

## Original Research Article

# Moisture Conservation Techniques and Micro-Climate Moderation for Late Season Production of Selected Maize (*Zea mays*) Varieties in Southeastern Nigeria

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## Abstract

The experiment assessed the growth and yield of four maize varieties – TZSR (W), TZESR(Y), DMRSR (Y) and local *Oka-Nkporo* grown under four sources of mulch (bare, grass, wood shavings and egusi melon). The experiment was laid in a randomized complete block design of four replicates, and executed for two consecutive years. Growth and yield data correlations of maize for the two years were analyzed statistically using Genstat (2008) for Windows. Partial input-output analysis as maize production enterprises was summarized. Mulched maize varieties attained superior growth and higher yields than the control. Although all improved maize varieties were superior to the local *Oka-nkporo*, the improved TZSR (W) produced the highest maize yield (4.14 t ha<sup>-1</sup>) ( $P \leq 0.05$ ). The TZESR(Y) matured earliest and out-yielded *Oka-nkporo* and DMRSR (Y). Mulched maize varieties tolerated lodging, stem borer and termite infestation better than the control. However, the *Oka-nkporo* was the most susceptible variety in both mulched and unmulched late maize production systems. Most yield components correlated positively and significantly ( $P \leq 0.05$ ) with maize grain yields except in TZESR(Y) maize variety where days to 50% tasselling and silking significantly and negatively correlated with maize grain yield. The maize/wood shavings enterprise incurred a net loss, (in Nigerian Naira), of – ₦9500.00 per hectare. TZSR (W) maize/trash and maize/melon enterprises gained ₦4,800.00 and ₦14,900.00 respectively per hectare. Maize/melon intercrop (melon live mulch) is advocated for late season maize production for high return on inputs in southeastern Nigeria.

**Keywords:** Moisture, late season, pest, maize enterprise.

## Introduction

The increasing prospects of a global food deficit, have led to intensified efforts from all fronts to increase food production. These include increase in total hectare under production and increase in

yield per hectare. However, increased yield per hectare in southeastern Nigeria is achievable through increased individual crop yield or multiple cropping. To achieve this option, the key areas of research focus include positive manipulation of production technologies, growing of improved, high-yielding, disease-resistant and drought-tolerant crop varieties, and multiple cropping.

Maize (*Zea Mays*, L) is an important cereal crop grown globally, and it ranks second after wheat in hectareage (177,379,567 ha; FAOSTAT, 2013). Globally maize production stood at 872.8 million metric tons in 2012 (FAO, 2014). In Nigeria, maize is an important food, fodder and industrial crop grown both commercially and at subsistence level (Eleweanya *et al.*, 2005). It also provides the bulk of raw materials for many agro-allied industries in the world (Bello *et al.*, 2010). Nigeria produced 5,288,020 tonnes of these assorted maize on an area of 3.5 million hectares of 25 million hectares arable land devoted to crop production. Maize is a dominant component crop in farming systems of Nigeria despite its constant damage by cattle, rodents and wild animals. Maize consumption and utilization are high in Nigeria. Humans consume 20%, livestock, 60%, and agro-related industries, 20%. The development of improved maize varieties and production technology have helped tremendously in boosting maize yields nationwide. However, some major inconsistencies have been observed in the field with regard to expected and actual yields of most elite maize varieties. These inconsistencies which often result in reduced yields have been attributed to factors such as cropping patterns, variations in climate, upsurge in disease outbreaks, and varietal breakdowns among others. An effort to tackle some of the above problems called for screening of some elite maize varieties for late season cropping in the rain forest ecological zone of Nigeria.

