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Effects of storage conditions and tillage operation on some fungal diseases and yield of maize

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Maize (*Zea mays* L) belongs to the family *Poaceae* and it is mostly grown as food for man and feed for animal. A two-season experiment was conducted in 2006 and 2007, respectively, to determine the effect of storage condition and tillage operation on some fungal diseases and yield of maize. Analysis of variance indicated that storage condition significantly affected plant height (cm) 5.69; 6.26 at 9 weeks after planting. Tillage operation was statistically significant on leaf spot and blight infection at 9 weeks after planting at 5% probability level. Interaction of storage condition and tillage operation was also significant on blight infection at 9 weeks after planting 0.50; 0.58. Seeds from dehusked maize recorded highest plant height, leaf formation and grain yield, while shelled was lowest on both parameters in 2006 and 2007, respectively. However, the three storage conditions investigated were statistically similar on blight infection. Dehusked and undehusked plots recorded statistically similar result on leaf spot severity while shelled had the highest. Spot tilled plots recorded lowest leaf spot and blight severity but highest grain yields when zero-tilled plots (control) had the highest in all the field diseases investigated, but lowest grain yield in 2006 and 2007 respectively. Micro-organisms identified on infected leaves were *Helminthosporium* spp*,* *Spermospora* spp, while *Fusarium* spp, *Penicilium* spp*,* *Blastomyces* and *Aspergillus* species were identified with infected grains with *Fusarium* and *Penicilium* species occurring highest in 2006 and 2007, respectively.

Key words: Storage condition, tillage operation, fungal diseases, yield, maize.

NTRODUCTION

Maize (*Zea mays* L) is a native of America, although, origin has yet to be shown and Teosinte is a wild relative of maize. It is introduced by Portuguese early in the 10th century along the West Coast of Africa. It grows well in under the most varied conditions, unlike barley, wheat and rice which are limited by Climate Fischer and Palmer 1984. In Southern Nigeria, maize has been the principle cultivated cereal until the introduction and expansion of production of rice and has been used primarily as human food FAO (1990). It can be eaten whole and can also be processed into different products consumable by man, as animal feed and for industrial uses. In Nigeria, maize consumption (both man and animals) ranges from 26 - 28 kg per week. The seed is the nucleus of farmers' production activities, its activities quality, should be guaranteed at all times. In 1977, about 90,000 tons of maize grain was imported into the country at a cost of over ₦25 million while 293,000 and 345,000 tons were imported in 1981 and 1982, respectively (FAO,1980).

In any crop production system, good quality seed inspires the confidence of farmers, because all other input will merely assist the seed to produce optimally. Germination percentages and purity in seed certification, seed maturity at harvest and method of drying are among the major deciding seed quality (Robinson, 1977). Maize quality are often reduced by drying injury, although the cause of impairment of lip body alignment along storage method has been associated with decrease in germination, quality and vigorous of maize seedling. The temperature of the seeds at storage greatly affects the germination and quality of a maize seed. Fungi accounts for about 75% (Anon, 1973; Obi et al., 1980) and it has been found to contribute to maximum damage in maize, such as abortion, rot, necrosis, discoloration and reduced germination and vigous. Grain moisture of 20% in cereals often causes corn rot and toxin production before harvest Essien (2000). *Fusarium* species is the most important field fungi

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Table 1. Severity of leaf spot and blight diseases.

Severity estimation (%)	Scale	Interpretation
0	0	No infection
1 - 20	1	Slight infection
21 - 41	2	Moderate infection
41 - 60	3	Severe infection
61 - 80	4	Very severe infection
81 - 100	5	Complete infection

This was recorded on monthly basis in 2006 and 2007, respectively.

disease of maize worldwide and is known to produce over 100 secondary metabolites that can adversely affect human health (Visconti, 2000).

