Tropical Agricultural Research & Extension 10, 2007

Effects of Three Mulch Types on the Growth and Yield of Tomato (*Lycopersicon esculentum* Mill.) and Weed Suppression in Ibadan, Rainforest-savanna Transition Zone of Nigeria

*R.O. Awodoyin, F.I. Ogbeide and Olufemi Oluwole
Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria
E-mail: frawodoyin@yahoo.com

Accepted 19th August 2007

ABSTRACT

Field experiments were conducted in the 1998 and 2004 cropping seasons to assess the impacts of different mulching materials on weed control, soil temperature, soil moisture depletion and performance of tomato (*Lycopersicon esculentum* Mill.) in Ibadan, a rainforest-savanna transition ecological zone of Nigeria. The crop growth and fruit yield were studied under plastic (grey-on-black), woodchip (Teak) and grass (*Pennisetum*) mulches, with handweeded and unweeded as controls in a randomized complete block design with three replicates. Also assessed were weed dry matter and species spectrum, soil temperatures at 5-cm and 15-cm depths, and soil moisture depletion. Compared to unweeded control that had the least total fruit yield (2.7 t/ha in 1998 and 4.2 t/ha in 2004), mulch types and handweeded treatments increased the fruit yield by 152-237% in 1998 and 188-202% in 2004. Compared to mean pooled fruit yield from all mulched plots, unweeded treatment reduced tomato fruit yield by about 65% and 66% in 1998 and 2004, respectively. The weed control efficiencies of the mulches ranged between 91% and 100%. Dicotyledon weed species dominated the plots in the two years accounting for 81.8% in 1998 and 90% in 2004. The number of low-growing weed species enumerated on the plots was 11 in 1998 and 18 in 2004. After four weeks of no rainfall in 1998, moisture loss was least (1.68±0.10%) under plastic mulch and highest (13.96±0.08%) on the unweeded plot. The differences between morning and afternoon soil temperatures at 5 cm depth were low under grass mulch, woodchip mulch and unweeded control (5.0-5.9^{o}C) but high under plastic mulch and handweeded control (8.7-8.9^{o}C). Mulches are effective in weed control and conservation of soil moisture, and the plant-based mulches are most effective in reducing soil temperature. These improvements of crop growing environment resulted in increased tomato growth and fruit yield.

Keywords: mulches, *Lycopersicon*, weed control, moisture and temperature

INTRODUCTION

Weeds reduce crop productivity by interfering with crop growth. For example, in Nigeria uncontrolled weed reduce yield by about 40% in maize and 84% in upland rice (Akobundu, 1980), 31-70% in groundnut (Lagoke *et al.*, 1981), and 73-78% in cayenne pepper (Awodoyin and Ogunyemi, 2005). Akobundu and Ekeleme (2001) reported that uncontrolled *Imperata cylinderica* (L.) Raeuschel resulted in 92% reduction in maize grain yield in the drier savanna zone of southwestern Nigeria. Reduction of crop yield apart, weeds contaminate and taint farm product to reduce their market values and change their end use. However, weed control requires more labours which limits the land area a farmer could cultivate (Chianu and Akintola, 2003). Also, Akobundu (1987) reported that labour requirement for weeding as a percentage of total labour needed for crop production (harvesting inclusive) is 30% for maize, 37% for sorghum, 25% for cassava and 22% for white yam. Usoroh (1983) reported that weeding alone takes 30-45% of total cost of labour required for fruit and vegetable production in Nigeria. Chianu and Akintola (2003) reported that weeding demands 32.1-45.0% of total labour input under bush fallow, 32.3-38.4% under cover cropping and 24.1-35.4% under alley cropping.

Mulching is an effective method of ma-

*Corresponding author

nipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Opara-Nadi, 1993; Hochmuth *et al.*, 2001; Awodoyin and Ogunyemi, 2005). Awodoyin and Ogunyemi (2005) have reported that the weed control efficiency of different types of mulch in cayenne pepper production ranged from 27% to 97%.

