The Effects of Different Types of Duckweed Manure on Height and Yield of Floridade Tomatoes

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Abstract

Duckweed can be used as a source of nutrient because of its higher trapping efficient. The research study was carried out in Mbizo 3, some 3km north-west of the city of Kwekwe in the Midlands Province. Kwekwe is in Agro-ecological Region 3 with an altitude of 1000 m above sea level. Higher yields were obtained in green manure treatments compared to compost and control treatments. Overall, the highest growth rate (1160, 7mm) was obtained from plots treated with green manure at 17th week followed by plants under control plots (520mm). Both duckweed green and compost manure can significantly increase the yield and growth rate of tomatoes, though green manure had both higher yield and growth rate than compost manure. The major variation between compost and green manure was due to differences in C: N ratio. Materials that have a high C: N ratio will also lower the availability of N content to plants and time of harvesting the weed.

Key words:

Introduction

Sparrow *et al.* (2001) and Cotching *et al.* (2002) defined organic matter as a vital component of health soils and an important part of soil physical, chemical and biological fertility. Soil organic matter comprises living soil organisms, dead organisms in their various degrees of decomposition (Edward, 1993; Katyayana, 2004). Living organisms include microorganisms and can range in size from small animals to single celled bacteria. Plant and animal materials in the soil are essential sources of nutrients such as nitrogen (N), potassium (K), calcium (Ca), phosphorous (P), magnesium (Mg), and other essential micro nutrients like copper for crop growth (Van Slyke, 2001, Aquaah, 2002). Van Slyke (2001), states that organic fertilizers have several benefits and these include the improvement of soil physical characteristic that includes porosity, water-holding capacity and temperature. More so, fertilizer consists of important sources of primary elements such as potassium, magnesium, nitrogen, phosphorus and as well as trace elements such as sulphur, copper, boron (Shamma, 2004). Soil organic fertilizer consists of about 45% of carbon and when decomposed the humans will hold individual minerals together in clusters (Edward, 1993). Organic matter improves soil structural stability and increase plant available water reserves and etc (Rattan, 1997).

Duckweeds are small free-floating aquatic flowering plants that grow ubiquitously on fresh or polluted water throughout the world. The weed has a great application in genetic or biochemical research. However, at times they grow on mud or water, swamps, ditches and small ponds that are only a few millimeters deep up to a water depth of 3 metres. The weed has leaves 3-5mm in length from which one root fibris extends down into the water. The unisexual flowers occur in threes on the edge of stems (Rodriguez, 1996). Duckweed is whitish in colour, rounded slightly compressed and very delicate. The plant flowers very rapidly, and has a needle-like crystal occurring in plant cells. According to Rodriguez and Preston (1996) the needle-like crystals occurring in the plant cells prevent it from sludge damage. Duckweeds have a carbon to nitrogen ratio of 20:1 when comparing with other weeds such as water hyacinth with C: N ratio of 18:1 (FAO, 1990). It is therefore a potentially important source of nutrients.

Duckweed belongs to four genera namely lemna, spirodela, wolfia, wolfiella and about 40 species are known worldwide. The species develop root-like structures in open water which assist it to obtain nutrients where these are in dilute concentration (Rodriguez, 1996). More so, the weed does well when conditions are favorable in terms of water temperature, pH, incident light and nutrient concentrations, which found them complete in terms of biomass production. If duckweed growth is unrestricted there will be an exponential that a biomass of duckweed covering 10 cm^2 may increase to cover one hectare in 50 days or a 10 million fold increase in biomass in that time.

A study carried out in Vietnam by (Wangerman and Ashbey, 1950) found that the incidence of showers stimulated the rapid growth of duck weed in small ponds and their appearance have evolved, so as to make good use of the periodic flushes of nutrients that arise from natural sources. However, in recent times duck weed is more likely to be found growing in water associated with cropping and fertilizers wash out or downstream from human activities, particularly sewage works, housed animal production systems and to some extent industrial plants.

Duckweed consists of highly cutinized, unwettable upper epidermis and the stomata are on the upper side for all genera (Wolf and Landolt, 1994). The lemnae family is worldwide, but most diverse species appear in the subtropical or tropical areas, they provide habitant and protection for a number of insects that associate with them. The main predators appear to be herbivorous fish, snails, flatworms and ducks. The muskrat appears to enjoy duckweeds and many other animals like pigs and ruminants (Skillicorn *et al.*, 1993).

