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THE EFFECTS OF DIFFERENT FUNGICIDES ON THE GROWTH PARAMETERS OF FOUR MAIZE VARIETIES INFESTED WITH *FUSARIUM OXYSPORUM* IN HADEJIA, JIGAWA STATE

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ABSTRACT: Maize is one of the most popular food crops in Nigeria is widely consume by millions of Nigerians and also used for the product of animal feeds. However, the maize plant in field is suffering from many biotic constrains, one which is vascular wilt disease caused by *Fusarium oxysporum*. The study was aimed at investigating the effects of different fungicides in the control of this disease. The Experiment was conducted at Botanical Garden, Federal University Dutse to determine the relative efficacy of some seed treatments fungicides in the control of fusarium wilt in four varieties of maize (Quality protein maize, Early maturing maize, Susuma maize and hybrid variety maize). The four seed treatment fungicides were Seed care, Blast force, Dress force, and Z force). The experimental design was 4×4 factorials laid out in Completely Randomized Design with four replications given a total of 64 treatment combinations. The procedure of general linear model was employed to analyze the data. Results of this experiment showed that all the four Fungicides demonstrated effectiveness in controlling wilt diseases, with the Seed Care fungicide proving to be the most effective in reducing disease incidence. Fungicide treatments also positively influenced

plant growth parameters such as plant height, leaf number, and chlorophyll content.

Keywords: *maize varieties, wilt, Fusarium oxysporum, disease incidence %, growth parameters.*

INTRODUCTION

Maize is one of the most popular food crops in Nigeria is widely consume by millions of Nigerians and also use for the product of animal feeds. In 2019 Nigeria was Africa's second largest maize production after South Africa. And 14th largest producer globally. According to USDA maize import into Nigeria doubled 500,000 tons to 1 million metric tons between 2019 to 2020 (Thomm *et al.*, 2005).

Wilt disease in maize and many other crops is caused by *Fusarium oxysporum* f. sp. *lycopersici* (Sacc.) W.C. Snyder and H.N. Hans, a soil borne plant pathogen in the class Hyphomycetes. There are more than 100 *Fusarium* vascular wilt diseases worldwide. Apart from causing diseases, they colonize outer cells of roots as harmless endophytes after the pathogen has killed the root tissues and others live as saprophytes in soil. This disease was first described by G.E. Massee in England in 1895. The pathogen has three physiological races (1, 2, and 3, hereafter r1, r2 and r3) and are distinguished by their specific pathogenicity on tester plants carrying dominant race-specific resistance genes. It is of worldwide importance where at least 32 countries had reported the disease, which is particularly severe in countries with warm climate. Symptoms of attack first appear as slight vein clearing on the outer portion of the young leaves followed by epinasty of the older leaves. This symptom often occurs on one side of the plant or on one shoot. Successive leaves yellow wilt and die, often before the plant reaches maturity. As the disease progresses, growth is typically stunted, and little or no fruit develops. If the main stem is cut, dark brown streaks may be seen running lengthwise through the stem. The browning of the vascular system is characteristic of the disease and generally can be used for its identification. On the outside of affected stems, white, pink or orange fungal growth can be seen especially in wet conditions.

The control of *Fusarium* wilt is important in maintaining plant vigour and fruit quality and quantity. Though *Fusarium* wilt is a difficult disease to control.

Numerous strategies have been proposed to control this fungal pathogen. However, attempts to control the disease have experienced limited success due mainly to emergence of new pathogenic races. Documented methods that are used in the control of the disease include cultural, biological, use of resistance, chemical and use of natural Products. The aim of this research work was to determine the effects of four fungicides in the control of wilt disease caused by fusarium oxysporum in some maize varieties.