In the rainforest zone of southeastern Nigeria, rainfall is bimodal (Onweremadu *et al.*, 2007), and ranges from 2000-2500mm during the early (March-July), and late (July-October) cropping seasons. Both seasons are adequate for maize production. Naturally, two crops of maize (early and late) are normally grown. Most early season maize is lost due to high relative humidity, incidence of pests and diseases, poor drying and poor grain storage conditions. The late season maize faces unpredictably frequent dry spells, and attacks from stem borers and termites. These lead to maize crop failure. Supplementary irrigation under such situations is ideal. However, facilities for irrigation are expensive, and unaffordable by resource-poor maize growers in the rainforest ultisol.

A more practical approach therefore would be the use of appropriate agronomic practices including optimal plant populations of improved early-maturing maize varieties, intercropping, and suitable ground cover. Mulching to conserve moisture, provide nutrients and moderate soil temperatures is a conventional cultural practice. Dry mulch, depending on locality, is efficient but may be bulky, uneconomical, location-dependent and rarely available. Some live mulches such as legumes, egusi melon, and sweet potato in maize mixtures will generate additional income apart from serving as cover crop and weed suppressor (Emma-Okafor *et al.*, 2016).

### ***Objective of the Study***

This study was aimed at ascertaining the best combination(s) of maize and mulch material for sustainable late season maize production in southeastern Nigeria.

## **Materials and Methods**

### ***Study Area***

The experiment was carried out at the Federal University of Technology Farm, Owerri, Nigeria, situated between latitudes 5<sup>o</sup>20'N and 5<sup>o</sup>27'N and between longitudes 7<sup>o</sup>E and 7<sup>o</sup>7'E in the rainforest agroecology of southeastern Nigeria. This zone has minimum and maximum annual ambient temperatures of 20<sup>o</sup>C and 32<sup>o</sup>C, respectively and mean annual rainfall of 2,500mm (Onweremadu, 2006). Rainfall distribution is bimodal with peaks around the months of June and September. The dry season extends from November to March with a characteristic cold, dry, dust-laden interval (the harmattan) during the months of January through February.

### ***Land Preparation***

In each of the two years of this study, the field was cleared, ploughed, harrowed and ridged. Experimental plots, measuring 4.0 x 4.0m were mapped out in September for 2013 and 2014 late season experiments.

Prior to the experiments, soil core samples were collected randomly from the representative locations at 30.0cm depth, bulked and dried for physio-chemical analyses.

### ***Experimental Design***

The treatments consisted of four maize varieties (Oka-Nkporo, TZESR (y) (Tropicalised *Zea mays* Early Maturing, Steak Resistant and Yellow), TZSR (W)- (Tropicalised *Zea mays*, Streak Resistant and White), DMRSR (Y) – (Downy Mildew Resistant, Streak Resistant and Yellow) which were mulched with four mulch sources of zero, wood shavings, farm trash each at 10tha, and egusi melon spaced 1.0 x1.0m. The 4 x 4 factorial experiment was laid out in a randomized complete block design and replicated four times.

### ***Cultural Operation***

Mulch was applied one week ahead seeding while maize was sown at 53,000 ha<sup>-1</sup> (75.0 x 25.0cm). All seeds were sown two seeds/hill and later thinned to one per hill at two weeks after emergence.

The maize varieties were procured from IITA Ibadan, melon (Bare) variety from Department of Crop Science and Technology, Federal University of Technology Owerri while the dry mulches were procured from Owerri environment. A compound fertilizer, NPK, was applied in two split doses at the rate of 600kg ha<sup>-1</sup> (1.08kg/plot).

### **Data Collection**

Data on soil nutrient content, maize emergence and growth, weed cover, and yield component of maize were collected at different stages of maize growth.

### **Data analyses**

Growth and yield parameters were statistically analyzed with GenStat Discovery 2008 while correlations of maize grain yield and economic return on the enterprise were done.

## **Results**

### **Maize emergence and height**

Emergence of maize was generally high (92.4 to 97.3%) and was affected by neither the variety nor mulch source (Table 1). This was similar to the leaf area index.