In Vietnam, duck weed was collected from small ponds where eutrophication took place and the weed was being harvested on a daily basis immediately mixed with cassava waste and fed to ducks (Fleay, 1966). In Taiwan, duckweed was traditionally produced for sale to pigs and poultry producers and as vegetable manure due to its higher phosphorous content, which has been to areas where there are major deficiencies (World Watch, 1997). According to Fleay (1966) the crude protein of duck weed growing on diluted effluent such as sewage effluent and soil deposit had increased water levels of nitrogen from about 15% crude protein with trace elements of nitrogen (1 - 4 mg N/1itre) to 37% at between 10 – 15 mg N/1itre.

It was noted that there was an association of nitrogen fixing cyanobacteria with duck weed and cyanobacteria are firmly attached to the lower epidermis of older leaves, inside the reproductive pockets and occasionally attached to the roots. They calculated the nitrogen fixation via these colonies could amount to 3.7 to 7.5 kgs nitrogen per hectare of water surface in tropical lemna blooms, but the association of cyan bacteria with lemna trisulca was 10 times more effective (Doung and Tiedge, 1985). Thus make duckweed more important for manuring in the research. The weed thrives in water pH between 5and9 but grows best over the range of 6,5 and 7,5 water temperature of between 6?C to 33 ?C but grows best at around 30?C, water depth of more than 0,5 meters (world watch, 1997).

Due to higher rate of vegetative growth, rapid colonization by duckweed in water bodies has led to high biological oxygen demands that suffocate other aquatic species. Therefore, there is need to control the weed by harvesting and using it as an alternative source of organic manure. The growth of the duckweed had led to choking of sewage treatment ponds and reduction in their storage capacity. Taking the weed to uses such as fertilizer can be a solution to reduce the population of the weed in the ponds. More over, the need to increase yield of tomatoes through provision of fertilizer to improve crop nutrient for growth has lead to the use of duckweed as a fertilizer instead of the synthetic fertilizers that are unavailable readily on market.

Scarcity and exorbitant prices of inorganic fertilizer on the local market has forced most farmers to use organic fertilizer which is readily available and cheap to obtain. In addition the need to improve soil status and provide the necessary essential nutrients to crops has resulted in the use of duckweed as green manure and compost manure. According to Stambolie and Leng (1994), duckweed has the ability to utilize the nutrients leaching from urban agriculture, leaking sewer pipes and sediments. As green manure, duckweed can be applied as surface mulch or ploughed into the soil. According to Ashbey and Wangerman (1950), the biomass of duckweed doubles every 1 to 2 days and by 60 days it will cover 32 hectares. More so, by being vegetative the weed is a reliable source of organic fertilizer for the growth of vegetables since it contains the required macro and micro nutrients. Moreover, 50 fifty kg of ammonium nitrate cost US$30 such that few people will afford to buy synthetic fertilizer on the local market. This is the current information of season 2009 from companies such as Cottco, Olam, and the national fertilizer suppliers whose prices are pegged at US$50 which is far beyond farmer's capability (Bulla, 2009).

Duckweed can be used as a source of nutrient because of its higher trapping efficient (Vetta *et al.*, 1995). It has effects of polluting water bodies and occupies more space, which ultimately leads to higher biological oxygen demand that causes suffocation of aquatic species. Therefore it requires quick and proper monitoring measures to reduce its effects though on the other hand it purifies water. So the major option might be to use the weed as green and compost manure. Duckweed was commonly used in USA as compost under the organic tomato production (NCAT Agric specialist, 1999).

Pieters (2004) defines green manuring as the practice of enriching the soil by turning into the soil, undecomposed plant materials (except crop residues) under the soil. Green legumes have especially been used as green manure due to their high N content (Greenland, 1994). Lee (1991) states that N availability in green manure normally depends upon quality and quantity of green manure turned under, soil characteristics, type of crop, growth stage of the material to be turned and time it is turned under. Shamma (2004) observed that at flowering stage, plants contain the greatest bulk of succulent organic matter with low C: N ratio and thus the incorporation of green matter at this stage allows a quick liberation of N in available forms.