Materials and Methods

Study Area

Hadejia town is located in eastern jigawa state, northern Nigeria. It lies on the northern bank of Hadejia river a seasonal tributary of the komadugu yobe, which flows into lake chad. Hadejia geographical coordinates as latitude 12.45, longitudes 10.04, 12°27'0 North 10°2'24"East, altitude 358M (1,175ft). Hadejia climate is semi-arid climate, the wet season is hot, oppressive, and mostly cloudy and the dry season is sweltering and partly cloudy. Temperature varies from 59°F to 105°F.The inhabitant are dominantly Hausa, Fulani, Kanuri and some other groups such as Tivi, Yoruba, Igbo, Gala etc. The main occupation of the inhabitants is cropping farming and animal rearing with considerable percentage engaged in fishing and civil service. Hadejia has a total population of 105,628 in 2006 census, and covers a total area of 32.5 km.

The experiment was conducted at Botanical Garden, Federal University Dutse, Jigawa state, during 2021 rainy season in completely randomized design (CRD) design with 3 replications and treatments and control to evaluate different fungicide effects against rice blast disease under field condition using pot experiment.

Pot preparation.

Sterilized clay-loam soil was used, plastic pot of 30cm size and 17cm breadth was used. The pots were filled with the soil mixture after creating a small hole at the bottom of the pot to allow passage of water so as to minimize water logging and allow air passage. The pots were watered and allowed to stand for a day before transplanting of the rice seedling (Zafar *et al.*, 2024).

Experimental Design

The experimental design was a 4x4 factorial laid out in Completely Randomized Design (CRD) with three replications and control. The experiment was conducted to test the efficacy of four fungicides namely; Seed Care (SDC = (Imidacloprid 10%, Thiram 10% WS),), Blast Force (BLF= Isoprothiolane 40% WP) and Hexacal (50g Hexaconazole per liter), Dress Force (DRF= (Imidacloprid 20%, Metalaxyl-M 20% and Tebuconazole 2%),) and Z-force (Mancozeb 80% WP), as treatment against fusarium wilt caused by *Fusarium oxysporum*. For each treatment, there were three different concentrations with three replications and one control. The pots were arranged as each treatment per row with its control making a total of 50 pots. Irrigation was used throughout the experiment as a water supply to the plants two times daily for proper growth and development (Kutama *et al.*, 2024; Hadiza *et al.*, 2020).

Inoculation of F. *oxysporum*

Inoculation of pathogen was carried out before sowing as recommended Kutama *et al.* (2022) by seed deep method. The maize seeds were soaked in a spore suspension of the isolated fungi and then treated with fungicide according to the manufacturer's instructions.

Agronomic practice

The agronomic practices were followed as per package of practices for raising the crop (Singh *et al.*, 2019). NPK (20:10:10) fertilizer at 60kg per hectare were applied at 1.5 gram per pot, and weed were control by direct removing as it appears (George, 1997, Kumar *et al.*, 2014).

Application of Fungicides

The maize seeds were soaked in a spore suspension of the *Fusarium oxysporum* isolate and then treated with fungicide according to the manufacturer's instructions as described by Kutama *et al.* (2023). The control pots were sprayed using normal water.

Data Collection

The following data were collected;; Incidence (%) of the disease (DI), Plant height, Number of leaves and Chlorophyll content (SPAD)

Determination of Incidence of Disease

The observations on occurrence of wilt symptoms caused by *F. oxysporum* were recorded as percentage of disease incidence by using the formula; DI=number of diseased plant/total number of plants X 100 (Kutama *et al.*, 2024).

Plant height

Plant heights were measured using a meter rule. The measurements were taken at two weeks after the final spray (2WAFS) of the fungicides (treatments). Height was measured by holding a meter stick (ruler) from the bottom to the tip of the tallest maize plant. This is done by gently grabbing all the maize plant in the pot with single hand, and carefully raising the plant up to determine the tallest leaf from the plants in the pot. The ruler is then placed on the soil surface close to the maize plant and the measurement of the tallest rice plant in the pot was taken. The record of the tallest plant was measured from each pot and the average was calculated from three replication of all the fungicides concentration (Zafar *et al.*, 2024).

Number of leaves

The number of leaves of the plants found in each pot was counted at two weeks after inoculation treatment with fungicides. All the leaves of each plant in a pot were counted and the average was calculated from the three replications.

