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Determination of Efficacy of Metalaxyl Seed Treatment Fungicide on Incidence of Sorghum Diseases and Its Cost-Benefit in Borno State of Nigeria

Richard, B. I.
Department of Crop Protection, University of Maiduguri, Nigeria
Ojo, G. O. S.
Department of Crop Production, University of Agriculture, Makurdi, Nigeria
Maina, T. Y.
Department of Crop Protection, University of Maiduguri, Nigeria

Abstract

Sorghum (*Sorghum bicolor* (L.) Moench) is an economically valued food and cash crop in of Nigeria. In 2001 and 2002 cropping seasons, field experiments were conducted in a split-pot using randomized complete block design to determine the efficacy of Metalaxyl fungicide and it cost-benefit on incidence of sorghum diseases in Borno State at the Teaching and Research Farm of the Department of crop protection, University of Maiduguri. Six sorghum genotypes which include BES, ICSV 111, ICSV 400, Warwarbashi, Paul-Biya and Ex-Mali were used. The seeds were treated with 2.5g a.i/kg of Metalaxyi, plus control before sowing. Results showed that plants grown from the untreated seeds significantly had the highest mean anthracnose incidence of 33.6% and 33.9%, sooty stripe mean incidence of 42.1% and 38.6% in 2001 and 2002, and a higher covered smut mean incidence of 10.7% in 2002 respectively. Long smut incidence and grain yield were not significant among treated and untreated seeds in 2001 and 2002. Treated plants had an increased yield of 0.28% and 28.9% more than the untreated in 2001 and 2002 respectively. Treated Ex-Mali and untreated Paul-Biya, Ex-Mali recorded higher cost-benefit ratio and net profit in monetary valued. The physiological attributes of each sorghum genotypes can dictate their choice for local uses as well.

Keywords: Disease incidence, sorghum genotype, metalaxyl, cost benefit

Introduction

Sorghum is a potential economic cash crop and also one of the most important food grain crops grown in Nigeria and other parts of the semi-arid regions of Africa like Sudan and Ethiopia. It is the fifth most important cereal crop in the world (FAO, 1985). The five largest producers of sorghum in the world are U.S.A. (25.0%), India (21.5%), Mexico (11.0%), China (9.0%) and Nigeria (7.0%). Together, these five sorghum cultivating countries account for 73.5% of the total world area devoted to sorghum production (FAO, 1995). In Nigeria, sorghum account for about 50% of the total cereal production and more than 95% of the sorghum grains produced in the country are consumed in the form of thick porridge, thin gruel, while the stalks are put into other economic uses such as building, basket making, fencing, fish traps, fuel wood and fodder for farm animals (Obilana *et al.,* 1984).
Sorghum yield losses due to diseases are a major economic setback particularly in third

Corresponding author's
Name: Richard, B. I.
Email address: richybwala@gmail.com

world countries where seeds are not treated before sowing. According to Richard *et al.* (2009), diseases of sorghum constitute a major problem to sorghum production in areas where the crop is grown. Sorghum diseases like anthracnose, downy mildew, sooty stripe, leaf blight, charcoal rot, smuts and oval leaf spot are biotic factors that limit sorghum production in the Semi-arid areas of the World. Anthracnose is of great importance in Latin America where it is the most serious disease and one of the main yield-limiting factors, especially in Brazil, Venezuela and Guatemsala (Maunder, 1975). Anthracnose cause severe foliar damage on sorghum in Nigeria (Tyagi, 1980) and the most important in more than 95% of the surveyed fields in Niger (Pande *et al.*, 1993).

Sooty stripe is common throughout the sorghum producing areas of the USA and the substantial hybrid variation in susceptibility to sooty stripe impact on yield ranging from 10 – 26% as a result of two or more lesions per leaf in Kansas (Jim, 2009). In Nigeria, Richard *et al.* (2011) observed sooty stripe incidence of 84.3% and 61.8% on susceptible BES in 2001 and 2002 respectively in Nigeria.