As green manure the weed should be harvested 2-3 weeks before applying it as green manure or mulching and is done at flowering stage which is in May to April. At this stage of growth and development the weed is rich in nutrients (Skillicorn *et al*., 1993). The composts consist of alternating and repeated layers of straw and chicken droppings. Water is sprinkled to provide stable conditions for micro-organisms to decompose the materials in a pit of one metre wide, four meter long and one metre deep. After four weeks, the contents are used as manure for vegetables at an application rate of 30t/ha (Preston, 1997).

Yawalkar *et al*., (2002), defines composting as a biological process in which micro-organisms of both types namely, aerobic and anaerobic decompose organic matter under medium to higher temperatures and lower the carbon-nitrogen ratio of refuse. In about 3-6months, an amorphous, brown to dark brown humified material called compost is obtained because of higher organic content and due to a relatively higher content of major nutrients compared to farmyard manure. Compost helps in maintenance of soil organic matter and improves soil physical conditions and biological activities (Van slyke, 2001). According to Musgrave (2005), soil structure management is aimed to conserve soil by decreasing its detachability and transportability by agency of erosion thereby increasing infiltration and percolation capacity (Aquaah, 2002).

Duckweed is a perennial aquatic weed, which grows ubiquitously on fresh or polluted waters throughout the world. The weed is a small, fragile, free floating aquatic plant. However at times it grows on mud or water that is only a few millimetres deep to water depth of 3 meters (Wangerman and Ashbey, 1950). Reproduction is both vegetative and sexually but mainly vegetative. Vegetative propagation is by stolons (Wolff and Landolt, 1994). Vegetative reproduction allows the plant to quickly colonize large areas in relatively short periods of time. When conditions are ideal, in terms of temperature, pH, incident light and nutrient concentration, the weed competes in terms of biomass production with the most vigorous photosynthetic terrestrial plants doubling their biomass in between 16 hours and 2 days depending on conditions.

Biomass of duckweed increases exponentially under favourable conditions (World Watch, 1997). Duckweed biomass doubles every 1-2 days; by 60 days this could extend to cover 32 ha (Preston, 1990). Vegetative growth of duckweed exhibits cycles of senescence and rejuvenation under constant nutrient availability and consistent climatic condition (Ashbey and Wangerman, 1949). Duckweed contains C: N ratio of 20:1 (Harare Polytechnic, 2008) the weed is flat, oval, and leaf-like and has one thread-like root on each frond. New or daughter fronds are produced alternatively and in a pattern from two pockets on each side of the mature frond. The pockets are situated close to where the roots arise (Preston, 1990).

It's a small plant, which floats on the surface of water and comprises a plant body of round or oval leaves of 3mm to 5mm in length from which root fibril extends down into the water. The unisexual flowers occur in threes on the edge of the stem. They are whitish in colour, rounded, slightly composed and very delicate. The vessels yield seeds that are ribbed length-wise. The numerous dagger-like aphides (needle-like crystal occurring in plant cells) protect the plant from potential damage by sludge (World Watch, 1997).

The plant can be found growing on fresh water ponds and pools all over the world except in East Asia, South America and countries with a cool, oceanic climate (Preston, 1990). In recent times, they are more likely to be found growing in water associated with cropping and fertilizer wash out downstream from human activities, particularly from sewage works and urban agriculture (Preston 1990). The weed is associated with difficult marine navigation, angling and irrigation.

The plant has the ability to reproduce rapidly, its growth is remarkable and it has survival mechanisms to persist until the seeds are viable. The plant has ability to survive drought conditions and has very few natural enemies like locust, ducks and fish. Duckweed presents indication of problems such as global warming or a strong indication of rising water temperature throughout the world, in areas of Europe (Wollf and landolt, 1994). Fully-grown duckweed mats have the effect of reducing available oxygen, change water chemistry, and affect flora and fauna (Vetta *et al.*, 1995).

Material and Methods

Site description

The research study was carried out in Mbizo 3, some 3km north-west of the city of Kwekwe in the Midlands Province. Kwekwe is in Agro-ecological Region 3 with an altitude of 1000 m above sea level. It is located 29? 50'E and 18? 56'S.

Mbizo receives 650 mm to 850 mm of rainfall and higher temperature during drought condition. The area is characterized by moderate rainfall, dry winter with average annual temperature of 29 ?C. The general soil types of the area are lithosoils with black clay loam and sandy clay.

