**YIELD RESPONSE TO TYPE OF MULCH AND TIME OF MULCH APPLICATION IN ORGANIC PRODUCTION OF TOMATO (*SOLANUM LYCOPERSICUM* L.).**

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**Abstract**

Mulching in organic agriculture is important for a variety of roles it performs. Mexican weeping pine (*Pinus patula* Schelde. ex Schltdl and Cham) and wild lemon grass (*Cymbopogon spp.*) were used as mulch to evaluate the effect of type of mulch, time of applying mulch and influence of seasons on yield of organically produced tomato (*Solanum lycopersicum* L.) in Lushoto district, north-eastern Tanzania. The experiment followed a Randomised Complete Block Design (RCBD). The treatments were pine mulch applied 3 days after transplanting, pine mulch applied 3 weeks after transplanting, grass mulch applied 3 days after transplanting, grass mulch applied 3 weeks after transplanting, weeded and unweeded (control). Yield data were taken at harvesting. Data analysis was done by using Genstat Statistical Package. Results showed that the time of mulch application at an interval of three days and three weeks from transplanting did not have an influence on yield but yields of tomato were significantly higher in mulched than in unmulched treatments. Tomato yields recorded in season 1 (wet and cold) were higher at both sites than yields recorded in season 2 (dry and warm).This study reveals that the type of mulch used and the time of application affect tomato yield only positively.

**Introduction**

Tomato (*Solanum lycopersicum* L.) is a highly valued horticultural crop consumed as a source of Vitamins A and C necessary for supplementing the daily dietary requirements of the human body. Tomato is used in diverse ways around the world in its raw form and in a cooked form as an ingredient in many dishes. Tomato is cultivated by using conventional as well as organic methods however, the ecological, toxicological and environmental shortcomings concerning synthetic pesticide and fertilizer residues in food and the environment have raised some restrictions on the use of the conventional agricultural produce (Cohen and Yuval, 2000). The raised doubts and restrictions on conventional produce is the driving force behind the recent preferences in organic produce worldwide (Willer and Yussefi, 2006). Organic agriculture in general combine tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved (IFOAM, 2007). Organic production not only reduces health risks to both producers and consumers but also maintains and improves soil qualities (van Elsen, 2000). Soil-bound organisms also benefit because of increased bacteria populations due to incorporation of natural fertilizer such as manure, while experiencing reduced intake of pesticides (Hole *et al*., 2005). Crop management in organic production systems requires an integration of all possible cultural and preventive practices. Among the cultural practices allowed in organic production systems, mulching is highly emphasized for its role of suppressing weeds, conserving soil moisture, providing nutrients upon decomposition, conserving natural enemies of insect pests by providing them with a suitable habitat, moisture, protection and alternative prey (Cortesero *et al*., 2000

Lushoto district, in the northeastern of Tanzania is one of the areas where organic production of many vegetables including tomato occurs. Farmers commonly use star grass, banana leaves, bean plants and pods and other crop residues as mulch. However, several challenges have been associated with the use of common organic types of mulch such as an increase in labour cost in terms of time and money as most of these mulches require frequent replenishment, scarce availability of these mulches as most of them are also used as animal feed and seasonal availability of the mulch which does not guarantee a year-through access to mulch. Challenges associated with such commonly used mulches in Lushoto district, has diverged attention towards alternative organic mulches. Pine litter and wild lemon grass have been considered as the potential alternative organic mulch that can be used in organic production of tomato in Lushoto district. However, an investigation is necessary as much is still unknown regarding the use of pine and wild lemon grass as organic mulch in organic production of tomato in Lushoto district. This paper reports the outcome of studying the effect of type of mulch and time of applying mulch on yield of organically produced tomato.

**Materials and methods**

**Description of study area and materials**

The study was done in Lushoto district, Tanga region, Tanzania. The district is located in the West Usambara mountains lying between 38º 10’ and 38º 36’E and 4º 24’ and 5º 00’S. The altitude in Lushoto is between 800-2300 m above sea level. The rainfall received is in bimodal pattern with the short rains from October to December and the long rains from March to June. Annual rainfall ranges from 600 to 1200 mm while temperature ranges from 16 - 30º C. The soils are generally latosols. The experimental sites were Lushoto (38° 17’ 24’’ East and 4° 47’ 55’’ South) with an altitude of about 1500m. a.s.l. located at Lushoto town-forest area and Ubiri (38° 21’ 59’’ East and 4° 50’ 29’’ South) with an altitude of about 1218m. a.s.l. located at Ubiri village along Mombo-Lushoto road.

Tomato variety ‘Tanya’ was grown for two seasons from April to December, 2013. The first season (season 1) began in April to September 2013 at Lushoto experimental site and from April to August 2013 at Ubiri experimental site while the second season (season 2) began in August to December 2013 in both experimental sites. The two seasons experienced two very different weather conditions. Season 1 was wet and cold while the season 2 was dry and hot. In season 1 seeds were sown in late February 2013, transplanting of seedlings was done in April 2013 while in the second season seeds were sown in July and seedlings were transplanted to the field in late August, 2013. Organic compost used was ERTHFOODTM (1.5-0.5-0.5) at the quantity of 500g per hole applied one day before tomato seedlings were transplanted. This was later supplemented with a seven day soaked solution of cow urine (20 litres), cow dung (50 kg) and water (200 litres) as top dressing organic manure applied at 0.5 litres per plant. The seeds of *Azadirachta indica* A. Juss. in dried, ground and sieved form (0.5 kg), sour milk (0.5 litres), ashes (0.5 kg), banana flower (1 piece) and kerosene (0.25 litres) all mixed in 15 litres of water, were used to prepare a local biopesticide. This mixture was applied against aphid outbreak in season 1 and against thrips outbreak in season 2. This biopesticide was also used against fungal and bacterial diseases. Crops were irrigated by tap water (at Lushoto) and by furrow water (at Ubiri). Organic mulch used was dried pine needles and dried wild lemon grass.