According to Pande *et al.* (1993) panicle diseases such as covered, loose, kernel and head smuts are the most widespread and most destructive group of sorghum diseases. In an infected panicle the grains are replaced and covered with smut sori. In Nigeria, covered smut incidence of 14.9% and 12.4% and long smut incidence of 43.2% and 77.5% has been reported on ICSV111 in 2001 and 2002 respectively (Richard *et al.*, 2008). Many disease control management strategies have been adopted to reduce crop disease menace to economic minimum level. Hence, the evaluation of chemical efficacy, diagnosis and measurement of plant diseases is very important and fundamental to disease prediction, disease management and crop yield loss assessment for retrospective and prospective aspects. The objective of this work was to determine the efficacy of metalaxyl seed dressing fungicide on the incidence of sorghum diseases and its cost-benefit in Borno State.

Materials and methods

The field experiment was conducted during the rainy seasons of 2001 and 2002 at the Teaching and Research Farm of the Department of Crop Production, Faculty of Agriculture, University of Maiduguri in the Sudan Savannah of Nigeria. The experiment was laid in a strip-plot using Randomized Complete Block Design with three replications. The seed treatment fungicide was tested in the sub-plots while the six sorghum genotypes were tested in the main-plots. Each replicate had 12 plots of 5 x 5m separated from adjoining replicate by 0.5m alley. There were a total of 36 sub-plots and each sub-plot contained 32 plants with 90cm and 60cm as inter-row and intra-row spacing respectively. The seedbeds were prepared after the land was ploughed and compound fertilizer (NPK 15:15:15) was applied at the rate as recommended by Borno State Agricultural Development Programme (BOSADP) (1993). The six sorghum genotypes used include three ICRISAT improved varieties namely: ICSV111, ICSV400, and BES obtained from the Lake Chad Research Institute Maiduguri, while Paul Biya, Ex-mali and WBS are local landraces obtained from BOSADP.

The metalaxyl (Apron Star 42WS) seed treatment fungicide was applied at the rate of 2.5ga.i/50gm seeds by shacking properly to ensure proper adhesiveness. Both the treated and the untreated check were sown within 24 hours. First weeding was done three weeks after sowing (WAS) and the crop was thinned down to two plants per stand. Subsequent weeding was done regularly to keep the entire farm weed-free throughout the farming season.

Data collection

Disease incidence (%)

At 65 days after sowing (DAS), data on incidence of sorghum foliage anthracnose, sooty stripe while the incidence of covered and long smuts on the panicle was recorded at 95 DAS. Disease Incidence was calculated using the formula:

$$Disease\ Incidence\ (\%) = \frac{No.\ of\ disease\ infected\ plants\ in\ the\ middle\ rows}{Total\ No.\ of\ plants\ (diseased\ \&\ healthy)\ in\ the\ middle\ rows} x\ 100$$

Grain yield

At maturity stage, the panicles in all the middle rows of each sub-plot were harvested separately, sundried, threshed, winnowed, weighed and converted into kilogram per hectare. Economic data were taken using the following formula:

$$Yield\ increase\ over\ theuntreated\ chech = \frac{Treated - untreated}{Tretead} x\ 100$$

Selling price = Mean yield x cost of grain in the market at that year

Profit = selling price – cost of production

$$\textbf{Cost benefit ratio} = \frac{\text{Profit}}{\text{Total cost of production}}$$