**Table 1:** Effect of mulch sources on two year mean percentage emergence, maize height (cm) at 3, 6 and 9 weeks growth stages

Maize variety	Mulch	Emergence %	Height (cm) weeks after planting		
			3	6	9
<i>Oka-Nkporo</i>	Zero	93.00	19.14	146.70	247.26
	Trash	94.62	20.72	146.36	259.18
	Wood shavings	97.33	20.36	144.25	248.46
	Melon	93.80	21.64	147.85	267.28
	<b>Mean</b>	<b>94.69</b>	<b>20.47</b>	<b>146.29</b>	<b>255.55</b>
TZSR(W)	Zero	94.82	21.00	146.51	217.30
	Trash	94.16	20.76	127.86	258.14
	Wood shavings	93.64	20.54	126.38	229.25
	Melon	95.29	21.46	118.45	228.46
	<b>Mean</b>	<b>94.44</b>	<b>20.94</b>	<b>129.80</b>	<b>233.29</b>
TZESR(Y)	Zero	95.86	21.70	149.24	214.66
	Trash	95.75	22.72	120.00	266.18
	Wood shavings	95.56	20.20	120.46	235.30
	Melon	93.58	23.00	115.28	234.25
	<b>Mean</b>	<b>95.19</b>	<b>21.91</b>	<b>126.25</b>	<b>237.59</b>
DMRSR(Y)	Zero	96.75	22.52	121.60	215.04
	Trash	94.28	21.90	142.60	262.15
	Wood shavings	92.46	21.44	124.48	234.35
	Melon	94.36	19.85	125.36	237.48
	<b>Mean</b>	<b>94.45</b>	<b>21.40</b>	<b>128.51</b>	<b>237.26</b>
LSD <sub>0.05</sub>	Variety (V)	N.S.	N.S	4.48	6.51
LSD <sub>0.05</sub>	Mulch (M)	N.S	N.S	3.64	2.61
LSD <sub>0.05</sub>	Variety x Mulch	NS	NS	7.27	6.21

The height of maize was similar during the early vegetative growth at three weeks after planting during which neither the maize variety nor the mulch source had any remarkable impact on maize growth (Table 1). However, at six and nine weeks after planting, maize varieties exhibited significant ( $P \leq 0.05$ ) growth variations between and among the treatment combinations. Thus, local maize variety, *Oka-Nkporo*, was the tallest (46.0 and 275.0cm) at six and nine weeks after planting respectively. The TZESR was the shortest 214.6cm at nine weeks after planting. At six weeks after planting and beyond, the mulched maize varieties had superior height advantages over the unmulched varieties.

### **Maize growth**

The Leaf Area Index (LAI) was affected by neither the variety nor mulch source (Table 2) at 3WAP. However, the LAI of maize, after six weeks, manifested significant ( $P \leq 0.05$ ) variations among the maize varieties. Thus, the TZSR (W) maize variety developed the highest LAI (3.96) while the DMRSR (Y) variety formed the lowest LAI (3.21) within six weeks after planting. Mulching had similar effect on the development of Leaf Area Index of the maize varieties at each growth phase. Maize grown under trash mulch developed significantly ( $P \leq 0.05$ ) higher LAI than those grown under other sources of mulch and the control (unmulched). The maize grown with wood shavings and melon mulch had similar LAI.

**Table 2:** Effect of mulch sources on two-year mean Leaf Area Index (LAI) and days to 50% tasseling and silking of maize varieties at various growth stages

