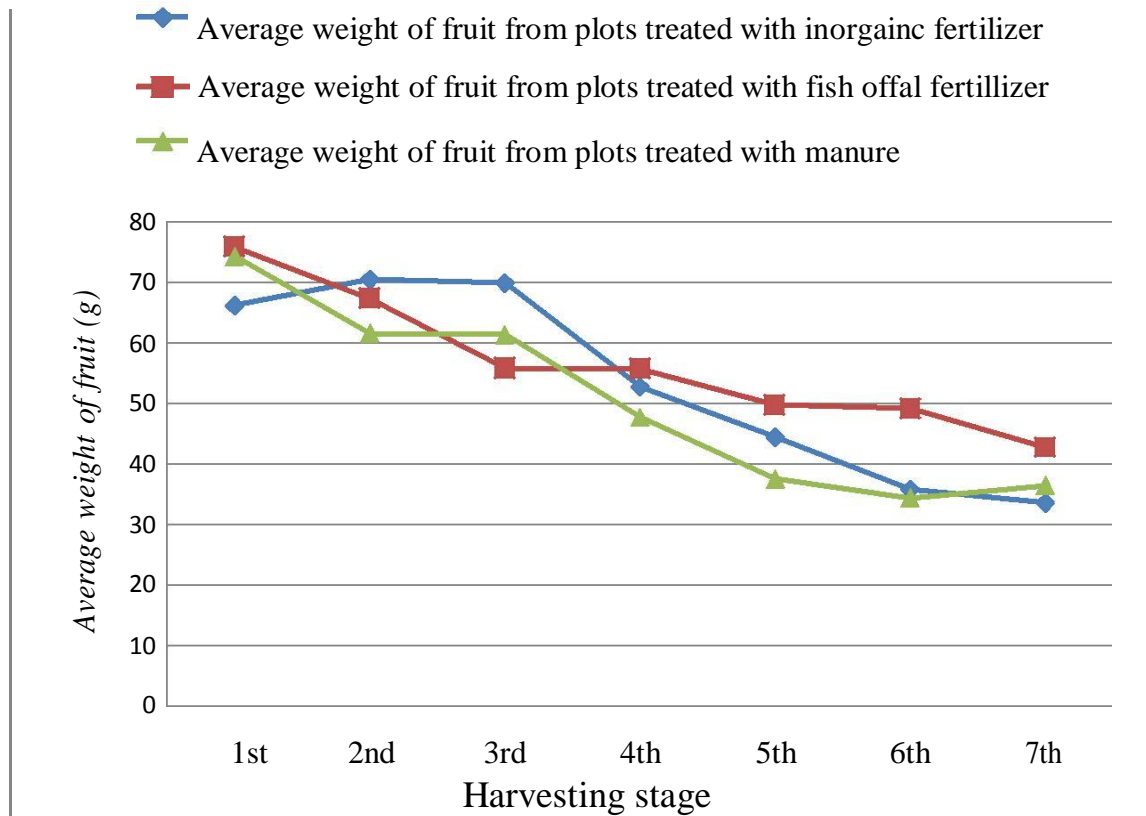


Figure 1. Average weight of fruits in gram collected from six plants with an area of 1.8 m².

the application of the three fertilizers. Tomato heights at 1st harvesting were significantly different at $p < 0.05$ with the highest length obtained from plot treated with fish offal's fertilizer. This result is in agreement with those obtained by Irshad and Javed (2006), where the high yield of Mung bean and Okra were obtained from plants treated with fish fertilizers as compared to Nitrogen-Phosphorous-Potassium (NPK) and Urea fertilizer. Fish fertilizer is a good soil conditioner and is great to use in vegetable plots because it will help in root development (Irshad and Javed, 2006).

Fish fertilizers help to provide complex arrays of nutrients and minerals as proven by trial done in poor soil that were lacking many nutrients and minerals. Fish offal fertilizer provides plenty of phosphorous and organic nitrogen (Irshad and Javed, 2006). Studies done on peas, radishes, tomatoes, corn, straw berry, lettuce, soybeans, and peppers indicated that fish offal's fertilizer promote plant growth and retard senescence (Aung et al., 1984). The lowest amounts of marketable yield was collected from plots treated with manure due to the slow availability of the nutrients from the manure and immobilization of Nitrogen (Teklu et al., 2004), manure has relatively little phosphate (Shankara et al., 2005).

At 1st harvesting the numbers of marketable fruits collected from plots treated with fish offal fertilizer were small as compared to plots treated with chemical fertilizer. But, tomato treated with fish offal fertilizer at 7th harvesting was still green and others were completely dried at this stage. This condition is complemented by fish fertilizer is growth promoting, retards senescence, delays flowering and fruiting in tomatoes (Aung et al., 1984). This could be a very important management tool to extend the time a single variety would be available for picking and marketing (Aung et al., 1984).

Fish fertilizer is speculated to cause a reduction in the production of buds on fruits trees (Aung et al., 1984). At the early growth stages, yield of plot treated with fish offal's fertilizer was lower but turned higher at later growth stages, compared with the chemically fertilized tomato. This might be due to the low nutrient availability at the beginning, which limited the plant growth. Nutrients in chemical fertilizers are immediately available when applied to the soil but the sustainability is low (Seran et al., 2010). On the contrary, organic materials sustain the nutrients for longer time than chemical fertilizers. Specifically, the nitrogen in the fish fertilizer encourages lots of leaves and branches, which help support the tomato plant's large root system and bountiful crop (http://www.ehow.com/about_6327673_fish-emulsion-tomatoes.html, 26 August, 2012).

Onion (*A. cepa*)

The lowest bulb diameter, bulb weight and marketable yield were obtained from plots treated with manure. The

low bulb weight (88.24 ± 8.816 g) obtained from plots treated with manure could be due to the gradual decomposition of manure by soil microbes (Abbey and Kanton, 2004). Shallow root vegetables like onion, requires quickly available nutrients (Abbey and Kanton, 2004). Onions have a small root system that limits their ability to acquire nutrients from the soil (Horneck, 2004). The maximum bulb weight (112.51 ± 16.4 g) was recorded from plots treated with chemical fertilizer where as the minimum bulb weight (88.24 ± 8.816 g) was recorded from plots treated with manure. This situation can be justified as chemical fertilizer quickly available to the plant supply the nutrient in excessive way where as manure takes long time to supply appropriate nutrient for bulb development.

CONCLUSION AND RECOMMENDATION

The escalating price of chemical fertilizer makes it necessary to develop and recommend organic fertilizer in order to meet the ever increasing demand for food, especially in the developing world. From the current study, one can conclude that fish offal's fertilizer prepared from the waste materials of fish can provide readily absorbed nutrient required for growth and yield production of tomato and onion. The yield harvested from tomato and onion treated with fish offal's fertilizer is as comparable as that of chemical fertilizer. Therefore, it is advisable to use as alternative to the chemical fertilizer for tomato.

Fish offal fertilizer like other organic fertilizer is environmental friendly, does not leach readily and stay long in the soil hence do not pollute the aquatic ecosystems. Fish offal's fertilizer boosted the production at the later age. Tomato fertilized with fish offal's fertilizer grew better than those fertilized with chemical fertilizer at later stages. Therefore, the growers should take some measures to make the nutrients in fish offal's fertilizer available before plants begin to grow. The use of fish offal's fertilizer for different crops, application time and amounts should be further studied.

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