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Effects of Mulch Materials and Plant Density on Some Fungal Diseases and Yield of Maize

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Abstract: Maize (*Zea mays* L.) is a well-known cereal grain grown in the savannah rejoin as well as in the rain forest zone of the country. Experiments were conducted during the rainy season of 2004 and 2005 to determine the effects of mulch material and plant density on some fungal diseases and yield of maize. Analysis of variance indicate that mulch material was significant on leaf spot disease 1.66;1.45, Blight 1.10; 1.04, Rust 0.012; 0.050 and grain yield 0.55; 0.63 tons/ha in 2004 and 2005, respectively. Grass mulch recorded highest plant height 90.10; 89.73 followed by live mulch 70.81; 76.60 when no mulch (control) recorded the lowest plant height 56.25; 57.74. Same trend was observed on grain yield. Grass mulch had 1.20; 1.23 when control recorded lowest 1.00; 0.87 in 2004 and 2005, respectively. Plant density was significant on plant height, 546; 493.07, grain yield 2.65; 2.31, leaf spot disease severity 0.40; 0.12 and rust 2.96; 3.20. 25×75 cm recorded highest in plant height 82.30; 79.88, grain yield 1.65; 1.42 as well as leaf spot disease severity 1.52; 1-33, blight 1.62; 1.85 and rust 1.65; 1.43 when 75×75 cm had lowest plant height as well as the diseases investigated and the fungi observed were *Heliminthosprum* sp. *Puccinia* spp and *Aspergillus* link in 2004 and 2005, respectively.

Key words: Mulch materials, density, fungi, yield, maize

INTRODUCTION

Maize (*Zea mays* L.) also known as corn, is a cereal that belongs to the family *Gramineae* which most recently is called Poaceae. The botanical family *gramineae* is a very large and specialized family of about ten thousand species (Weiss, 1992). Different varieties of maize vary in colour, composition and nature of the grains, (Gibson and Benson, 2002). Every part of the maize plant has economic value. The grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food and non-food products. Maize is largely used as livestock feed and as for raw material for industrial products, as well as human consumption (Rossi, 1995; Jiskani, 1999).

Maize productivity in hampered by the menace of diseases such as leafspot, rust, more than 70 different diseases of maize have been reported in the world which hits the crop and cause considerable damage (Kamel and Moghal, 1995). Also inadequate sunshine, waterlog conditions, poor soil nutrient status and fluctuation in day length period, all added up to possible constraints posed, which impede normal maize growth and yield in the area hence the research center on use of mulch materials to reduce disease development and improve yield.

Mulching maintains soil organic matter and fertility, conserves soil and water thereby improving soil structure, macroporosity, infiltration rate, reduce run-off and evaporation and suppress weeds. And close spacing favour an air borne disease (FAO, 1990; Ihejirika *et al*., 2006). Hence the objective of the research is to determine the effect of mulch materials and plant density on some fungi diseases and yield of maize.

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MATERIALS AND METHODS

The experiment was conducted at the Crop Science and Technology Research Plot and Laboratory of Federal University of Technology, Owerri in 2004 and 2005 planting seasons. Annual rainfall 100-150 cm was distributed during the growing seasons and temperature ranging 23 to 28°C and the research plot was located at 91.19 m above sea level. Soil samples were collected at 0-15 cm and 15-30 cm, respectively and analyzed in the laboratory to determine the nutrient status of the soil. Maize variety TZESR (Y): Tropicalized *Zea mays* streak resistant yellow of 88% viability was used. Fourty Eight plots were mapped out and beds measuring 2×3 m^2 constructed at each plot with 0.75 m as main plot gap and 0.5 m as sub-plot gap.

Four mulch materials and four levels of plant density were used. Mulch materials include grass mulch, wood shaven mulch, live mulch (Groundnut was planted at 25×25 cm as live mulch) and no mulch, which acts as control. While the planting densities were 25×75, 50×75, 50×50 and 75×75 cm and the experiment was replicated three times in a Randomize Complete Block Design (RCBD), with mulch materials as main-plot while plant density occurred as sub-plot.

Data were collected on plant height, leaf spot disease, rust, blight as well as grain yield.

Maize from each plot were measured from base to the apex of primary shoot and recorded bi-weekly. The severity of leaf spot, rust and blight were obtained using the method of visual observation and scoring according to Ford and Hewitt (1980), using a scale of 1 to 5 showing, 0-no infection, 1-slight infection, 2-moderate, 3-high infestation, 4-very high and 5-complete infestation, respectively. On yield t ha^{-1} cobs were threshed and the grain weighed in the laboratory and yield expressed in t ha^{-1} per treatment per plot.

The diseased plants/seeds were taking to the laboratory and isolated using Standard Blotter Methods as recommended by the International Seed Testing Association (ISTA, 1996) and the organisms identified using Barnett and Hunter (1998). Data were analyzed using methods of Steel and Torrie (1981) and means separated using the Fischer's Protected Least Significant Difference (LSD).

RESULTS

The result of soil analysis carried out prior to planting revealed that pH was 5.0, nitrogen 5.6, phosphorus 0.8% and potassium 0.58% showing that the soil was acidic and nitrogen, phosphorus and potassium content were low.