Tomato (*Lycopersicon esculentum* Mill.) is a common and important fruit vegetable. It is rich in Vitamins A and B, and iron. It is grown for fresh market and tops the list of canned vegetables (Mc Donald and Low, 1984). Tomato is grown all over Nigeria with an average yield of 15-20 t/ha recorded in the forest ecozone of the south and up to 60 t/ha reported for savanna ecozone of the north (Anon, 1989). It has been reported that much of tomatoes, peppers, egg plants, strawberries and melons are produced under mulches in southern Florida (Hochmuth *et al.*, 2001). Hudu *et al.*, (2002) reported that tomato grown under irrigation in semi-arid zone of northern Nigeria benefited greatly from mulches.

Table 1: Monthly average rainfall, ambient air temperature and relative humidity in Ibadan, Nigeria in 1998 and in 2004

	Rainfall (mm)		**Mean Temperature (°C)**		**Mean Relative Humidity (%)**	
Months	**1998**	**2004**	**1998**	**2004**	**1998**	**2004**
January	0.0	35.3	26.7	26.7	58.4	61.4
February	2.8	16.3	29.8	28.0	62.3	60.5
March	8.0	11.1	30.7	29.1	61.3	58.1
April	54.4	209.2	30.3	27.4	73.5	75.1
May	82.6	143.6	28.5	26.8	80.0	78.7
June	158.0	172.1	26.9	25.1	80.9	79.8
July	71.8	191.3	25.5	24.5	86.8	84.7
August	50.9	53.4	25.1	24.1	86.0	85.0
Sept.	143.5	87.8	26.0	25.2	85.0	78.7
October	178.8	191.8	27.2	26.1	82.5	77.9
Nov.	31.2	8.1	28.7	27.3	73.9	69.0
Dec.	11.3	0	27.0	27.9	71.2	61.3
Total	**794.3**	**1120.0**	**-**	**-**	**-**	**-**
Average	**-**	**-**	**27.7**	**26.5**	**75.2**	**72.5**

Source: International Institute of Tropical Agriculture, Ibadan

Therefore, the study reported in this paper sought to compare the impact of different types of mulches (organic and inorganic) on the performance of tomato, *L. esculentum,* in Ibadan, a forest-savanna transition ecological zone in the southern Nigeria.

MATERIALS AND METHODS

The study was conducted during the early season (July-November) of 1998 and 2004 in the crop garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan (7°30^{1}N, 3°54^{1}E; 234 m asl), Nigeria. Ibadan is located in the rainforest-savanna transition zone of Nigeria, which falls within the Guineo-Congolian rainforest:drier type as described by White (1983). The floristic composition is a mosaic of lowland rainforest trees and secondary grassland. The land used for the study was under a 2-year bush fallow before each experiment. The area was dominated by a mixture of *Talinum fruticosum* (L.) Juss, *Amaranthus spinosus* L. and *Laportea aestuans* (L.) ex Miq in 1998 and a mixture of *Acanthospermum hispidum* DC, *Tridax procumbens* L. and *Chromolaena odorata* (L.) R.M. King & Robinson in 2004. The soil is sandy loam in texture and slightly acidic (pH 6.4 in 1998; pH 6.6 in 2004). The soil contained 2.07% organic matter, 0.18% total N, 0.50 ppm available P and 0.34 meq/100g K in 1998, and 3.13% organic matter, 0.21% total N, 0.80 ppm available P, 0.40 meq/100g K in 2004. The rainfall pattern was bimodal with peaks in June and October (Table 1). The total rainfall was less in 1998 (794.3 mm) than 2004 (1120.0 mm). The mean relative humidity and average annual air temperature were respectively 75.2% and 27.7°C in 1998, and 72.5% and 26.5°C in 2004 (Table 1).