Results and discussion

The efficacy of the metalaxyl seed dressing fungicide on the incidence of four major sorghum diseases namely anthracnose, sooty stripe, covered and long smuts are shown in Table 1. The results showed that the untreated sorghum had significantly the highest anthracnose incidence means of 33.6% and 33.9% compared to the treated sorghum crops with lower incidence of 28.4% and 20.9% at 65 DAS in 2001 and 2002 respectively. Similarly, results also indicated that the untreated sorghum genotypes recorded significantly the highest sooty stripe incidence of 42.1% and 38.6% while the treated recorded lower disease incidence of 28.4% and 29.4% in the respective years. The efficacy of metalaxyl seed dressing fungicide in lowering the initial inoculum was obvious in light of The lower incidence of anthracnose and sooty stripe recorded for the treated sorghum genotypes in the current work is in agreement with the findings of Richard *et al.* (2009) who reported that seed treatment with Apron Star 42WS controlled the early stage of anthracnose and ensured high seedling establishment. Similarly, Richard *et al.* (2011) also reported that plants grown from seeds treated with metalaxyl fungicide were less susceptible to sooty stripe by recording the lowest disease incidence. Results in Table 1 showed that there was no significant difference on panicle covered smut incidence among the fungicide treated and untreated sorghum genotypes at 95 DAS in 2001. However, in 2002, the treated sorghum plant significantly had the lowest panicle covered smut incidence mean of 0.72% while the untreated recorded the highest panicle covered incidence mean of 10.7%. There was no significant difference between the treated and untreated plants in relation to panicle long smut incidence. In the two years, both the treated and untreated plants significantly recorded high panicle long smut incidence. This study also agree with Mtisi (1996) who reported that metalaxyl and thiram based formulation gave better control of covered smut. El Hilu and Fredericksen (1992) reported that loose and covered smut can be effectively controlled by seed dressing. Long smut is an air-borne disease which was not significantly lowered by the seed treatment and hence resulted in significantly high long smut incidence at 95 DAS in the two cropping seasons (Table 1).

Results in (Table 1) showed that both the treated and untreated recorded higher mean grain yield of 731.7kg/ha and 729.6kg/ha in 2001, and mean grain yield of 998.8kg/ha and 710.4kg/ha in 2002 which was significantly indifferent from each other.

The production activities and cost involved on fungicidal treated sorghum genotypes was higher (N12670.00) compared to the untreated plants (12270.00) (Table 2).

In Table 3, the cost-benefit analysis of mean production of treated sorghum genotypes indicated a slight yield increase of 0.29% above the untreated in 2001, but in 2002, there was a significant yield increase of 28.9% above untreated and a higher cost benefit ratio of 1:0:6 while the untreated was 1:0:2. The cost benefit analysis of production of each of the six sorghum genotypes when chemically treated and untreated showed that treated and untreated Ex-Mali had the highest cost benefit ratio of 1:1:10 and 1:1:9 and with a net profit of N24795 and N23071 against the production cost of N12670 and N12270 respectively in 2001 (Table 4). The untreated ICSVIII, BES, Paul Biya and WBS recorded higher percentage yield increase than their untreated counterparts in the same year.

Similarly, in 2002, results (Table 4) indicated that the treated Ex-mali and untreated Paul Biya equally had the highest cost-benefit ratios of 1:1:4 and 1:1:3 with monetary net profit value of N18264.5 and N16081.5 against their production cost respectively. In 2001, among the treated sorghum genotypes ICSV400 and Ex-Mali recorded an increased grain yield of 48% and 5.7% over their untreated counterpart respectively. In 2002, the treated ICSV111, ICSV400, BES, Ex-Mali and WBS had an increased grain yield of 64%, 9.04%, 43%, 51.3% and 22.4% above their untreated counterparts respectively.

The mean grain yield of both years was far below the annual average grain yield of 1.532 kg/ha (FAO, 1985). Crop diseases, insect pests and lack of farming incentives are major production constraints in Nigeria. This finding also agrees with Onyenweaka *et al.* (2000) who stated that about 70% of the Nigerian population is engaged in agriculture, yet the country is still not self-sufficient in food production. This work has revealed the yield potentials of the six sorghum genotypes evaluated. However, the marginal grain yield in some genotypes may not be the only basis for recommendation. The individual choice of genotypes may not be dictated by the grain yield alone, but such traits like height, robustness of the stalk for building local houses, fencing, basket making, fish traps, fuel wood and fodder for farm animal as observed in Table 5. This is consistent with the findings of Obilana *et al.*, 1984 who had earlier recommended some sorghum genotypes for building, fencing, roofing and as fodder for farm animals.