Analysis of variance indicted that mulch material was significant on leaf spot disease 1.66; 1.45, maize blight 1.10; 1.04, rust 0.012; 0.050 and grain yield 0.55; 0.63 in 2004 and 2005, respectively. Plant density was also significant on these diseases investigated. However, there was no significant difference on the mulch material and density interaction, on these diseases. Table 1. Grass mulch recorded lowest severity of leaf spot, maize blight and maize rust but highest plant height 90.10, 80.73 and grain yield 1.20, 1.23. This is followed by live mulch, then the wood shaven mulch,

Table 1: Analysis of variance of plant height, leaf spot disease severity, blight, rust and grain yield in 2004 and 2005

	Plant height		Leaf spot severity		Blight		Rust		Grain yield	
Analysis	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Factor A	2846.0*	31381.1*	1.66*	1.45*	1.10*	1.04*	0.012*	0.050*	0.55*	0.63*
Plot/block (SSK)	50.0	42.0	0.38	0.29	3.55	2.26	3.04	3.25	0.96	0.87
Error (SSAK)	64.10	59.75	0.51	0.40	0.25	0.45	0.30	0.18	0.080	0.023
Factor B	546.1*	493.07*	1.68*	1.5*	3.20*	2.32*	2.96*	3.20*	2.65*	0.1*
Ab intraction	310.0*	245.9*	0.40	0.12	2.00	1.86	2.55	2.40	0.40	0.031
Error	28.4	25.01	0.20	0.13	0.06	0.04	0.51	0.06	0.061	0.035
TSS	377.2	301.1	0.45	0.33					0.35	0.25

* Indicate significant at 5% probability level

Table 2: Mean values of main effects of leaf spot disease score at different times of plant growth in 2004 and 2005

	Time after planting (Weeks)							
	4th		6th		8th		Cummulative mean	
Mulching materials	2004	2005	2004	2005	2004	2005	2004	2005
No mulch (control)	0.77	0.83	1.50	1.42	2.35	2.25	1.63	1.50
Live mulch	0.42	0.33	0.84	0.75	1.89	2.1	1.23	1.06
Wood shaving	0.46	0.52	0.72	0.83	2.00	2.5	1.30	1.28
Grass mulch	0.28	0.25	0.55	0.64	1.38	1.5	0.90	0.79
Planting density								
25×75	0.34	0.25	1.26	1.33	2.66	2.42	1.54	1.33
50×75	0.46	0.50	0.95	0.83	2.05	1.92	1.20	1.08
50×50	0.63	0.50	1.10	1.0	2.40	2.2	1.18	1.23
75×75	0.77	0.67	0.43	0.5	1.95	1.83	1.10	1.00

Table 3: Means of main effects of mulch material and plant density on plant height, leaf spot disease, maize blight and grain yield in 2004 and 2005

	Plant height		Leafspot disease		Maize Blight		Grain yield (t ha^{-1})	
Mulch material	2004	2005	2004	2005	2004	2005	2004	2005
No mulch	56.25	57.34	1.11	1.06	1.5	1.86	1.00	0.87
Live mulch	70.81	76.60	1.46	1.28	1.25	1.35	1.36	1.02
Wood shaving	60.43	56.20	1.82	0.79	1.20	1.16	1.10	1.07
Grass mulch	90.10	89.73	1.00	0.60	1.08	1.10	1.20	1.23
$LSD_{0.05}$	7.70	8.340	0.772	0.510	0.350	0.284	0.526	0.314
Plant density								
25×75	82.30	79.88	1.52	1.33	1.62	1.85	1.65	1.43
50×75	68.50	66.29	1.00	1.08	1.54	0.50	0.82	0.71
50×50	70.40	74.68	1.00	1.23	1.40	1.25	1.22	1.19
75× 75	62.15	59.03	0.96	1.00	0.88	0.10	0.65	0.48
$LSD_{0.05}$	6.71	8.435	0.906	0.823	0.115	0.210	0.224	0.314

when no much (control) recorded highest severity of leaf spot, maize blight and rust but lowest plant height 56.25; 57.34 and grain yield 1.00; 0.87 in 2004 and 2005, respectively Table 3.

Result also revealed that the highest plant density, recorded the highest plant height as well as highest severity of leaf spot disease 1.52; 1.33 and maize blight 1.62; 1.85 while 75×75 cm recorded lowest plant height, grain yield as well as lowest severity of leaf spot disease 0.96; 1.00 and maize blight 0.88;1.10 in 2005 and 2006, respectively. Result also showed that the severity of leaf spot disease was highest followed by maize blight when maize rust was low and the organisms identified were *Heliminthosprum* sp. *Puccinia* and *Aspergillus* Link.