The tomato variety used for the study (158-3) was obtained from the National Horticultural Research Institute (NIHORT), Ibadan. It is an indeterminate variety and produces tyre-shaped red fruits. Four weeks old tomato seedlings obtained from a nursery were transplanted in the field on 2nd July in the 1998 experiment and 26th July in the 2004 experiment. The field was prepared by clearing and tilling with hoe. The field was not prepared into beds because the soil is well-drained. The seedlings were spaced 0.8 m X 0.5 m (25,000 plants/ha) in the field. Each plot measured 3.5 m X 2.5 m and had 20 plants. The contiguous plots and blocks were separated by 1 m alley way. Fertilizer (NPK 15-15-15) was applied by ringing at 5 cm distance from the base of each plant at the rate of 150 kg/ha (6 g/plant) at two weeks after transplanting (WAT).

The three mulching treatments namely plastic mulch (0.25 µm thick dual surface grey-on-black polyethelene sheet), wood-chips (sourced from *Tectona grandis* L.), grasses mulch (*Pennisetum polystachion* (L.) Scult) with two control treatments (unmulched hand-weeded and unmulched unweeded) were arranged in a randomized complete block design (RCBD) replicated three times. The plastic mulch was laid just before transplanting with the grey surface turned up to reduce the amount of radiant energy absorbed. Transplanting holes were made at pre-marked points on plastic mulch. The wood-chips (6 t/ha dry matter per annum) and grass mulches (30 t/ha per annum) were applied to 2 cm thickness at 2 WAT. While the grass was applied in 3 splits because of rapid decomposition, wood-chips was applied once for each study.

Three tomato plants were randomly selected at the core of each plot (to have nine plants per treatment) to measure crop growth and fruit yield. At 12 weeks after transplanting (WAT), plant height and stem diameter at soil surface were measured using a meter rule and vernier caliper respectively. The number and fresh weight of fruits were recorded every four days from 9 WAT until the study was terminated at 14 WAT. The data were pooled for analyses. At 14 WAT, weed samples were collected from three 25 cm X 25 cm quadrats randomly laid per plot. The weeds were identified up to species level and the above-ground parts within each quadrat were clipped with a secateur at soil surface, oven-dried at 80°C for 48 hours and weighed with a top-loading mettler balance (model P1210) to determine the dry matter (DM). The weed control efficiency (WCE) of each treatment was determined by the following equation:

$$WCE = \frac{(\text{Weed DM on unweeded control} - \text{Weed DM on a Treatment}) \times 100}{\text{Weed DM on unweeded control}}$$

(Gill and Kumar, 1966)

Soil temperatures in the morning (0800 hr) and late in the afternoon (1600 hr) in each plot were measured in triplicate at 5 cm and 15 cm depths only in 1998, by using long-stemmed mercury-in-glass thermometer calibrated to 50°C. The period of dry spell (August break) in 1998 was targeted to monitor the effect of mulches on soil moisture depletion. The difference between soil moisture results obtained on 5th August and 6th September 1998 on each plot was taken as the % moisture depletion over the period. 20 g soil samples from the 0-10 cm soil depth were weighed in 5 replicates into crucibles and dried in Gallenkamp oven at 105°C to a constant weight (Allen *et al.*, 1976). The percentage soil moisture was calculated by the following equation:

% Soil moisture = {[Loss in weight on drying/ Initial Sample wt. (20g)] X 100} %

(Allen *et al.*, 1976)

Analysis of Variance procedures following Gomez and Gomez (1984) were adopted to various parameters to compare treatments. The weed DM data were transformed (square root) according to Little and Hills (1978). The 0800 hr and 1600 hr temperatures under the 5 treatments at 5 cm and 15 cm soil depths were separately compared using one-way ANOVA. The % moisture depletion values under the five treatments were also compared by one-way ANOVA. Mean separation was done using least significant difference (LSD) at 5% level of probability. Correlation coefficient (r) was adopted to relate the plant height, stem diameter, total number of fruits, fruit yields, weed DM, 1600hr temperature at 5-cm depth and % moisture depletion (Gomez and Gomez, 1984).

RESULTS

Growth and Yield

The differences in plant height between treatments were highly significant ($P<0.001$) in both years (Table 2). The plant height as affected by the treatments was in the order plastic > wood-chips > grasses > hand-weeded > unweeded in 1998 and Plastic > wood-chips > hand-weeded > grasses > unweeded in 2004. In both years, the mean height of tomato under plastic, wood-chips grasses and handweeded treatments were not significantly different but significantly ($P<0.05$) higher than unweeded control (Table 2).