Fusasium moniliform has been found to be associated with pre-harvest and stored maize in Nigeria, (Hointink and Boehm, 1999), while Essien (2000) had reported that *Aspergillus flavus*, *Aspergillus nominus* and *Aspergillus parasitica* were isolated from cultures of most seed chips and cereal crops in Nigeria. Also, Bankole and Adebanjo (2003) observed heavy dietary health problems in inhabitants of sub-Sahara Africa as a result of mycotoxin particularly *Fumanisius* produced by *F. moniforum* and Aflatoxins from injection by *Aspergillus* specie. Tillage aims at creating soil environment favourable to plant growth. Lal (1973) observed that tillage is physical, chemical or biological soil manipulation to optimize condition for germination, seedling establishment and crop growth. Tillage system include no- tillage or slot planting, mulch tillage, strip or zonal tillage, ridge till include no-till include on ridges and reduced tillage. (Parr et al., 1990; Gajiri et al., 1994; Opara-Nnadi, 1990). Hence, the objective of this project is to determine the effects of storage conditions and tillage operation on some fungal diseases and yield of maize as well as to identify micro-organisms associated with these diseases.

MATERIALS AND METHODS

The experiment was conducted at Federal University of Technology, Owerri Research Farm. It is situated at Latitude 3˚N and Longitude 7˚E in Utisols of South Eastern Nigeria. The annual rainfall range was 2400-2500 mm and temperature range of 26-27˚C in 2006 and 2007 seasons, respectively. The experiment comprised of two treatments. These include storage conditions which appear as main plot while tillage operation occurs as sub plot. Storage conditions include shelled, unshelled and threshed maize seeds and tillage operations consist of three combinations which were zero (control), spot tilled and strip tilled plots, respectively. The treatment management was 3 x 3 factorial fitted into a randomized complete block design (RCBD) giving 3 x 3 = 9 treatments at 4 replications giving 9 x 4 = 36 experimental plots in 2006 and 2007, respectively.

Planting was carried out at the rate of 2 seeds per hole at three tillage operations, with spacing of 25 x 75 cm, giving 53,333 plants per hectare. Data were collected on leaf formation, plant height, leaf formation, grain yield, leaf spot and blight diseases.

Plant height (cm)

This was collected by measuring with a tape from the base to the apex of newly formed leaf at 3, 6 and 9 weeks after planting.

Leaf formation

This was obtained by counting the leaves formed by the sampled plants one after the other at 3, 6 and 9 weeks after planting.

Grain yield

This was obtained by threshing the grains from sampled plots and weighing in a precision balance and expressed in kilogram per hectare in 2006 and 2007, respectively.

Diseases severity

Severity of leaf spot and blight diseases were obtained monthly by visual observation and scoring according to the following format as proposed by Ford and Hewitt (1980) (Table 1).

Cultural, isolation and identification of some fungi species

The diseased leaves and grains were subjected to microbial isolation and identification. 280 g of fresh Irish potatoes were weighed, peeled and chopped into small pieces. Then, it was boiled in beaker using distilled water. After 30 min, the whole content was transferred to a muslin cloth in a beaker and the extract squeezed into a beaker. It was then made up to one liter with distilled water. 20 g of glucose and 20 g of agar powder were added. It was stirred on the hot plate and transferred into a conical flask. It was then covered with a cotton wool and foil to avoid contamination. The contents were poured into Petri-dishes at 20 ml each and allowed to cool to solidification, in line with Bankole and Adebayo (2003) as well as Barnett and Hunter (1998).

Samples were collected from each of the sampled diseased leaves and grain and they were inoculated into the nutrient potato dextrose agar medium. Growth was observed after 48 h; it was stained and observed using binocular microscope. The pathogens were identified using the laboratory manual by Barnett and Hunter (1998).

Data analysis

Data were analyzed using methods of Steels and Torrie (1981) and means were separated using the Fishers protected Least Significant Difference (LSD) according to Statistical Analysis System (SAS, 1999).

RESULTS

The result of soil analysis prior to planting showed that nitrogen is 0.09, potassium 0.238, calcium 0.38, aluminum 1.38, hydrogen 0.41% (Centimol/gram), according to AOAC (1990). The result also showed that storage condition was not significant at all stages in the

Table 2. Effect of storage condition and tillage operation on plant height, leaf formation and leaf spot disease in 2006 and 2007.