Maize variety	Mulch	LAI weeks after planting			Days to 50%	
		3	6	9	Tasseling	Silking
<i>Oka-Nkporo</i>	Zero	0.56	2.22	3.00	55.52	67.5
	Trash	0.55	2.24	4.00	47.24	60.4
	Wood shavings	0.56	2.26	3.50	55.30	67.0
	Melon	0.53	2.30	3.59	53.20	67.2
	<b>Mean</b>	<b>0.55</b>	<b>2.26</b>	<b>3.52</b>	<b>52.80</b>	<b>65.4</b>
TZSR(W)	Zero	0.42	2.50	3.89	54.64	65.4
	Trash	0.49	2.62	4.00	44.32	62.7
	Wood shavings	0.53	2.58	3.98	51.50	60.1
	Melon	0.57	2.70	3.97	51.40	61.4
	<b>Mean</b>	<b>0.50</b>	<b>2.60</b>	<b>3.96</b>	<b>50.40</b>	<b>62.3</b>
TZESR(Y)	Zero	0.59	2.30	2.95	46.24	59.3
	Trash	0.56	2.37	3.91	47.12	60.3
	Wood shavings	0.47	2.32	3.54	45.40	61.2
	Melon	0.57	2.34	3.56	46.10	61.4
	<b>Mean</b>	<b>0.55</b>	<b>2.33</b>	<b>3.49</b>	<b>46.20</b>	<b>60.5</b>
DMRSR(Y)	Zero	0.59	2.01	2.98	53.06	64.6
	Trash	0.54	1.98	3.89	45.30	61.3
	Wood shavings	0.58	2.05	3.02	51.10	61.2
	Melon	0.48	2.17	2.96	49.40	62.6
	<b>Mean</b>	<b>0.55</b>	<b>2.05</b>	<b>3.21</b>	<b>49.70</b>	<b>62.4</b>
LSD <sub>0.05</sub>	Variety	N.S	0.08	0.13	1.14	1.01
LSD <sub>0.05</sub>	Mulch	N.S	N.S	0.08	2.11	1.21
LSD <sub>0.05</sub>	Variety x Mulch	N.S	N.S	N.S	N.S	N.S

**Weed cover**

Maize varieties tolerated similar weed cover score at every growth stage of the maize plant (Table 2). The weed cover scores increased from an average of 0.70 to 1.30 in three to nine weeks after planting in each maize variety. Weed cover scores were alike within three weeks after planting. After six weeks of planting, however, significant weed score variations were recorded. Thus, the highest weed scores (1.28 and 1.85) were recorded from the unmulched maize at six and nine weeks planting respectively while the lowest weed scores (0.46 and 0.76) were recorded in maize plots under wood shaving mulch which was most efficient weed suppression.

During the late growth phase in maize, (6-9 WAP), mulching significantly ( $P \leq 0.05$ ) reduced weed dry weight (Table 4). The unmulched maize had the highest weed dry weight (0.36 and 0.39t/ha) at 6 and 9 weeks after planting respectively. Wood shavings mulch most effectively controlled weed in maize (0.22 - 0.30t ha<sup>-1</sup> dry weed) at all stages of growth.

**Table 3:** Effect of mulch sources on two-year mean weed cover (score 0-10) of maize mulch plots at 3, 6, and 9 weeks after planting

Maize variety	Mulch	Weeks after planting		
		3	6	9
<i>Oka-Nkporo</i>	Zero	8.96	1.30	0.50
	Trash	1.34	0.80	0.80
	Wood shavings	1.56	0.52	0.40
	Melon	4.42	0.90	0.50
	<b>Mean</b>	<b>1.40</b>	<b>0.90</b>	<b>0.60</b>
TZSR(W)	Zero	8.85	1.40	0.64
	Trash	1.55	0.80	0.70
	Wood shavings	1.70	0.50	0.74
	Melon	4.24	0.80	0.62
	<b>Mean</b>	<b>1.30</b>	<b>0.90</b>	<b>0.70</b>
TZESR(Y)	Zero	8.86	1.10	0.72
	Trash	1.38	0.80	0.60
	Wood shavings	1.76	0.40	0.70
	Melon	2.48	0.90	0.70
	<b>Mean</b>	<b>1.10</b>	<b>0.80</b>	<b>0.70</b>
DMRSR(Y)	Zero	8.92	1.30	0.80
	Trash	1.38	0.80	0.70
	Wood shavings	1.86	0.50	0.60
	Melon	4.40	0.90	0.70
	<b>Mean</b>	<b>1.40</b>	<b>0.90</b>	<b>0.70</b>
LSD <sub>0.05</sub>	Variety	N.S	N.S	N.S
LSD <sub>0.05</sub>	Mulch	0.07	0.08	N.S
LSD <sub>0.05</sub>	Variety x Mulch	N.S	N.S	N.S

