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Cost-benefit of Fungicidal Control of Anthracnose on Sorghum in Northern Nigeria

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ABSTRACT

Field studies were conducted to evaluate the economics of controlling sorghum anthracnose caused by *Colletotrichum sublineolum* using different fungicides. The field experiments were laid out at the Research farm of the University of Maiduguri (Latitude 11^0 15 N & Long. 13^0 15 E) during the rainy seasons of 1998 and 1999. Six fungicide combinations: metalaxyl followed by benomyl, metalaxyl followed by mancozeb, metalaxyl followed by carbendazim, thiram followed by benomyl, thiram followed by mancozeb, thiram + carbendazim were applied as treatments for the control of the fungus at different stages of the plant growth while the control plots were left un-treated. Application of any of the fungicide treatments resulted in 70 - 80% reduction of anthracnose and more vigorous plants that gave higher yields, as much as two times that of un-treated control. The cost-benefit analysis revealed the positive return per hectare from the use of the fungicides for the control of anthracnose in the region. Using seed treatment metalaxyl followed by foliar applied benomyl for instance, gave 51% yield increase, which translated into a net profit of N45375.00 of Nigerian naira equivalent to US $454.00 per hectare. Even the least effective fungicide treatment (seed treatment thiram folloed by foliar appliedd benomyl) in this trial gave a yield increase of 34.8% over the control. This translated to a net profit of N32925.00 equivalent to US $329.25 per hectare. These returns are attractive particularly for the relatively high yielding early maturing local sorghum variety Warwarabashi.

Key Words: Sorghum; Anthracnose; *Colletorichum sublineolum;* Fungicides; Grain yield

INTRODUCTION

Anthracnose, caused by the fungus *Colletotrichum sublineolum* Henn in Kab and Bubak [syn. *Colletotrichum graminicola* (Ces) Wils.] is the most important disease of sorghum in Nigeria. The damage caused by this disease ranges from deterioration of grain to peduncle breakage, stalk rot and foliage damages (Pastor-Carroles & Federiksen, 1980; Gwary *et al*., 2002). Damages by this disease may occur at different stages of plant growth (Warren & Nicholson, 1975; Gwary *et al*., 2003). Marley *et al*. (2004) reported crop losses as high as 47% for Nigeria and similar losses for other West African countries have also been reported by Pande *et al*. (1993). Various strategies have been suggested for the control of this disease, however, the use of resistant crop varieties has often been recommended as the best option. The International Crops Research Institute for the Semi-Arid Tropics based in India with field stations in West Africa has been working hard for the general improvement of sorghum and has released some sorghum varieties for the semi-arid regions that are drought tolerant, high yielding and anthracnose resistant. The availability of seeds of such variety is, however, the greatest problem of the farmers. The other problem associated with the use of resistant cultivars is that of sustainability; the pathogen is known to have high pathogenic variability (Ferreira & Warren, 1982; Cardwell, 1989; Pande *et al*., 1991) and under optimal conditions for pathogen development, host plant resistance is known to break down rapidly.

So far farmers in this region are fairly conversant with the use of fungicides for the control of variety of crop diseases and these chemicals are readily available. The main objective of this study was to evaluate the cost-benefit of using some selected fungicides for the control of sorghum anthracnose in the field where sorghum is grown mainly for food and the crop residues used for livestock feed and as fencing materials.

MATERIALS AND METHODS

Field trials were conducted at the Research farm of the Department of Crop Protection, University of Maiduguri, (Latitude 11^o 15' N & Longitude 13^o 15' E) during the rainy seasons of 1998 and 1999. The soil type of the experimental site was a sandy loam. The experiment consisted of 7 treatments: metalaxyl + benomyl (MB), metalayxl + mancozeb (MM), metalayxl + carbendazim (MC), thiram + benomyl (TB), thiram + mancozeb (TM), thiram + carbendazim (TC) and a control (Table I). The seed dressing fungicides were applied at the manufacturer's rate of 10 g per 3 kg of sorghum seeds, while the foliar fungicides were applied at the rate of 17 kg a.i. ha^{-1} at 45, 60 and 75 days after sowing (DAS). The trials were laid out in randomized

Table I. Fungicide treatments used and their formulations and rates of application