	Plant height		Leaf formation		Leaf blight		Leaf spot disease	
	2006	2007	2006	2007	2006	2007	2006	2007
Shelled	44.73	42.1	10.05	9.51	1.17	1.35	2.75	3.20
Undehusked	47.31	46.54	9.01	8.25	1.17	1.25	2.92	2.80
Dehusked	64.00	56.20	13.9	14.35	1.17	1.26	2.92	2.40
$LSD_{0.05}$	0.92	0.85	1.95	1.85	0.07	0.14	0.66	0.72
Zero tillage	64.87	68.9	11.08	13.00	1.58	1.88	3.42	3.65
Strip tillage	32.24	40.20	8.55	8.62	1.08	1.16	2.83	2.55
Spot tillage	56.03	60.54	9.17	9.38	0.83	0.78	2.3	2.00
$LSD_{0.05}$	0.265	0.31	2.84	2.02	0.56	0.52	0.58	0.66

Table 3. Effects of storage condition and tillage operation on cob weight and grain yield (kg/ha) in 2006 and 2007.

Sources	Cob weight (kg/ha)		Ai yield (kg/ha)	
	2006	2007	2006	2007
Shelled	980.10	110.22	2627.02	2636.1
Undehusked	8478.43	7570.4	3519.84	3620.6
Dehusked	11571.93	16805.5	7019.84	6875.41
$LSD_{0.05}$	6.95	8.55	2.72	3.15
Zero tillage	14738.84	13728.2	9731.27	9840.1
Strip tillage	6867.42	7080.54	2629.85	2752.5
Spot tillage	10968.6	11042.1	5847.96	6020.5
$LSD_{0.05}$	130.47	155.35	34.52	35.40

severity of leaf blight and leaf spot diseases when tillage operation significantly influenced leaf spot (3.53; 4.44) and blight (1.75; 1.88) disease infections at 9 weeks after planting in 2006 and 2007, respectively (Table 2). Subsequently, the interaction of storage condition and tillage operation was significant on cob weight and grain yield.

Seeds from dehusked maize recorded the highest plant height (64.00; 56.20) with shelled (44.70; 42.10) recording the lowest. Dehusked seeds also had the highest leaf formation (13.90; 14.35) while undehusked recorded the lowest (9.01; 8.25). Storage condition hayed statistically similar result on leaf blight and leaf spot infection in 2006 and 2007, respectively (Table 2). Considering the tillage operation, zero tilled plots recorded the highest plant height (64.87; 68.90) with strip tilled plots recording the lowest (32.24; 40.06), while similar results were obtained on leaf formation. Zero tilled plots recorded highest leaf spot disease severity (3.42; 3.654) as well as highest leaf blight (1.58; 1.88) with spot tilled plots recording lowest in all the diseases investigated in 2006 and 2007, respectively (Table 2). Dehusked recorded the highest cob weight (11571.93; 10805.50) and grain yield (7019.82; 6875.65) when shelled had the lowest cob weight (980.92; 110.22) as well as grain yield (2627.02; 2636.10) (Table 3).

The interaction of storage conditions showed that zero tilled plots recorded the highest severity of blight and leaf spot diseases, while shelled and strip tillage interaction recorded the lowest leaf spot and blight diseases. The interaction of dehusked and zero tillage had the highest severity of all the diseases investigated (Table 4). Dehusked interaction with strip tillage recorded the highest cob weight as well as grain yield, while undehusked and spot tillage recorded the highest cob weight and grain yield in 2006 and 2007, respectively (Table 5). Micro-organisms identified with infected leaves were *Helminthosporum maydis, Spermospora*, while that with grains were *Aspergillus spp, Penincilium spp, Blastomyces* and *Fusarium spp* with *Fusarium* and *Penincdillum* species occurring most in all the seasons investigated.

DISCUSSION

The low level of nitrogen, phosphorus and potassium may be attributed to the typical fragile nature of the tropical soils, marked with intense leaching and volatilization due to the high rainfall and temperature leading to low fertility in soil status. The acidic nature of the soil may be due to low potassium and basic nutrient, hence low level of phosphorus impairs fixation. This is in agreement with AOAC (1990). The significant difference recorded by storage condition on plant weight with shelled recording lowest may be attributed to the complete separation of the seeds from husks. They are then subjected to high stress created by moisture stress, reduction in seed constituents. This may lead to high dormancy and reduced metabolic and biochemical processes resulting to low plant height.