Statistical Analysis

Data generated was statistically analyzed using procedure of General Linear Model software GenStat 7TH edition was used. There are sixty-four (64) treatments combinations altogether. Analysis of variance (ANOVA): To determine the significant differences in disease incidence, prevalence, severity, and plant growth parameters among treatments. LSD (Least Significant Difference): To separate the means of treatments when ANOVA indicated significant differences.

RESULTS AND DISCUSSION

Effect of fungicides on % disease incidence of maize varieties under *Fusarium oxysporum* infection

Table 1 showed the percentage Disease incidence of maize varieties grown as affected by fungicides under *Fusarium oxysporum* infestation. No significant interaction across the treatment was noticed; bearing in mind that fungicide kills and inhibits growth of fungi that cause disease to plants. The fungal infection pressure was low during the period of the experiments. The results showed that maize variety QPM consistently exhibits the lowest disease incidence across all time points, making it the most resistant variety to the diseases in this study. HBR shows the highest disease incidence at the beginning but has a relatively stable level at 6 weeks. SSM and EMM have moderately higher disease incidences, especially as time progresses. Regarding the fungicides, SDC appears to be the most effective in reducing disease incidence, especially at 2 and 4 weeks, while ZFC seems to be the least effective, especially at 4 weeks.

No significant interaction was found between variety and fungicides, meaning that the fungicide treatment's impact on disease incidence does not differ significantly across the varieties. These results are at par with what was obtained by Zafar *et al.*, (2024a and b) in rice blast disease when the same fungicides were used. This suggests that different fungicides possess different effect on the same pathogen. The relative importance of these fungicides might also be affected by the temperature and other environmental conditions prevailing at the point of application e.g; moisture and other soil conditions. This is in tandem with the report of Kutama *et al*. (2023) on fusarium wilt of tomato in Jama are.

Table 1: Effect of fungicides on % disease incidence of maize varieties under *Fusarium oxysporum* infection

Treatment	Mean Disease Incidence in Weeks After Application of Fungicides		
VARIETY	DI2	DI4	DI6
QPM	1.4b	1.8a	1.6a
SSM	1.3b	1.9a	2.5a
EMM	1.6ab	1.8a	2.2a
HBR	1.9a	2.1a	1.8a
LSD ($P \leq 0.05$)	0.35	0.53	0.98
FUNGICIDES			
SDC	1.4b	1.8a	1.6a
BLF	1.3b	1.9a	2.5a
DRF	1.6ab	1.8a	2.2a
ZFC	1.9a	2.1a	1.8a
LSD ($P \leq 0.05$)	0.35	0.53	0.98
INTERACTIONS			
VARIETY *FUNGICIDES	NS	NS	NS

Values with the same alphabet are not statistically different according to DMTR

Effect of fungicides on Plant height (cm) of maize varieties under Fusarium oxysporum infection

The result of height of maize varieties grown at Botanical garden affected with fungicides is represented in Table 2 below. Hybrid Maize exhibits the lowest growth, with the lowest plant height at all time points. Seed Care fungicide appears to be the most effective in promoting plant growth, showing the highest plant height at all time points, similar to QPM’s results. Blast Force, DRF, and ZFC show lower plant heights, with ZFC performing the worst, similar to Hybrid Maize. No significant interaction was found between variety and fungicide, meaning the plant height was similarly influenced by fungicides across the different varieties. QPM consistently shows the highest plant height, indicating superior growth performance compared to the other varieties.