This work has therefore proved that metalaxyl fungicide seed treatment lowered the incidences of both foliar and panicle diseases of sorghum. It has shown Ex-Mali as having the highest cost benefit ratio and net profit. This work has also high-lighted the performances of each genotypes and physiological attribute which can dictate the choice of the farmers. Hence the evaluation of the chemical efficacy and determining the cost-benefit of any chemical used in controlling crop disease(s) is of paramount importance in order to ascertain effective disease control and production efficiency.

Table 1: Efficacy of chemical seed treatment on mean disease incidence and grain yields in 2001 and 2002 cropping seasons

Diseases	Incidence means 2001 Treated	Incidence means 2001 Untreated	Incidence means 2002 Treated	Incidence means 2002 Untreated	Mean grain yield 2001 Treated	Mean grain yield 2001 Untreated	Mean grain yield 2002 Treated	Mean grain yield 2002 Untreated
Anthracnose	23.4b	33.6a	20.9b	33.9a	731.7a	729.6a	998.8a	710.4a
	SE ± 1.091*		SE ± 0.828**		SE ± 49.27 NS		SE ± 65.16 NS	
Sooty stripe	28.4b	42.1a	29.4b	36.6a				
	SE ± 2.366**		SE ± 0.960*					
Covered smut	5.8a	8.9a	0.72b	10.7a				
	SE ± 1.799 NS		SE ± 1.432*					
Long smut	22.7a	18.4a	42.9a	43.5a				

	SE ± 4.175 NS	SE ± 4.201 NS

Mean within the same letter (s) in the same column are not significantly different from each other at 5% level of probability.

Table 2: Production activities and cost of production for the treated and untreated sorghum genotypes in 2001 and 2002 cropping seasons

Production activities/cost	Cost /ha (N)	
	Dressed	Undressed check
Land preparation/planting	3000	3000
Fertilizer (NPK) 3 Mudus	360	360
Cost of application	250	250
Urea application 4 Mudus	560	560
Cost of application	300	300
3 weeding operation	4800	4800
Cost of fungicide (N150 per sachet)	300 (2)	0
Seed dressing labour	100	0
Harvesting	1200	1200
Threshing/winnowing/bagging	1500	1500
Transportation	300	300
Total cost of production	12670	12270

Table 3: Cost benefit of production of sorghum in 2001 and 2002

Income	2001		2002	
	Dressed	Undressed	Dressed	Undressed
Yield of marketable grain kg/ha	731.7kg	729.6kg	998.8	710.4kg
Yield increase over undressed check	0.29%		28.9	-
Production cost (N)	₦ 12670.0	₦ 12270.0	₦ 12670.0	₦12270.0
Selling price	₦21585.15	₦ 21523.2	₦ 20475.4	₦14563.2
Profit	₦ 8915.15	₦ 9253.2	₦ 7805.4	₦ 2293.2
Cost-benefit ratio	1:0.7	1:0.8	1:0.6	1:0.2

The cost-benefit ratio is based on ₦ 29.50/kg and ₦ 20.50/kg (mudu measure), the prevailing cost of sorghum grain at Monday market in 2001 and 2002 cropping seasons respectively

Table 4: Cost-benefit analysis for production of each of the six treated and untreated sorghum genotypes in 2001 and 2002 cropping seasons