The significant difference recorded by tillage operation on leaf spot and blight diseases especially at 9 weeks after planting, with zero tilled plots recording highest severity of all the diseases may be attributed to the fact that accumulation of organic matter in the soil which enhanced the activities of the micro-organisms in line

Table 4. Mean values of storage condition and tillage operation on leaf spot and blight severity in 2006 and 2007.

		Leaf spot		Leaf blight	
		2006	2007	2006	2007
	Z	3.25	2.92	2.0	2.4
Shelled	St	3	3.25	1.0	1.1
	Sp	2.0	1.8	0.5	0.58
	Z	3.25	3.7	1.25	1.50
Undehusked	St	3.0	3.25	1.25	1.44
	Sp	2.5	2.6	1.0	0.96
	Z	3.75	3.86	1.5	1.67
	St	2.5	2.62	1.0	1.11
Dehusked	Sp	2.5	2.0	1.0	1.18
	$LSD_{0.05}$ storage condition	1.18	1.2	0.07	0.012
	$LSD_{0.05}$ tillage operation	0.58	0.48	0.56	0.6

Table 5. Means of main effects on storage condition and tillage operation on cob weight and grain yield in 2006 and 2007.

		Cob weight (kg/ha)		Grain yield (kg/ha)		
		2006	2007	2006	2007	
	Z	6666.625	6725.6	333.3	3416.7	
SH	St	2319.99	2410.38	386.67	390.11	
	Sp	3533.31	3644.5	1879.98	1957.8	
	Z	3433.32	3455.42	2613.32	2570.04	
UND	St	2693.35	2711.98	1199.99	1216.2	
	Sp	5333.3	5475.1	3199.86	2894	
	Z	4519.97	4428.7	1773.32	1560.36	
DEH	St	1839.99	1754.66	1026.66	1088.25	
	Sp	2039.96	2128.5	746.64	785.9	
$LSD_{0.05}$ storage condition		6.95	5.26	7.70	5.88	2.7
$LSD_{0.05}$ tillage operation		130.47	20.18	12.55	26.74	34.52

with Lal (1976), Ahn and Hintz (1990) as well as Hoitink and Boehm (1999). Storage condition recorded significant cob weight as well as grain yield with shelled recording the lowest in line with same reasons assumed above for plant performance. Significant difference recorded by tillage operation with zero tilled plots recording highest cob weight and grain yield may be related to the sandy nature of the tropical soil, which is prone to degradation due to adverse effects of weather, thus, continued tillage decreases the level of organic matter in the soil by improving condition for its oxidation, hence no tillage operation encourages organic matter reduction, soil matter losses, soil erosion, less destruction of soil structure, decrease in labour and energy consumption (Ahmed and Young, 1982). Moreover, the interaction of zero tillage and virtually all the storage conditions recorded highest disease severity with spot tillage and its interaction with any of the storage condition low, may be as a result of non-exposure of the sub-soil to the surface to the action of the ultraviolet rays. This helps to eliminate most of those pathogens and their spores as no-tilled plots encourage the colonization of maize root fungi which is in line with Ahmed and Young (1982). The presence of *H. maydis*, *Spermospora* spp on maize leaves, as well as *Aspergillus* spp, *Penincilium* spp, *Blastomyces* and *Fusarium* species on the grain with *Fusarium* and *Penincdillum* species occurring most, may be due to the fact that these micro-organisms are responsible for the disease development and spoilage of tropical crops, in line with Blancard (1994); Essien (2000); Bankole and Adebanjo (2003).

In conclusion, spot tilled plots recorded the lowest severity of leaf blight and leaf spot diseases, while zero tilled plots recorded the highest on both seasons investigated. Seeds from shelled maize recorded the lowest plant performance, while zero tilled plots had the highest. Same trend was observed in its interaction with any of the storage condition in all the seasons investigated.

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