Pine mulch was collected under pine trees located in the pine forest near Lushoto experimental site while wild lemon grass was collected from the big rocks on top of the mountains at Kizara village near Ubiri village also located along the Mombo-Lushoto road. Pine mulch came in dry form and did not require chopping due to its needle-like shape while wild lemon grass came in fresh form hence required about three weeks to dry before it was chopped and used. Pitfall traps were employed to collect beneficial arthropods in the two consecutive vegetable growing seasons in both locations.

The experiment followed a Randomized Complete Block Design (RCBD) with six treatments and three replications. The treatments were pine mulch applied 3 days after transplanting (PI) tomato seedlings, pine mulch applied after three weeks (PA), wild lemon grass mulch applied 3 days after transplanting (GI), wild lemon grass mulch applied after three weeks (GA), weeded and unweeded (Controls). The size of each replication was 9m2.

Data on yield of organically produced tomato were collected based on the type of mulch applied and on time of mulch application. All data were subjected to Analysis of Variance (ANOVA) using GenStat Discovery Edition 4 package.

**Results**

Tomato yields in all mulched treatments were statistically similar (on each location and within seasons revealing that the type of mulch whether pine or wild lemon grass did not have an influence on yield (Table 1). The difference in yield is only significant when mulched treatments are compared to unmulched treatments. The time of applying mulch between treatments applied in 3 and 21 days after transplanting in all cases did not show a significant difference in yield. Yields between mulched and unmulched treatments in all cases show huge differences implying that mulch is very important than simply doing weeding. Tomato yields were significantly (p<0.05) influenced by seasons (Table 2). Yields in season 1 at Lushoto were significantly (P<0.05) higher than yields in season 2. Yields at Ubiri showed no significant (p>0.05) difference between season 1 and season 2.

**Table 1: Influence of types of mulch on tomato yield at Lushoto and Ubiri**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Yield (t/ha) | | | | |
|  | Lushoto | | Ubiri | |
| Treatments | Season 1  (Apr-Aug) | Season 2  (Aug-Dec) | Season 1  (Apr-Aug) | Season 2  (Aug-Dec) |
| PI | 18.20ab | 14.98a | 17.37a | 14.63ab |
| PA | 19.70ab | 12.03ab | 15.42a | 16.10a |
| GI | 22.90ab | 12.05ab | 16.75a | 14.63ab |
| GA | 21.40ab | 12.23ab | 15.08a | 13.88ab |
| Weeded | 14.70b | 9.73b | 10.15b | 10.45b |
| Control | 3.17c | 2.10c | 2.52c | 2.34c |
| Mean | 16.66 | 10.77 | 13.10 | 11.99 |
| LSD | 8.63 | 3.91 | 4.35 | 4.79 |
| p-value | 0.043 | 0.026 | 0.008 | 0.036 |

Mean values with the same letter(s) within the column are not significantly different at P=0.05 according to LSD. Season 1: April-September, 2013. Season 2: August-December, 2013.

**Table 2: Influence of seasons on tomato yield at lushoto and Ubiri**

|  |  |  |
| --- | --- | --- |
| Yield (t/ha) | | |
| Seasons | Lushoto | Ubiri |
| Season 1 (wet and cold) | 17.63a | 13.98 |
| Season 2 (dry and hot) | 11.42b | 13.02 |
| Mean | 14.53 | 13.50 |
| LSD | 2.77 | 1.88 |
| p-value | <0.001 | 0.304 |

Mean values with the same letter(s) within the column are not significantly different at P=0.05 according to LSD. Season 1: April-September, 2013. Season 2: August-December, 2013.

**Discussion**

Yield of organically grown tomato was two times higher in pine and grass mulched plots than yield of tomato in unmulched (control) plots in both season 1 and season 2 at Lushoto and at Ubiri sites. The results show clearly that using any of the two types of organic mulch was much better than having no mulch at all. Pine needles are known for the ability to last long and to possess high amounts of N (Singh, 1982) while grass mulch posses high amounts of P (Sinkeviciene *et al*., 2009). This explanation is perhaps the reason behind the similar quantities of yield recorded. Like any other organic mulch, grass mulch show effectiveness in regulating soil moisture and temperature in the beginning of the experiment before it decomposes to release nutrients to the soil.

The time of mulch application did not have an influence on yield in all mulched treatments. This is probably due to the fact that in the first three weeks after transplanting the emerged weeds were not aggressive enough to cause yield reduction as the critical period of weed competition in tomato is around four to five weeks after transplanting (Monks, 1993).

The differences in tomato yield between season 1 and season 2 are clearly observed at Lushoto site. Season 1 which was characterized by long rains from late March to the end of May followed by cold temperatures form June to August. Tomato plants at Lushoto were able to withstand the weather although some plants were affected by late blight, those which survived the weather ended up with very high yields harvested in August. The probable cause for this response is perhaps due to slow growth and the ability to utilize soil water and nutrients both from the soil and from pine and grass mulch. In season 2, temperatures went high and it was dry. The yields were not very high probably because the soils had dried up and irrigation water was not enough to enable plants to draw nutrients from the soil as it was in season 1.

**Conclusion and recommendations**

Employing organic mulch in tomato production is quite useful for its contribution on yield, suppression of weeds, protecting soil fauna, protecting the soil against solar radiations thereby reducing evaporation and providing conducive environment for tomato growth. It is recommended that, using organic mulch is better than not using at all.

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