The mean stem diameter ranged from 0.74 cm in unweeded plot to 1.74 cm in wood-chips plot in 1998, and 0.54 cm in unweeded plot to 1.49 cm in wood-chips plot in 2004. The differences between means of the treatments were highly significant ($P<0.001$), but differences between grasses mulched and handweeded treatments were not significant in the two years (Table 2).

The differences between treatments in total number of fruits (TNF) per plant were highly significant ($P<0.001$) in both years. For TNF, the order followed by the treatments were plastic > grass > wood-chips > handweeded > unweeded in 1998 and handweeded > grass > wood-chips > plastic > unweeded in 2004.

The orders followed by mean fruit yields were plastic > wood-chips = handweeded > grasses > unweeded in 1998 and woodchips > handweeded > plastic > grasses > unweeded in 2004 (Table 2). In 1998 the mean fruit yields obtained from woodchips, grasses and handweeded were not significantly different but significantly ($P<0.001$) lower than plastic mulch and higher than unweeded treatment (Table 2).

Table 2: Effect of mulch types on the growth and tomato fruit yield at Ibadan, Nigeria in 1998 and in 2004 (n=3)

Mulch Types	Plant Height (cm/plant)	Stem Diameter (cm/plant)	Total number of Fruits per plant	Fruit Yield (t/ha.)
		1998		
Plastic	84.2	1.02	131.3	9.1
Wood-chips	75.8	1.74	96.7	7.4
Grass	75.6	1.00	104.7	6.8
Hand-weeded	71.1	0.90	89.0	7.4
Unweeded	55.8	0.74	42.1	2.7
LSD $_{(0.05)}$	**11.8**	**0.1**	**9.1**	**1.1**
CV (%)	**8.7**	**5.7**	**5.2**	**8.5**
		2004		
Plastic	110.3	1.04	143.5	12.2
Wood-chips	105.2	1.49	220.8	12.7
Grass	103.1	0.76	286.0	12.1
Hand-weeded	103.9	0.89	336.4	12.4
Unweeded	80.0	0.54	97.5	4.2
LSD $_{(0.05)}$	**17.5**	**0.2**	**21.0**	**0.7**
CV (%)	**9.2**	**13.0**	**6.6**	**3.2**

However, in 2004 the fruit yields obtained on plastic, woodchips, grasses and handweeded treatments were not significantly different but were significantly ($P<0.001$) higher than unweeded treatment. Compared to unweeded treatment the plastic mulch, wood-chips mulch, grasses mulch and handweeded control increased the fruit yields by 237%, 174%, 152% and 174% respectively in 1998, and 190%, 202%, 188% and 195% respectively in 2004. Compared to the mean fruit yield on all the mulched and handweeded treatments, uncontrolled weed reduced tomato fruit yield by 65% in 1998 and 66% in 2004.

Weed Control Efficiency (WCE) and weed species composition

The plastic mulch and handweeded control treatments had the least weed DM (0 – 1.8 g/m^2), and unweeded plots had the highest weed DM (884.0 g/m^2) (Table 3). The differences in the mean weed DM among the treatments were highly significant ($P<0.001$) and the two years were also significantly different ($P<0.01$). The WCE was lowest under the grass mulch and highest under the plastic mulch in both years (Table 3).

Out of eleven weed species identified in the field in 1998, 9 species (81.8%) were dicotyledon plants. The two monocotyledon species were *Mariscus alternifolius* (Cyperaceae) and *Commelina benghalensis* (Commelinaceae). The dominant weed species were *A. spinosus*, *T. fruticosum* and *L. aestuans* (Table 4). In 2004, 18 weed species were identified in the

Table 3: Effects of mulch types on weed dry matter (DM) (g/m^2) in tomato field at Ibadan, Nigeria (n=3)