Fungicide treatments	Formulation	Rate of application*
Metalaxyl *followed by* Benomyl	Apron plus Benlate 50% W.P	10g of product to 3kg of seeds; 17 kg a.i./ha
Metalaxyl *followed by* Carbendazim	Apron plus Bavistin F1	10g of product to 3kg of seeds; 17 kg a.i./ha
Metalaxyl *followed by* Mancozeb	Apron plus Dithane M-45	10g of product to 3kg of seeds; 17 kg a.i./ha
Thiram *followed by* Benomyl	Blekritt 50% W.P. Benlate 50% W.P.	10g of product to 3kg of seeds; 17 kg a.i./ha
Thiram *followed by* Carbendazim	Blekritt 50% W.P. Bavistin F1	10g of product to 3kg of seeds; 17 kg a.i./ha
Thiram *followed by* Mancozeb	Blekritt 50% W.P. Dithane M-45	10g of product to 3kg of seeds 17 kg a.i./ha
Control	None	None

*As recommended by manufacturers for the region

complete block design and replicated four times. Inter- and intra-row spacing was at 0.9 m and 0.4 m with four rows per treatment. Data were taken on the two middle rows. The trial was planted when rainfall was fully established; in 1998 planting was done on 15th July, while in 1999 it was planted on the 12th of July. Each of the 2 seed dressing fungicides were mixed with seeds at the treatment rates before sowing, while foliar spray were applied twice (at 45, 60 & 75 DAS) using a knapsack sprayer. Compound fertilizer (NPK 15: 15: 15) was applied at the rate of 259 kg ha^{-1}, this was followed by side dressing with urea at 4 weeks after planting at the rate of 100 kg ha^{-1} as recommended for the area (BOSADP, 1989). Manual weeding was done at two weeks after emergence and plants were thinned to two plants per stand. Subsequent weeding was carried out at 4 weeks intervals. All the farm operations and cost of inputs were computed.

Source of inoculum. The trial was established in an anthracnose 'sick plot'. The natural inocula had built up over several years of cultivation of susceptible sorghum cultivars. In addition, the disease pressure was increased by incorporating infected crop residues from every previous growing season, into the soil during land preparation.

Disease assessment. Disease was monitored and the severity was last measured at crop maturing at 85 DAS. Disease severity was assessed on 10 –tagged plants on a rating scale of 1 - 9 (Sharma, 1983), where: 1 = No symptoms or presence of chlorotic flasks; 2 = 1 - 5% leaf area covered with lesion; 3 = 6 - 10% leaf area covered with lesion; 4 = 11 - 20% leaf area covered with lesion; 5 = 21 - 30% leaf area covered with lesion; 6 = 31 - 40% leaf area covered with lesion; 7 = 31 - 50% leaf area covered with lesion; 8 = 51 - 75% leaf area covered with lesion; 9 = more than 75% area covered with lesion. The values obtained were expressed in % severity.

Grain yield. The grain yield of sorghum (tons ha^{-1}) was computed from grain yield of each net plot as:

$$\text{Grain yield (tons ha}^{-1}) = \frac{\text{Grain yield plot}^{-1}\text{ (tons) x 10,000 m}^2}{\text{Net plot size (8 m}^2)}$$

Data analysis. All data collected were analyzed statistically. Mean comparisons were carried out using Duncan's multiple range test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Table II shows the severity of anthracnose during the two separate years and the combined analysis of the two years data. The disease reached a severity of over 50% on control plants in both 1998 and 1999 and a mean of 54.42% for the two years. With the introduction of fungicides consisting of seed dressing at sowing, followed by series of foliar sprays lead to a reduction of the disease (Table II). Following the fungicidal treatment, disease was checked and maintained below a mean of severity of 16%. However, it is also evident from the results that the performance of the fungicides varied between seasons. In 1999 the fungicides reduced anthracnose much more than in 1998. When metalaxyl (Apron plus) was applied as a dust to the seeds and later followed up by foliar application of benomyl (benlate 50% WP) to the growing plants, the highest reduction of disease was achieved although this was not significantly different from the performance of the other treatments. Seed dressings provided the emerging seedlings protection against both seed born anthracnose as well as against the soil inocula for about four weeks when the foliar sprays were applied to sustain the protection. The grain yield of sorghum not protected by fungicides was low at 1.71 tons per hectare (Table II). Again metalaxyl + benomyl and metalaxyl + carbendazim treatments produced the highest yields of 2.76 and 2.63 tons per hectare, respectively (Table II). Gwary *et al*. (2001) have shown that management of anthracnose and Striga hermonthica are essential for a profitable production of the Warwarabashi cultivar of sorghum.