	ICSV111		ICV400		BES		CS-35		Ex-Mali		W.W. bashi	
	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated
2001 Income												
Yield of marketable grains (kg/ha)	616.9 kg	815.1 kg	502.1 kg	261.4 kg	652.5 kg	689.0 kg	881.5 kg	906.8 kg	1270.0 kg	1198.0 kg	467.3 kg	507.4kg
Yield increase over untreated check	-	23.3%	48%	-	-	5.3%	-	2.7%	5.7%	-	-	7.9%
Production cost ₦	12670	12270	12670	12270	12670	12270	12670	12270	12670	12270	12670	12270
Selling price ₦	18198.55	24045.45	14811.95	7711.3	19248.75	20325.5	26004.6	26750.6	37465	35341	13785.35	14968.3
Profit ₦	5528.55	11775.45	2141.95	4558.7	6578.75	8055.5	13334.25	14480.6	24795	23071	1115.35	2698.3
Cost-benefit ratio	1:0.4	1:0.10	1:0.2	1:0:4	1:0:5	1:0:7	1:1:1	1:1:2	1:1:10	1:1:9	1:0:1	1:0:2
2002 Income												
Yield of marketable grains (kg/ha)	1222.0kg	432.8kg	441.3kg	401.4kg	806.8kg	460.0kg	9187kg	1383.0kg	1509.0 kg	735.0kg	1096.0kg	850.4kg
Yield increase over untreated check	64.5%	-	9.04%	-	43.0%	-	-	33.6%	51.3%	-	22.4%	-
Selling price ₦	25051	8872.4	9042.55	8228.7	16539.4	9430	18833.35	28351.5	30934.4	15067.5	22468	17433.2
Profit ₦	12381	3397.6	3627.45	4041.3	3869.4	2840	6163.36	16081.5	18264.5	2797.5	9798	5163.2
Cost-benefit ratio	1:1:0	1:0:3	1:0:3	1:0:3	1:0:3	1:0:2	1:0:5	1:1:3	1:1:4	1:0:2	1:0:8	1:0:4

The cost benefit ratio is based on ₦29.50/kg and ₦20.50/kg (mudu measure), the prevailing cost of sorghum grain at Monday market in 2001 and 2002 cropping seasons respectively

Table 5: Attributes of six sorghum genotypes for economic uses

Genotypes	Characteristics
ICV111	Medium tall (1.8 – 2.1m), leaves are 70 – 80cm long, 7-10cm wide, midrib colour is white, panicles are semi compact, elliptic, completely exserted (2-5cm) 20-25m long and 9-13cm wide. The glumes are tough, leathery yellowish brown. Awns are absent. Tolerate to drought and resistant to leaf diseases.
WBS	Tall, erect with robust stalk (2-3m), the panicles are loose, cylindrical shape with reddish brown grains most susceptible to anthracnose foliar disease, Awns are present.
Ex-Mali	Medium height (1.8 – 2m, light green leaf compact panicle, big panicle with oval shape that bend downward (gooseneck) grains are big and creamy in colour. Moderately resistant to most foliar diseases and resistant to panicle smut diseases.
Paul Biyia	Very tall (2 – 2.5m) high green leaf liable to lodging, moderately compact panicles and cylindrical in shapes, grain coloiur is light brown with some blackish spots. Susceptible to foliar and panicle disease.
ICSV400	Medium tall (1.8 – 2m) tan colour, and matures in 105 to 115 days. Leaves are 70 – 80cm long, 8 – 11m wide, and semi-erect. The midrib is white, panicles are semi-loose, long and elliptical, completely exserted (6 to 15cm), 25 – 35cm long, and 7 – 12cm wide. The slimes are soft, leathery and light red. Awns are absent, tolerant to drought, lodging and resistant to leaf diseases.
BES	Dwarf genotype (1 – 1.3m), leaves are 40 – 50cm long, 5 – 8cm wide. Midrib colour is white. Panicles are compact and elongated. Grains are medium in size and light yellow in colour. Tolerant to drought and resistant to foliar diseases.

Source: Gupta *et al*. (1994), BOSADP (1993) and Richard (2002)

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