Collection of duckweed

Duckweed was collected from various locations in Kwekwe including the sewage works in Mbizo 9 suburb, sections of the Kwekwe river, open spaces receiving urban and industrial wastes as well at sewage leaks. 50 kg of empty bags were used to collect the weed to the experimental size and 10 x 50 kgs of duckweed was used for both composting and green manuring.

Green manure

Duckweed was harvested from Dutchman's pool sewage treatment ponds at flowering stage. The weed was harvested four weeks before planting and immediately ploughed into the plots.

Composting

Duckweed was collected and added to other composting material consisting of sawdust, chicken droppings and soil. Composting materials included sawdust (20cm), chicken dropping (15cm), duckweed (25cm) and soil (10cm). The layers of the above composting materials were repeated up to a height of 2, 5 m. Water was sprinkled at each layer to facilitate microbial activities to decompose the composted material. The measurements of the pit were 2m wide, 5m long and 2, 5 high. Turning of composted material was done on a daily basis to improve aeration. From 4 to 8 weeks, this process was done every 3 to 4 days until the compost was completely decomposed and suitable to be applied in the plots (Yawalkar *et al.*, 2002).

Soil sampling

Soil sampling is usually performed to enable the farmer to know which crops to grow and what types of nutrients are available and or are required (Brady 2000). Soil sampling was done to determine soil chemical and physical properties. In order to reduce bacterial infections and other related diseases, all the equipment was first disinfected with ethanol. Soil samples were collected using an auger at depth of 30cm and was performed 4 weeks before planting the tomatoes. The sub soil samples were mixed to come up with a composite sample. The composite sample sent for analysis, was tightly wrapped in a plastic bag and kept away from direct insolation as to avoid volatilization of nutrients such as nitrogen. The composite soil sample was made from 10 different soil subsamples. Soon after analysis of the composite soil sample, the soil characteristics were determined and are presented in chapter 4. This was done in Harare in August 2008.

Table 1: Soil chemical composition

Soil Characteristics	**% Composition**
pH	5.50
Available P	3.05
Total N	0.18
Calcium	4.06
Boron	1.07
Magnesium	4.34
Sodium	1.04
Potassioum	1.70
CEC	4.45

Table 1N show characteristics of soil obtained at the study area. The clay loamy was the most dominant soil with a pH of 5.5 and it is suitable pH for tomatoes (pH5.5) according to (Boelema, 1975).

Bed preparation

Firstly, the plots were cleared, ploughed using a hand hoe and the bigger clods were reduced to smaller, fine tilth suitable for planting with a hand hoe. The leveling was done using a garden rake (Boelema, 1975), beds of (2 x 1.9) m^2 were prepared. Marking out of bed size was done using a hand hoe, measuring tape, string, and stakes. Two rows of beds were made and were all the three treatments in each row. A distance of two meters separated the two rows of beds and management aspects like watering, weeding and pest control were done simultaneously.

Experimental design

The RCBD was applied on 3 treatments with 6 replicates for each treatment. The 3 major treatments were control (no organic fertilizer added), compost and green manure. Blocks of 19,5m long, 2m wide were prepared and there were 9 plots of 3, 8 m^2. There were two meters between each row. The treatments were allocated in blocks, because soil texture was not uniform and topography of the ground surface (Edward, 1993)

Analysis of duckweed organic fertilizer and application rate

Laboratory analysis of all the duck weed manure (compost and green) to determine the content of nitrogen (N), phosphorous (P) and potassium (K), copper, boron, magnesium and calcium was done. The analysis was carried at Harare Polytechnic College. The green manure was pounded and the juice was placed in a plastic container, frozen and sent for analysis together with the organic composted matter. This was done to reduce volatilization of other nutrients like nitrogen due to increase in temperature. The organic fertilizers were added into the soil 3-4 weeks before planting. Green manure application rate – 30t/ha. Compost manure application rate – 30t/ha. Control – no application rate (no manure)

Nursery management

The seeds were heat treated at 55?C for 25 minutes, dried, stored and then dusted with thirum. The seeds were sown (2-3) g per m^2 in a seedbed; 10 mm deep. The length of seed germination was 7-10days.

Transplanting

Transplanting was done at 4-6 weeks when the seedlings were (100-125) mm tall. Transplanting was carried under cool weather condition to reduce failure of transplanted seedling and hardening was done a week before transplanting. Plant spacing was (0, 9 x 0, 3) m^2.