**Table 4:** Effect of weed dry weight (t/ha) under different maize mulch sources at 3, 6 and 9 weeks after planting

Maize variety	Mulch	Weeks after planting		
		3	6	9
<i>Oka-Nkporo</i>	Zero	0.39	0.37	0.38
	Trash	0.26	0.31	0.25
	Wood shavings	0.21	0.19	0.20
	Melon	0.33	0.32	0.25
	<b>Mean</b>	<b>0.27</b>	<b>0.28</b>	<b>0.31</b>
TZSR(W)	Zero	0.36	0.37	0.39
	Trash	0.35	0.27	0.29
	Wood shavings	0.25	0.18	0.16
	Melon	0.33	0.24	0.29
	<b>Mean</b>	<b>0.28</b>	<b>0.29</b>	<b>0.30</b>
TZESR(Y)	Zero	0.34	0.35	0.38
	Trash	0.26	0.30	0.31
	Wood shaving	0.29	0.21	0.22
	Melon	0.29	0.30	0.29
	<b>Mean</b>	<b>0.29</b>	<b>0.30</b>	<b>0.30</b>
DMRSR(Y)	Zero	0.36	0.35	0.39
	Trash	0.31	0.27	0.29
	Wood shavings	0.20	0.20	0.22
	Melon	0.32	0.30	0.31
	<b>Mean</b>	<b>0.29</b>	<b>0.28</b>	<b>0.30</b>
LSD <sub>0.05</sub>	Variety	N.S	N.S	N.S
LSD <sub>0.05</sub>	Mulch	0.07	0.08	N.S
LSD <sub>0.05</sub>	Variety x Mulch	N.S	N.S	N.S

### *Stover yield*

The highest stover yield (Table 5) of 5.49tha<sup>-1</sup> was obtained from the local maize variety, *Oka-Nkporo* while the lowest (4.38 tha<sup>-1</sup>) was from the early-maturing variety, TZESR (Y). Based on the good growth performances of the local maize variety (Table 2), characteristics such as high stover weight index associated with this variety (*Oka-Nkporo*) is an economic waste which reduced the shelling percentage and grain yield.

### *Cobs per plant*

The local variety, *Oka-Nkporo*, produced significantly (P≤0.05) higher number of cobs per plant than the elite varieties.

Differences in grain yield variations were significantly (P≤0.05) among the maize varieties. TZSR (W) ranked the highest in grain yield (4.14 t/ha) followed by TZESR (Y) (3.84 t/ha). DMRSR (Y) (3.42 t/ha) and *Oka-Nkporo* (3.09 t/ha) in that order. Most yield components (Table 6) (kernel

depth and weight of grains per cob) were higher in TZSR(W) than in other varieties. The TZSR (W) maize variety grown under trash produced the highest grain yield ( $4.32\text{t ha}^{-1}$ ) ('000t). This is a further reflection of the superior genetic trait of TZSR(W) variety and the more conducive growth medium under trash mulch. Conversely, grain yield ('000t) of  $2.92\text{tha}^{-1}$  was lowest in the local maize variety, *Oka-Nkporo* grown under zero mulch.

***Number and weight of grains per cob and shelling percentage***

Both maize variety and mulch sources significantly affected the number and weight of grains per cob (Table 6). The local maize variety *Oka-Nkporo* recorded the least grain number (367) and the least weight of grains per cob (68.8g). TZSR (W) variety produced the highest grain number per cob (381) and the heaviest grain per cob (91.1g).