Mulch Types	1998		2004	
	***Weed DM**	**WCE (%)**	***Weed DM**	**WCE (%)**
Plastic	0.7 (0)	97.6	2.3 (4.8)	92.3
Wood-chips	12.6 (159.0)	57.1	13.5 (182.0)	55.0
Grass	14.1 (197.5)	52.3	15.7 (244.4)	47.8
Hand-weeding	0.7 (0)	97.6	0.71 (0)	97.6
Unweeded	29.5 (868.6)	-	30.0 (899.7)	-
LSD $_{(0.05)}$	**0.8**	**-**	**1.2**	**-**
CV (%)	**3.5**	**-**	**5.2**	**-**

* Values are means of square root transformed data. Original data are in parenthesis.
WCE = Weed Control Efficiency

field, out of which dicotyledon species accounted for about 90%. The dominant species were *A. hispidum*, *T. procumbens* and *C. odorata*. The two monocotyledon species identified in the field in 2004 were *Cyperus rotundus* (Cyperaceae) and *Setaria barbata* (Poaceae). None of the weed species did emerge under plastic mulch during the experimentation in 1998, but the tuberous nutsedge (*Cyperus rotundus*) emerged during the experimentation in 2004 (Table 4).

Soil temperatures and moisture depletion

The morning and afternoon temperatures were lowest under the unweeded treatment and highest under the plastic mulch both at 5cm and 15cm depths (Table 5). The morning temperatures under mulches did not differ significantly at 5cm depth but differed significantly ($P<0.001$) at 15cm depth. The afternoon temperatures under the mulches and control plots differed significantly ($P<0.001$) at the two depths. The differences between morning and afternoon temperatures under the mulches were highly significant ($P<0.001$) at the two depths (Table 5).

The moisture depletion in the soil followed the order unweeded > handweeded > grass > wood-chips > plastic (Table 6). The moisture depletion in the handweeded (13.87%) and unweeded (13.96%) plots did not differ significantly, but the differences between means of other treatments differed significantly ($P< 0.001$).

Correlations between tomato performance, weed DM and soil condition parameters

The fruit yield positively correlated with plant

Table 4: The weed species identified under different mulch types in 1998 and in 2004

Weed Species	1998					2004				
	PM	WC	GR	H/W	UW	PM	WC	GR	H/W	UW
A. Dicotyledon species										
Acanthospermum hispidum DC	-	-	-	-	-	-	+	+	-	+
Ageratum conyzoides L.	-	-	-	-	+	-	-	+	-	+
Amaranthus spinosus L.	-	+	+	-	+	-	+	-	-	-
Boerhavia diffusa L.	-	-	-	-	-	-	+	-	-	-
Boerhavia coccinea Mill.	-	-	-	-	-	-	+	-	-	+
Chromolaena odorata (L.) R.M. King & Robinson	-	-	-	-	-	-	+	+	-	-
Euphorbia heterophylla L.	-	+	+	-	-	-	-	-	-	+
Euphorbia hirta L.	-	-	-	-	+	-	-	+	-	+
Ficus exasperata Vahl.	-	-	-	-	-	-	-	-	-	-
Gomphrena celosioides Mart.	-	-	-	-	-	-	-	-	-	-
Laportea aestuans (L.) Chew	-	+	-	-	+	-	+	-	-	+
Momordica charantia L.	-	+	-	-	+	-	-	-	-	-
Peperomia pellucida (L.) H.B. & K.	-	-	-	-	-	-	-	+	-	-
Physalis angulata L.	-	-	-	-	+	-	-	-	-	-
Senna obtusifolia (L.) Irwin & Barneby	-	-	-	-	+	-	-	-	-	+
Solanum nigrum L.	-	-	-	-	-	-	-	+	-	-
Spigelia anthelmia L.	-	-	-	-	-	-	+	-	-	+
Synedrella nodiflora Gaertn.	-	-	-	-	-	-	+	+	-	-
Talinum fruticosum (L.) Juss.	-	+	+	-	+	-	-	+	-	+
Tridax procumbens L.	-	-	-	-	-	-	+	+	-	+
B. Monocotyledon species										
Commelina benghalensis L.	-	-	-	-	+	-	-		-	-
Cyperus rotundus L.	-	-	-	-	-	+	-	+	-	+
Mariscus alternifolius Vahl.	-	-	-	-	+	-	-	-	-	-
Setaria barbata (Lam.) Kunth	-	-	-	-	-	-	-	-	-	+

PM = Plastic Mulch; WC = Wood-chips Mulch; GR = Grass Mulch; H/W = Hand-weeding control; UW = Unweeded Control , + = Present , - = Absent

Table 5: The mean day time temperature (°C) at 5 cm and 15 cm soil depths under different mulch types in 1998 (n=3).