Trellising

Eighteen (18) wire lines with 18 posts of 60-100mm diameter, 2m tall were used at each plot for 3 treatments to support the growing tomatoes. The method of trellising reduces the falling and settling of plants on the ground surface that will cause rise to infections such as blight - related diseases which cause rotting. Trellising increases yield, growth and development of many tomato clusters (Were, 1975). The strings were tied at a forked branch to promote upward growth of the plants and other side branches were pruned.

Debudding and pruning

This involved the removal of side shoots in order to encourage single stem growth and this made the measurements of stem height easier. The lower branches and leaves were pruned and debudded up to a height of 0,9m to reduce stunting of plants.

Weeding and diseases control

Weeding was done manually, in the first two weeks after transplanting to avoid damage of roots at their tender age of growth. This also helped to reduce compaction and thus promoting infiltration and aeration. Dimethoate 40ec was applied as a general cover spray at a rate of 75 ml/ 100 ml of water to reduce disease infections. Dithane M45 was applied to prevent white fly and red spider mites from attacking the tomatoes.

Harvesting

The tomatoes were harvested on weekly basis in all the plots and yield was recorded. The harvesting was done from 12 to 16weeks and first flowering to first fruit ripening was (4-6) weeks. Yield records were taken from 10 selected tied plants in each plot.

Measuring stem height

Growth rate and the stem height of ten randomly selected plants was measured and recorded from the plots. The measurements were done from the onset of transplanting until the 17th week of growth and this was carried out on a weekly basis. The measurements were averaged for each plot. A measuring tape was used to obtain the height of plants and those with height to be measured were marked at the branches for identification during the study. The height was measured from ground level to the apex of the new top leaves of the main stem.

Data analysis

The data on yields and height of tomatoes were subjected to analysis of variance (ANOVA) using the GENSTAT 7, 0 statistical package. The data collected were tested at p <0, 05 for significance of treatment effects. Treatment means were separated using the L.S.D values.

Results

Results have shown that green manure contains 3.1% more potassium, 2.9% more nitrogen, 1% more phosphorous, and 0.6 more copper and 0.55% more boron compared to composted materials (Table 2). Duckweed compost had 0.6% more magnesium than green manure. The T-calculated values (0.71 and 0.35) were less than T-table value (6.61) at 5% significant level.

Table 2: Comparison of nutrient status between duckweed green manure and compost manure.

Nutrients	Compost (%)	Green (%)	Manure	Difference(Green-Compost)
N	1.9	4.8		2.9 (+)
P	1.5	4.5		3 (+)
K	2.4	5.5		3.1 (+)
Mg	1.8	1.2		0.6 (-)
Cu[4]	0.9	1.5		0.6 (+)
Br	0.5	1.05		0.55(+)

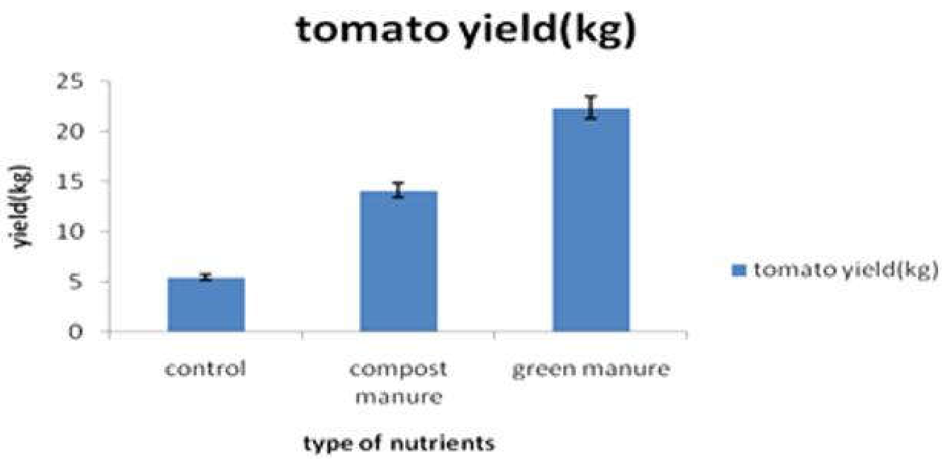

Figure 1: Average yield of tomatoes under different treatments

The yields were significantly different (compost, control and green manure) as shown in Figure 1. Higher yields were obtained in green manure treatments compared to compost and control treatments. The highest yield (22.88kg) was recorded from plots treated with green manure, followed by yield of

(14.13 kg) from compost manure. The least yields were obtained from plots with no fertilizer (5.42kg). Green manure had (8.75kg, 17.46kg) more yields than compost and control respectively. From the statistical analysis of the three treatments, there was a significant difference (F<0.001) tested at 0.05% level.