**Table 5:** Effect of mulch sources on grain yield, stover yield and cob number of maize varieties in maize/mulch production system

Maize variety	Mulch	Stover	Cobs/plant	Grain ('000 t/ha)
<i>Oka-Nkporo</i>	Zero	5.35	1.23	2.92
	Trash	5.99	1.16	3.27
	Wood shaving	5.08	1.15	3.05
	Melon	5.53	1.20	3.12
	<b>Mean</b>	<b>5.49</b>	<b>1.19</b>	<b>3.09</b>
TZSR(W)	Zero	4.53	1.04	3.98
	Trash	5.02	1.07	4.32
	Wood shavings	4.78	1.06	4.10
	Melon	4.82	1.07	4.17
	<b>Mean</b>	<b>4.79</b>	<b>1.06</b>	<b>4.14</b>
TZSR(Y)	Zero	4.09	1.06	3.70
	Trash	4.65	1.06	4.00
	Wood shavings	4.38	1.05	3.80
	Melon	4.38	1.06	3.85
	<b>Mean</b>	<b>4.38</b>	<b>1.06</b>	<b>3.84</b>
DMRSR(Y)	Zero	4.39	1.06	3.23
	Trash	4.69	1.07	3.61
	Wood shavings	4.65	1.06	3.41
	Melon	4.66	1.05	3.42
	<b>Mean</b>	<b>4.60</b>	<b>1.06</b>	<b>3.42</b>
LSD <sub>0.05</sub>	Variety	0.21	0.03	0.08
LSD <sub>0.05</sub>	Mulch	0.18	N.S	0.04
LSD <sub>0.05</sub>	Variety x Mulch	N.S	N.S	N.S

**TABLE 6:** Effect of mulch sources on two years of yield component characteristics of maize varieties

Maize variety	Mulch	Kernel depth (cm)	Grains per cob	Shelling grain (%)
<i>Oka-Nkporo</i>	Zero	0.82	342.04	80.04
	Trash	1.04	383.42	84.42
	Wood shavings	0.82	372.46	85.14
	Melon	0.86	360.86	85.52
	<b>Mean</b>	0.89	367.00	-
TZSR(W)	Zero	1.02	378.56	82.32
	Trash	1.00	384.68	85.30
	Wood shavings	1.03	378.84	84.54
	Melon	1.06	382.68	84.26
	<b>Mean</b>	1.03	381.00	-
TZESR(Y)	Zero	0.94	360.56	82.50
	Trash	0.94	377.48	84.40
	Wood shavings	0.93	370.60	84.75
	Melon	0.89	373.84	84.46
	<b>Mean</b>	0.93	370.00	-
DMRSR(Y)	Zero	0.89	361.66	81.80
	Trash	1.05	379.72	83.86
	Wood shavings	0.91	371.54	81.76
	Melon	0.94	372.48	82.3
	<b>Mean</b>	0.95	371.00	82.4
LSD <sub>0.05</sub>	Variety	0.02	2.15	0.73
LSD <sub>0.05</sub>	Mulch	0.05	1.67	0.60
LSD <sub>0.05</sub>	Variety x Mulch	N.S	3.34	N.S

### *Lodging, stem-borer and termite infestations*

The effects of mulch sources on the lodging, stem borer and termite infestations of maize varieties (Table 7) indicated that improved maize varieties that were mulched suffered least percentage (2.0 to 2.8) lodging. The local maize variety (*Oka-Nkporo*) lodged heavily. Unmulched maize varieties lodged most (5.3%). Maize varieties intercropped with melon or mulched with trash lodged with remarkable variations among and within mulch treatments. Percentage stem borer (6.2%) and termite (2.0%) infestations were significantly ( $P \leq 0.05$ ) more pronounced in the local variety, *Oka-Nkporo*. Percentage infestation for the elite varieties was low, and ranged from 2.1 - 2.4% for stem borers, and 0.6 - 1.2% for termites.