The result of the investigation revealed that diseases development increased with plant age, At 6 weeks of plant age, leaf spot disease severity increased by 100% in comparison with severity at 4 week of plant age and at 8 weeks it recorded well over 150% for zero mulch which occurred highest, followed by wood shaven mulch then live mulch when grass mulch were low. The disease severity also increases with plant age irrespective of the planting density. Result showed that there was a high infestation between 4 to 6 weeks of plant age. (Table 2). 25×75 cm recorded highest in all the plant age investigated when 75×75 cm recorded the lowest disease severity. Result also showed that disease severity was inversely related with plant density.Investigation revealed that interaction of grass mulch with 25×75 cm recorded highest plant height 86.70; 85.50 and grain yield 1.40; 1.33 tons/ha while wood shaving and 75×75 cm interaction recorded lowest plant height 54.20; 58.00. This interaction also recorded lowest grain yield 0.46; 0.23 in 2004 and 2005, respectively.

On disease severity, zero mulch control and 25×75 cm interaction recorded highest leaf spot disease 1.86; 1.43 and maize blight 3.10; 4.25 while Grass much and 75×75 cm interaction recorded lowest leaf spot disease severity 0.85; 0.90 and maize blight 0.28 (Table 4). Leaf spot disease development occurred higher than other diseases investigated 2004 and 2005, respectively.

Table 4: Mean values of interaction effects on plant height, leaf spot disease, blight and grain yield (t ha^{-1})

Treatments		Plant height		Leaf spot		Maize blight		Grain yield	
Mulch material	Plant density	2004	2005	2004	2005	2004	2005	2004	2005
No mulch (control)	25×75	74.30	68.99	1.86	1.43	3.10	4.25	1.60	1.15
	50×75	66.72	62.50	1.72	1.30	3.25	3.40	0.95	0.78
	50×50	58.96	62.85	1.54	1.39	2.10	1.80	1.23	1.03
	75×75	58.00	59.12	1.18	1.25	1.77	1.50	0.88	0.66
Live mulch	25×75	79.50	77.82	1.10	1.20	1.10	1.00	0.90	0.84
	50×75	68.43	71.01	1.00	1.07	0.44	0.50	0.63	0.42
	50×50	80.10	75.64	1.06	1.15	1.32	1.20	0.68	0.76
	75×75	60.50	68.00	1.00	1.03	0.86	0.70	0.80	0.43
Wood shaving	25×75	70.00	68.04	1.26	1.31	0.54	0.60	0.70	0.74
	50×75	58.20	61.25	1.16	1.26	0.66	0.72	0.50	0.38
	50×50	60.04	65.50	1.30	1.25	0.95	1.0	0.77	0.64
	75×75	54.20	58.00	1.06	1.14	0.33	0.45	0.46	0.23
Grass mulch	25×75	86.70	85.50	1.00	1.00	0.42	0.56	1.40	1.33
	50×75	70.10	77.50	1.00	0.93	0.52	0.45	1.00	0.97
	50×50	76.00	81.90	1.20	1.00	0.35	0.30	1.12	1.21
	75×75	70.30	75.05	0.50	0.90	0.28	0.35	1.00	0.86
Mulch $LSD_{0.05}$		7.410	8.430	0.624	0.808	0.350	0.306	0.741	0.788
Density $LSD_{0.05}$		6.820	8.530	0.710	0.758	0.240	0.255	0.628	0.804

DISCUSSION

The low fertility status of the soil are typical of the fragle tropical soils due to leaching, volatilization while low phosphorus may be due to fixation. Mulching influence yield and disease severity and best performance observed from grass mulch. This is in line with Fryrear (1989) who proposed that grass mulching moderate soil temperature, prevent run off and evaporation and increase soil organic matter. Thus enhancing soil fertility through nutrient addition from biomas and increase resistant to diseases attack. This is in contrast to zero mulch (control), which were mostly affected by disease, because normal physiological processes were hampered thereby favouring pathogen and host plant interaction. This result to quick penetration and spread of diseases and reduced yield.

Highest plant density 25×75 cm was mostly affected by disease development and this is also favoured by warm-humid condition, caused by close spacing in line with FAO (1990) and Ihejirika *et al*. (2006). The organism observed showed that they are mostly responsible for the disease development with aspergiths link always associated with rot or disintegration of tissues of maize grains. The direct relationship of leafspot disease severity with plant age may be attributed to the fact that as plant ages; the photosynthetic and metabolic activities reduce. The tissues become weak and plants ability to withstand disease infection reduce, resulting to high disease penetration and symptom manifestation.

Interaction of Grass mulch and 25×75 cm record of high plant height and grain yield may, be attributed to addition of high amount of nutrients to the soil by the grass more than other mulch materials. This increased biochemical activities leading to high yield in line with Hafiz (1986), who proposed that grass mulch add nutrients 2 times another organic manure to soil. Also as plants complete favourably for nutrient and space, they tend to out grow one another to have advantage of sunlight and hence high plant height.

CONCLUSION

In conclusion, grass mulch recorded high yield but lowest severity of diseases development, when no mulch had lowest yield but highest diseases development, 25×75 cm recorded high yield and high diseases severity when 75×75 cm recorded lowest disease development of all fungi diseases

investigated but produced high plant height and grain yield in all the seasons investigated. Interaction of grass mulch with 25×75 cm recorded highest plant height and grain yield while that of grass mulch with 75×75 cm recorded lowest severity of all the fungal diseases investigated.

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