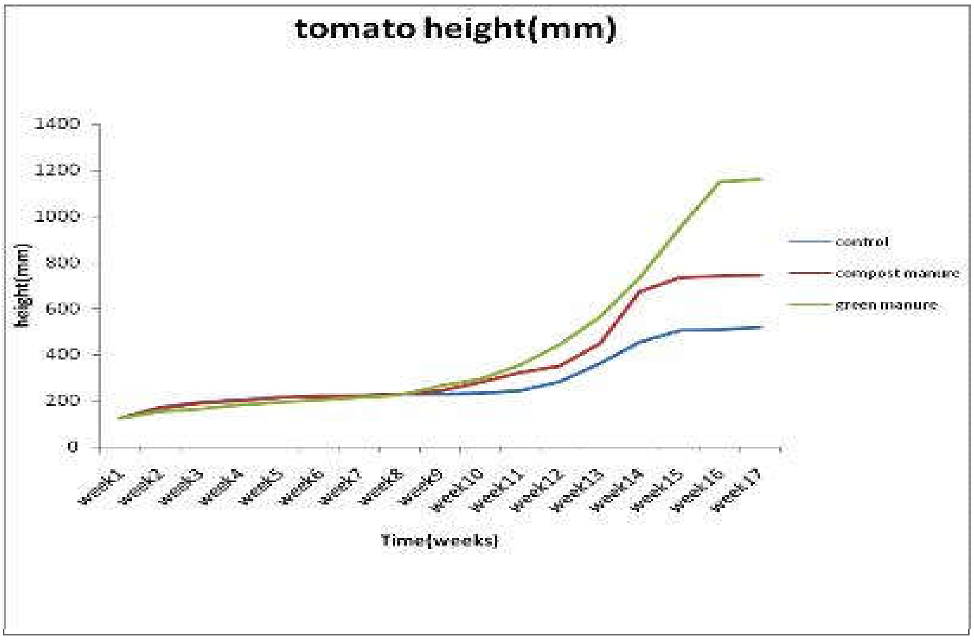

Figure 2: Effects of different nutrients concentrations on tomato height

The three treatments were statistically different (F<0,001) at 0,05 level of significance. Overall, the highest growth rate (1160, 7mm) was obtained from plots treated with green manure at 17th week followed by plants under control plots (520mm). Initially, the increases in height (growth rate) are almost the same in all the three treatments from week 1 to weeks 8. After week 8, the plants in the treatments responded differently with green manure showing faster growth rate than compost and control, and control being the least. From week 9 to week 15 the growth rate of crops under green manure was exponential followed by crops under compost manure from week 9 to week 14 and finally crops under control from week 11/12 to week 14. Then the growth rate ceased quickly first in control followed by compost and lastly green treatment at maturity stage and the maturity data were different up to week 17.

Table 3: Effects of different treatments on mean yield of tomatoes

Source of Nutrient	Means Yield (kg)
Control	5.42
Green manure	22.83
Compost manure	14.13
Grand mean	13.97
F	< 0.001
LSD	1.823
Sed	0.85
Cv (%)	10.5

Discussion

Yield

Highest yield was obtained from tomatoes grown under green manure plots, followed by compost manure plots and the least was under the control plots as shown in figure 2. The yields were statistically different among the treatments at 0, 05% significant level and F<0,001. This could have been caused by a difference in carbon nitrogen ratio. More yield in green manure was attributed by incorporation of green flowering plants that contain a greatest bulk of succulent organic matter at flowering stage, thus a low C:N ratio such that they will quickly liberate more N in available forms (Shamma , 2004).