### *Emergence and yield of melon*

The seed emergence, fresh fruit and seed dry yield of melon in the different maize varietal mixtures (Table 8) indicated high but similar, (92.7 to 93.2%) percentage emergence. The fresh fruit yield ranged from 14.20 to 14.86 t ha<sup>-1</sup> while the dry seed weight ranged from 0.36 to 0.39 t ha<sup>-1</sup>.

**Table 7:** Effect of mulch sources on two years mean percentage lodging, stem borer and termite infestation of maize varieties.

Maize variety	Mulch	% Lodging and Infestation		
		Lodging	Stem borer	Termite
<i>Oka-Nkporo</i>	Zero	5.34	7.55	2.82
	Trash	3.94	6.04	1.94
	Wood shavings	4.02	6.26	2.75
	Melon	2.74	5.04	0.66
	<b>Mean</b>	4.0	6.21	2.0
<b>TZSR(W)</b>	Zero	2.72	2.50	0.20
	Trash	1.80	2.14	0.20
	Wood shavings	3.25	3.06	1.40
	Melon	1.56	1.90	0.80
	<b>Mean</b>	2.3	2.4	0.6
<b>TZESR(Y)</b>	Zero	2.22	2.90	1.50
	Trash	2.04	1.94	1.00
	Wood shavings	1.92	2.24	0.64
	Melon	1.76	1.46	0.92
	<b>Mean</b>	2.0	2.1	1.0
<b>DMRSR(Y)</b>	Zero	3.52	2.75	1.26
	Trash	2.64	2.26	1.54
	Wood shaving	3.02	2.64	0.86
	Melon	2.15	1.88	1.18
	<b>Mean</b>	2.8	2.3	1.2
LSD <sub>0.05</sub>	Variety	0.44	0.36	0.25
LSD <sub>0.05</sub>	Mulch	0.32	0.13	0.18
LSD <sub>0.05</sub>	Variety x Mulch	N.S	N.S	N.S

**Table 8:** Emergence, fresh fruit and seed dry weights (tha<sup>-1</sup>) of melon in maize variety/melon mixtures

	Emergence (%)	Fresh fruit weight	Seed dry weight
<i>Oka-Nkporo</i>	93.20	14.46	0.37
<b>TZSR(W)</b>	93.10	14.61	0.37
<b>TZESR(Y)</b>	93.00	14.86	0.39
<b>DMRSR(Y)</b>	92.71	14.20	0.36
LSD <sub>0.05</sub>	N.S	N.S	N.S

### **Correlation coefficients**

The correlation coefficients between grain yields of maize varieties and major yield parameters of maize were significant (Table 9). Days to 50% tasseling and silking were negatively correlated grain yield ( $P \leq 0.05$ ). However, yield attributes such as grain weight (‘000t/ha), cob length and

kernel depth, were good estimates of maize yield because of their respective significant positive correlations with grain yield ( $P \leq 0.05$ ).

**Table 9:** Correlation coefficients of maize grain yield and some yield components of maize varieties

Maize Variety	Days to 50% Tasseling	Days to 50% Silking	Grain Number	Grain Weight ('000t/ha)	Cob Length (cm)	Kernel Depth (cm)
<i>Oka-Nkporo</i>	-0.70**	-0.65**	0.57*	0.66*	0.61*	0.70*
<b>TZSR(W)</b>	-0.66**	-0.40	0.49	0.62**	0.74**	-0.02
<b>TZSR(Y)</b>	0.45	0.15	-0.30	0.78**	0.71**	-0.03
<b>DMRSR(Y)</b>	-0.73**	-0.35	0.17	0.65**	0.39	0.65**