Mulch Types	5-cm Depth			15-cm Depth		
	0800h	1600h	Difference	0800h	1600h	Difference
Plastic	29.00	37.90	8.90	29.30	34.70	5.4
Wood-chips	28.47	33.17	4.70	28.70	32.30	3.6
Grass	28.37	34.20	5.83	28.40	32.40	4.0
Hand-weeded	28.27	36.80	8.53	28.50	34.90	6.4
Unweeded	28.00	33.00	5.00	27.80	32.10	4.3
$LSD_{(0.05)}$	**ns**	**0.57**	**0.35**	**0.42**	**0.42**	**0.52**
CV (%)	**0.67**	**0.86**	**0.71**	**0.78**	**0.67**	**0.87**

height (r=0.974; P<0.001), stem diameter (r=0.733; P<0.001), total number of fruits per plant (r=0.944; P<0.001) and 16-hr soil temperature at 5-cm depth (r=0.448; P<0.01) (Table 7). Weed DM negatively correlated with all the growth and yield parameters and soil temperature (r=-0.466 to -0.876). The 16-hr soil temperature at 5-cm depth positively correlated with all growth and yield parameters, except weed DM (r=-0.862; P<0.01). The soil moisture depletion negatively correlated with all the parameters (r=-0.230; P<0.001 to r=-0.681; P<0.001) (Table 7).

DISCUSSION

The mulches enhanced the growth of tomato plants in both years. The results agreed with previous studies which showed the superiority of mulched plants over the unmulched plants (Opara-Nadi, 1993; Hudu *et al.*, 2002; Awodoyin and Ogunyemi, 2005), and the report that tomato benefited from mulching (Hochmuth *et al.*, 2001). The increased growth and tomato fruit yield under the mulches may be explained by the conservation of moisture and reduction of temperature in the top soil, and suppression of weed growth. The latter resulted in reduced weed-crop competition. The best fruit yield obtained under plastic mulch in this study conformed to earlier report that plastic improves the performance of tomato (Hochmuth *et al.*, 2001). The better yield in wood-chips mulched plots than grass-mulched plots may be explained by the higher weed control efficiency and less moisture depletion. The wood-chips, having high carbon to nitrogen ratios was slowly decomposed compared with grass mulch that had to be split-applied three times during each year of the study. Therefore, wood-chips provides longer cover over the soil than grass mulch. Rose (1996) reported that straw, wood-chips and sawdust mulches have high carbon to nitrogen ratios. The increase of fruit yield effected by the plastic mulch that was higher in 1998 (237%) than 2004 (190%) is an indication that mulching is more beneficial to crop performance when there is water stress. The total annual rainfall in 1998 (794.3 mm) was lower than in 2004 (1120.0 mm).

Table 6: The mean soil moisture content (%) at the beginning and end of the dry spell (August break) and percentage moisture depletion in 1998. Values are mean±S.E. (n=3)

Mulch Types	Mean Moisture Content (%)		Moisture Depletion (%)
	5th August 1998	6th September 1998	
Plastic	15.19	13.51	1.68 ± 0.10
Wood-chips	21.83	12.63	9.20 ± 0.30
Grass	24.38	11.81	12.57 ± 0.13
Hand-weeded	20.26	6.39	13.87 ± 0.09
Unweeded	23.34	9.38	13.96 ± 0.08
$LSD_{(0.05)}$	-	-	**0.32**
CV (%)	-	-	**0.58**