Yield under compost manure plots was lower than green manure plots but higher than control. This is clearly shown in table 6 and figure 2. Therefore, it was because of large C: N ratio in compost manure than green manure (narrow C: N ratio) that results in more N available to plants and thus stimulate a higher productivity (Cotching et al., 2001). Organic matter with low C: N ratio has more N available and it can be utilized quickly by plants than the organic matter with higher C: N (Van Slyke, 2000).

The above statement can be supported by what Tisdale., (1993), noted that, if material added to the soil contains small amount of N in relation to C will result in micro-organism utilizing all the Ammonium or nitrate present in the soil to further decomposition and results in low yields.

Great difference between yields was due to difference in material used. In green manure the C: N ratio was 20:1 while in compost the C: N ratio was 400:1 (saw dust) (Hanck, 1984) and in addition fresh plants have carbon content of 25:40 times of organic nitrogen than decomposed material with 10:12 times of C: N ratio and hence differ in yields (Van Slyke, 2000).

Before week 10 the growth was nearly uniform because of initial development of roots by the plants and soon after, the growth rate increases at different rates with green manure (294mm), compost manure (280,6mm) and control (234,3mm) and week 12 the growth rate under green manure was (443,3mm), compost manure (352mm) and control was (284,3mm).This was due to either being sufficient leaf growth for photosynthesis coupled with vigorous root growth for greater extraction of nutrients.

Growth rate

The growth rate of tomatoes was almost uniform in all the treatments from transplanting (week 1 to week 8). This could be possibly due to, the channelling of more nutrients towards roots development, since young plants require more nutrients like nitrogen, phosphorous for growth and development of roots (Were, 1975). Also, it was due to the relatively large percentage of photosynthetic (photosynthetic product) for root establishment. In addition, development of roots should be the first in plant growth for constant supply of nutrients for further development (nutrient uptake and anchor the plant).

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Though the growth rate was almost uniform, the growth curve of tomatoes under compost manure was slightly above green manure from transplanting to week 5 and then there was a decrease. Even if was not significant, this might be due to slight immobilization of nutrients by micro organisms in the compost plots than green plots as sited by Suzuki (2010), that compost material adds nutrients to plants at early stages of growth than green manure but tends to decrease as time proceeds. After week 8, plants in all the treatments responded differently with a rapid increase in growth rate under green manure with highest growth rate followed by compost manure and lastly control. This was due to more nitrogen availability which in turn increases protein synthesis for vegetative growth. At this stage roots might have been well developed (Singh, 2004).

The rapid growth rate occurred could also have been due to further decomposition of duckweed by week 8 and they had been incorporated into the soil over a period of time before transplanting. In control plots, the plant responded to residual nitrogen of 0.18% (table, 4). Plants under green manure show an exponential growth rate from week 9 to 15, followed by plants under compost manure with an exponential growth between 9 and 14 and lastly plants under control with exponential growth rate between 11/12 and 14. This difference in exponential growth among the treatments may be attributed by difference in nutrients content such as nitrogen, potassium etc. The exponential growth may be due to the ability of capturing and utilizing more energy as it increases in flowering, size and thus more nitrogen for vegetative growth. Therefore a narrow C: N ratio in green manure than compost and control had resulted in more nitrogen available to plants than microorganism. This is in line with Singh (2004).

Plants under green manure reach maturity at a later stage than compost, control as shown by figure 4. This might be due to more nitrogen for growth and a narrower C: N ratio that reduces mobilization of nitrogen by micro-organisms as compared to a wider C: N ratio. As noted by Tisdale et al., (1993). Slow growth rate of plants under compost manure from week 1 to week 17 contradicts with what Suzuki (2010) noted and this might have been attributed by a larger C: N ratio and mobilization of nutrients by micro-organism.

The above condition was due to poor selection of composting material such as saw dust with a high C: N ratio. Thus more competition for the available N between plants and micro-organisms could have increased with time (Wolf and Snyder, 2003). Also Van Slyke (2001) state that, during decomposition micro-organisms require energy to break down organic matter and if delay to use the composted material, micro-organism may scavenge all the available nitrogen.

Conclusion

Both duckweed green and compost manure can significantly increase the yield and growth rate of tomatoes, though green manure had both higher yield and growth rate than compost manure. The major variation between compost and green manure was due to differences in C: N ratio. Materials that have a high C: N ratio will also lower the availability of N content to plants and time of harvesting the weed. Since the weed contains more nutrients like nitrogen, phosphorus, potassium at the flowering stage.

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