Table 2: Effect of fungicides on Plant height (cm) of maize varieties as affected by Fusarium infection

TREATMENT	Mean Plant Height (cm) in Weeks After Application of Fungicides		
VARIETY	PH2	PH4	PH6
QPM	14.3a	15.7a	18.9a
SSM	9.5b	13.0b	12.8b
EMM	6.8c	11.5c	11.8b
HYBRID MAIZE	4.1d	8.3d	11.4b
LSD (P≤ 0.05)	1.55	1.53	2.65
FUNGICIDES			
SEED CARE	14.3a	15.7a	18.9a
BLAST FORCE	9.5b	13.0b	12.8b
DRF	6.8c	11.5c	11.8b
ZFC	4.1d	8.3d	11.4b
LSD (P≤ 0.05)	1.55	1.53	2.65
INTERACTIONS			
VARIETY*FUNGICIDES	NS	NS	NS

Values with the same alphabet are not statistically different according to DMTR

Effect of fungicides on Number of leaves of maize varieties under Fusarium oxysporum infection

Maize variety QPM consistently shows the highest leaf number, indicating that it has the most favorable growth characteristics among the varieties. Variety HBR exhibits moderate leaf growth, while SSM and EMM show lower leaf numbers, particularly at later stages. SDC fungicide supports the best leaf development, consistent with the results seen in QPM. BLF and DRF result in moderate leaf growth, similar to the outcomes observed with SSM and EMM. The significant differences in leaf numbers highlight the varying effects of the varieties and fungicides, with QPM and SDC emerging as the best performers in terms of leaf production. The result shows significant difference in terms of number of leaves, this is also attributed to low fungal infection or pressure during the experiment as described by Jamalluddeen *et al.* (2012)

Table 3: Effect of fungicides on number of leaves of maize varieties under *Fusarium oxysporum* infection

S/N	TREATMENT	Mean Plant Number of Leaves in Weeks After Application of Fungicides		
	VARIETY	NL2	NL4	NL6
	QPM	2.6c	7.6a	10.5a
	SSM	3.5ab	6.4ab	6.9b
	EMM	3.1bc	6.1b	6.5b
	HBR	4.1a	5.8b	6.4b
	LSD (P≤ 0.05)	0.65	1.16	1.22
	FUNGICIDES			
	SDC	2.6c	7.6a	10.5a
	BLF	3.5ab	6.4ab	6.9b
	DRF	3.1bc	6.1b	6.5b

Values with the same alphabet are not statistically different according to DMTR

Effect of fungicides on Chlorophyll content (SPAD) of maize varieties under Fusarium oxysporum infection

Table 4 showed the Chlorophyll content of maize varieties grown under screen house condition. There was no significant difference between the varieties of maize and this indicates that the chlorophyll contents response to fungicides is consistent across the varieties used as reported by Hadiza *et al.* (2020) and Kutama *et al.* (2024a) who reported that fungicides inhibits the growth of pathogens and therefore make the crop plant healthy and more productive. This results show that EMM and SSM exhibit the highest chlorophyll content, particularly at the earlier stages (2 and 4 weeks), indicating that they support the best leaf development and photosynthesis. QPM and HBR show lower chlorophyll content, with a noticeable decline by 6 weeks, indicating less optimal photosynthetic activity compared to EMM and SSM. DRF and BLF fungicides support better chlorophyll content than SDC and ZFC, aligning with the performance of EMM and SSM, respectively. The absence of significant interactions suggests that the chlorophyll content response to fungicides is consistent across the varieties, meaning that each fungicide impacts chlorophyll content similarly regardless of the variety used (Tahir *et al*., 2024; Hadiza *et al*., 2022).

Table 4: Effect of fungicides on Chlorophyll content (SPAD) of maize varieties under Fusarium oxysporum infection

TREATMENT	Mean Chlorophyll Contents in Weeks After Application of Fungicides		
VARIETY	CC2	CC4	CC6
QPM	3.6b	4.3ab	1.6a
SSM	4.4a	4.3ab	2.5a
EMM	4.5a	4.6a	2.2a
HBR	3.9b	4.2b	1.8a
LSD (P≤ 0.05)	0.49	0.42	0.98
FUNGICIDES			
SDC	3.6b	4.3ab	1.6a
BLF	4.4a	4.3ab	2.5a
DRF	4.5a	4.6a	2.2a
ZFC	3.9b	4.2b	1.8a
LSD (P≤ 0.05)	0.49	0.42	0.98
INTERACTIONS			
VARIETY *FUNGICIDES	NS	NS	NS

Values with the same alphabet are not statistically different according to DMTR

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