Among the mulches, weed control was best under the plastic. This conforms to the report that plastic mulch most effectively controls weeds (Hartmann *et al.*, 1981). Also, Olabode *et al.*, (2006), working on response of okra to mulching in Ogbomosho, southern guinea savanna of Nigeria, reported that plastic mulch was best and grass mulch (*Panicum*) least in weed control efficiency. The grey-on-black polyethylene used in this study reflects and intercepts solar radiation that will induce germination of weed seeds and support production of assimilate by the seedlings. This might account for the zero survival of weed seedlings under plastic mulch in 1998. The tuberous nutsedge (*Cyperus rotundus*) that survived under plastic mulch in 2004 had pointed shoot end that pierced through and produced the above-ground shoot. When nutsedge seedlings were emerging, the food reserve in the tuber supported the growth before the shoot could produce chlorophyllous leaves to commence photosynthesis. Hochmuth *et al.*, (2001) reported that nutsedge with its tubers that produce enough energy for the young, sharp-leaved seedling to survive remain a problem on mulched plots, including plastic. The weed control efficiency of wood-chips that was better than grass can be explained by the slow decomposition caused by high carbon to nitrogen ratio. The preponderance of broad-leaved (dicot) weed species is a factor of the geographical location of the study site, which is in the rainforest-drier type ecological zone (White, 1983) characterized by high rainfall.

The prevention of direct contact of solar radiation with the soil by the organic mulches explains the low soil temperature. The consistent high temperature under plastic mulch is due to the green house effect that traps the little radiant energy and penetrates into the soil. Though the temperature on the unweeded plot was low, the poor crop performance obtained on the plot can be explained by the competition between crop and weeds.

Less moisture depletion under the mulches was a result of prevention of contact between the soil and dry air, which reduced water loss into the atmosphere through evaporation. Also, mulches reduce impact of raindrops and splash, thereby preventing soil compaction, reducing surface run-off and increasing water infiltration (Chancellor, 1977). All these combined to increase the soil moisture content and reduce moisture depletion. As moisture depletion is least under the plastic mulch so the rate of moisture recharging-ability would be least because water infiltration will be prevented. None the less, capillary movement of water molecules through the soil pores from the water table will supply water to the root zone of the crop grown under plastic mulch (Hochmuth *et* al., 2001). The slightly higher water depletion in unweeded plot than unmulched handweeded plot may indicate that water loss into the atmosphere through transpiration from crop and weeds is higher than combined water loss through evaporation from the exposed soil surface and transpiration from the crop.

The result of the correlation indicates that organic mulches reduced soil temperature while mulches generally reduced soil moisture depletion, and weed infestation. All these enhanced the growth and fruit yield of tomato. Hochmuth *et al.*, (2001) also reported that the primary objectives of mulching are weed control, soil moisture conservation and temperature modification.

CONCLUSIONS

Mulching increased growth and fruit yield of tomato through modification of the crop growing environment by reducing weed infestation, soil moisture depletion and ameliorating soil temperatures. This helps to reduce herbicide usage, thus prevents environment pollution and ensures production of organic food. Plastic mulch is more effective in the control of weed infestation. Temperature rise under the plastic mulch did not impair crop growth.

REFERENCES

Akobundu, I.O. (19800 Live mulch: a new approach to weed control and crop production in the tropics. *Proceedings 1980 British Crop Prodcution Conference – Weeds* pg. 377-382

Akobundu, I.O. (1987) Weed Science in the Tropics: Principles and Practices. John Wiley and Sons, Chicester, UK. 522 pp.

Table 7: Correlation coefficient (r) between crop growth, tomato fruit yield, weed dry matter, 1600h soil temperature and % moisture depletion as affected by mulch types in Ibadan, Nigeria in 1998

	1	**2**	**3**	**4**	**5**	**6**	**7**
Plant height (cm) **[1]**	-	0.709**	0.845ns	0.974***	-0.844 ***	0.620***	-0.681***
Stem diameter (cm) **[2]**		-	0.704***	0.733***	-0.466ns	0.055***	-0.495**
Total number of fruits per plant **[3]**			-	0.944***	-0.832***	0.448**	-0.230***
Fruit yield (t/ha) **[4]**				-	-0.876ns	0.577***	-0.518ns
Weed dry matter (g/m^2) **[5]**					-	-0.862**	0.492ns
16 hr Temperature at 5 cm depth **[6]**						-	-0.561***
% moisture depletion **[7]**							-