The cost-benefit analysis of using fungicides in the region for controlling anthracnose is presented in Table III. This clearly reveals the positive returns per hectare from the use of fungicides for the control of anthracnose as indicated by the cost-benefit ratio and the profit or return per hectare. Using metalaxyl followed by foliar benomyl for instance gave about 136% increase in yield due mainly to the reduction in the anthracnose infection, which translated into a net profit (return) of N37255.00 per hectare equivalent to US $372.55. This was followed by the metalaxyl + carbendazim with carbendazim with N34825.00 equivalent to US $348.25 and metalaxyl + mancozeb with a net profit of N31525.00 (US $315.25) per hectare. The lowest profit was obtained from the un-protected crops at the unprotected crops at. N13675.00 equivalent to US $136.75 per hectare. The metalaxyl fungicide based treatment has demonstrated superiority in controlling the pathogen than thiram based treatments. These returns are encouraging particularly for the farmers in this region, who prefer this sorghum variety for its early maturity. In addition to increased grain yield, Gwary and Asala (2006) have also

Table II. Effect of fungicidal treatment on Disease severity and yield of Warwarabashi sorghum in 1998 and 1999 cropping seasons

Treatment (Fungicide combinations)	Disease severity (%)			Grain yield (tons ha^{-1})		
	1998	1999	Combined two years analysis	1998	1999	Combined two years analysis
Metalaxyl+ Benomyl	13.33a	9.33a	11.33a	2.92a	2.60a	2.76a
Metalaxyl+ Mancozeb	18.08a	13.17a	15.63a	2.60ab	2.22ab	2.41ab
Metalaxyl+ Carbendazim	17.25a	11.41a	14.33a	2.69ab	2.57a	2.63a
Thiram+ Benomyl	18.33a	10.92a	14.63a	2.31ab	1.91ab	2.11ab
Thiram+ Carbendazim	19.42a	7.67a	13.55a	2.40ab	2.00ab	2.00b
Thiram+ Mancozeb	19.17a	12.25a	15.71a	1.88bc	1.40b	1.64b
Control	55.00b	53.83b	54.42b	1.56c	0.78bc	1.17c
S.E. (±)	2.26	5.47	3.27	0.29	0.32	0.20
CV (%)	9.8	3.26	5.83	8.36	4.86	8.01

Means in the same column bearing the same letter(s) are not significantly different at 5% significant level according to Duncan Multiple Test (DMRT); DAS = Days after sowing.

Table III. Cost-benefit of controlling sorghum anthracnose with fungicides in Maiduguri, Nigeria during 1998 and 1999 rainy seasons

Cost/Returns	Fungicide Treatments						
	MB	MC	MM	TB	TC	TM	Control
Labor costs (₦ ha-^{1})	2400	2400	2400	2400	2400	2400	1850
Other costs (₦ ha-^{1})	1125	1125	1125	1125	1125	1125	1125
Fertilizer	900	900	900	900	900	900	900
Fungicides	200	200	200	200	200	200	0
Total costs (₦ ha-^{1})	4625	4625	4625	4625	4625	4625	3875
Grain yield (tons/ ha-^{1})	2.76	2.63	2.41	2.11	2.20	1.64	1.17
Gross revenue (₦ ha-^{1})	41850	39450	36150	31650	33000	24600	17550
Returns (₦ ha-^{1})	37255	34825	31525	27025	28375	19975	13675
% Return of control	172	154	130	97	107	46	-
Cost-benefit ratio	1:8.1	1:7.5	1:6.8	1:5.8	1:6.1	1:4.3	1:3.1

MB = metalaxyl and benomyl; MC = metalaxyl and carbendazim; MM = metalaxyl and mancozeb, TB = thiram and benomyl; TC = thiram and carbendazim; TM = thiram and mancozeb. Exchange rate at 1998/1999 was $1.00 = ₦100.00

shown other benefit for the use of fungicides in sorghum protection; the forage dry weight was higher than in untreated controls. The forage (stalks & leaves) are used as animal feed.

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