**Table 10:** Partial budget analysis across maize variety/mulch sources enterprise

Benefits/Variable	Maize Production Enterprise			
	Maize/bare value ₦'000	Maize/grass value ₦'000	Maize/wood shavings value ₦'000	Maize/melon value ₦'000
<b>(A) Revenue</b>				
Maize grains (t/ha <sup>-1</sup> )	(3.46)103.80	(3.80)114.00	(3.59) 107.70	(3.64) 109.20
Egusi/Melon (t/ha <sup>-1</sup> )	-	-	-	(0.37) 14.80
Total Revenue (t/ha <sup>-1</sup> )	103.80	114.00	107.70	124.00
<b>(B) Variable costs</b>				
Maize seeds (15kg t/ha <sup>-1</sup> )	0.90	0.90	0.90	0.90
Egusi seeds (5kg t/ha <sup>-1</sup> )	-	-	-	0.50
Mulch materials	-	3.00	11.00	-
Fertilizer (0.6 t/ha <sup>-1</sup> )	12.00	12.00	12.00	12.00
Org.manure (8.33 t/ha <sup>-1</sup> )	3.80	3.80	3.80	3.80
<b>(C) Labour</b>				
Planting & harvesting				
Maize (12man days)	3.60	3.60	3.60	3.60
Egusi (16man days)	-	-	-	4.80
Mulching (8man days)	-	2.40	2.40	-
Fertilizer/manure (16man days)	4.80	4.80	4.80	4.80
Land preparation (t/ha)	5.00	5.00	5.00	5.00
Total variables cost (TVC)	30.10	35.50	43.50	35.50
Gross margin (A)-(B)	73.70	78.50	64.20	88.60
Gross Margin over control		4.80	-9.50	14.90

Figures in bracket indicates maize grain yield in t/ha<sup>-1</sup>

### ***Input-output analysis***

The partial budget analysis (Table 10) for the different maize/mulch-source production enterprises indicated the highest revenue (in Nigerian Naira) of ₦124,000.00 ha<sup>-1</sup> from the maize/melon mulch enterprise, followed by those from maize/trash mulch (₦114,000.00 ha<sup>-1</sup>), maize/wood shavings (₦107,700.00ha<sup>-1</sup>) and unmulched control (₦103,800.00 ha<sup>-1</sup>). The maize/melon mulch produced the highest gross margin (benefit) of ₦88,600.00 ha<sup>-1</sup> followed by the maize/trash mulch (₦78,500.00 ha<sup>-1</sup>). The maize/wood shavings mulch produced the lowest margin (₦64,200.00 ha<sup>-1</sup>). The maize/melon mulch also produced higher gross margin (₦14,900.00 ha<sup>-1</sup>) over the control, followed by maize/trash mulch (₦4,800.00 ha<sup>-1</sup>). However, the maize/wood shavings recorded a deficit (-₦9,500.00) over the control. Therefore, TZSR (W) maize/melon intercropping was the best late season maize production system for effective weed control, maize yield and income generation in this study.

### **Discussion**

The maize growth variations under similar conditions were probably genetic or partially a response to moisture stress occasioned by declining rainfall in the late season.

Wood shavings mulch is high in lignin and CN ratio, and therefore resistant to biodegradation and, thus, effective in weed suppression (Obiefuna, 1987). Melon mulch as a planophyle significantly ( $P \leq 0.05$ ) smothered weeds and exposed the ercetophyle, maize, to optimal utilization of growth resources of light and nutrients. The cost deficit recorded from the wood shavings mulch was obviously due to the very high cost of producing and transporting the wood shavings to the farm (₦11,000.00ha<sup>-1</sup>), and poor supplementary nutrient supply from the mulch (Obiefuna, 1987).

The yields of melon/maize intercrops were similar because the intercrops created an environmentally favourable microclimate which eliminated stress and competition among component crops and weeds. Cob number per plant is genetically determined, and this explains the clear disparity between the local and improved varieties. Mulch treatments only enhanced cob number per plant among the elite maize varieties.

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