** - Significant at 1% level of probability; *** - Significant at 0.1% level of probability;
ns – not significant

Akobundu, I.O. and F. Ekeleme. (2001) Effects of methods of *Imperata cylindrica* management on maize grain yield in the derived savanna of southwestern Nigeria. *Weed Research* 40: 335-341

Allen, S.E., Grinshaw, H.M., Parlinson, J.A. and Quarmby, C. (1976) Chemical analysis of ecological material. Blackwell Scientific Publications. Oxford. 565 pp

Anon, (1989) Fertilizer use and management practices for crops in Nigeria. Federal Ministry of Agriculture, Water Resources and Rural Development, Lagos

Awodoyin, R.O. and Ogunyemi, S. (2005) Use of sicklepod, *Senna obtusifolia* (L.) Irwin and Barneby, as mulch interplant in cayenne pepper, *Capsicum frutescens* L., production. *Emirate Journal Agricultural Science* 17(1): 10-22

Chancellor, W.J. (1977). Compaction of soil by agricultural equipment. *Division of Agricultural Sciences, University of California bulletin*, 1881

Chianu, J.N. and Akintola, J.O. (2003). Labour needs for weeding: Implications for the adoption of improved fallow management systems in the derived savannas of southwestern Nigeria. *Nigerian Journal of Weed Science* 16: 1-7

Gill, H.S. and Kumar, V. (1966) Weed Index. A new method for reporting weed control trials. *Indian Journal of Agronomy* 14: 96-98

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, New York. 2nd ed. 680 pp

Hartmann, H.T,. Kofranek, A.M., Rubatzky, V. E. and Flocker, W.J. (1981) Plant Science. Growth, Development and Utilization of cultivated plants 2nd ed. Prentice-Hall, Inc. Simon and Schusfet, Englewood Clif fs, New Jersey

Hochmuth, G.J., Hochmuth, R.C. and Olson, S.M. (2001) Polyethylene Mulching for Early Vegetable Production in North Florida. *University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS)*, Florida A & M University Cooperative Extension Programm. http:/edis.ifas.ufl.edu

Hudu, A.I., Futuless, K.N. and Gworgwor, N. A. (2002) Effects of mulching intensity on the growth and yield of irrigated tomato (*Lycopersicon esculentum* Mill.) and weed infestation in semi-arid zone of Nigeria. *Journal of Sustainable Agriculture* 21:37-45.

Lagoke, S.T.O., Choudary, A.H. and Tanko, Y.M. (1981). Weed control in rainfed groundnut in the savanna zones of Nigeria. *Weed Research* 21: 11-25

Little, T.M. and Hills, F.J. (1978) Agricultural Experimentation: Design and Analysis. John Wiley & Sons, New York. 350 pp.

Mc Donald, I. and Low, J. (1984) Fruit and Vegetables. Evans Brothers Ltd. Chiltern St., London. 137 pp

Olabode, O.S., Ogunyemi, S. and Awodoyin, R.O. (2006). Response of okra (*Abelmosch us esculentus* (L.) Moench) to weed control by mulching. *Ghana Journal of Agricultural Science* 39(1):35-40

Opara-Nadi, O.A. (1993) Effect of elephant grass and plastic mulch on soil properties and cowpea yield. In: Mulongoy, K. and Merckx. R. (eds.), Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture. John Wiley & Sons, New York. P. 351-360

Rose, M.A. (1996) Mulching Landscape plants. *Ohio State University Extension Fact Sheet*, HYG-1083-96. 5 pp

Usoroh, N.J. (1983) Weed problems and control strategies in fruit and vegetable production in Nigeria. *Acta Horticulturae*, 123: 299-304

White, F. (1983) UNESCO/AETFAT/UNSO Vegetation map of Africa: Descriptive me moir and map. UNESCO,Paris