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Assessing the Effects of Metalaxyl Seed Treatment Methods on Incidence of Downy Mildew [*Sclerospora graminicola* (Sacc.) Schroet.] in some Exotic Cultivars of Pearl Millet [*Pennisetum gluacum* (L.) R. Br.]

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Abstract: Field experiment was conducted at the University of Maiduguri Research Farm to evaluate the effect of metalaxyl seed treatment methods on downy mildew incidence and yield of pearl millet. Two methods of seed treatment viz. slurry and dust were tested against four improved pearl millet cultivars Super sosat, Sosat-c88, LCIC 9702 and PEO 5984, and a Local cultivar Ex-Borno. Dust application of metalaxyl on seed had higher seedling emergence, plant height and yield, and lower downy mildew incidence and severity than in slurry treatments. Dust application increased seedling emergence and establishment across the two years, by 61.7 and 17.3 %, respectively compared to control. It also reduced downy mildew severity by 79.5 % and increased yield by 181.2 kg/ha, representing 22.6 % increase over the control compared to the 21.9 % increase in yield by slurry treatment. Super sosat developed little or no downy mildew and had the highest grain yield. PEO 5984 was the most susceptible but the earliest maturing cultivar. To farmers who do not read or bother to read instructions or recommendations by manufacturers can apply the product as dust on the dry seeds and choose to plant either the early maturing more susceptible cultivars or the late maturing more resistant ones depending on rainfall or weather prediction for the preceding season.

Keywords: Cultivar, Metalaxyl, Seed Treatment, Pearl Millet

1. Introduction

Pearl millet (*Pennisetum glaucum* L.) R. Br is an important cereal produced as food, forage and stover crop mainly in the arid and the semi-arid regions of the world. It is grown worldwide on a total of 40 million ha (FAO, 1986). The world largest producer is India followed by Nigeria (FAO, 2008). This crop is affected by several diseases among which is downy mildew induced by *Sclerospora graminicola* (Sacc.) Sch. This disease is considered to be the most widespread and destructive disease of pearl, not only in Nigeria but in all millet growing areas of the world (Selvaraj, 1979; King, 1992).

Fungicides have been developed to protect plants against diseases and pests that cause yield losses. Seed treatment with fungicide is one of the cheapest and the most effective methods of controlling seed and soil borne diseases. Seed treatments provide an economical input that is applied directly on the seed using highly effective technology (Crop Life Foundation, 2013). They can be conveniently used by farmers to improve plant stands and seedlings vigour (ICRISAT, 1982).

Effective control of the disease has been achieved by seed treatment with metalaxyl (Williams and Singh, 1981; Singh, 1983) but not without its negative effects on germination and seedling emergence. Singh (1983) reported significant differences in germination and emergence among pearl millet cultivars treated with different metalaxyl formulations and/or application methods.

Metalaxyl is manufactured as Water Dispersible Powder for Slurry seed treatment. However, most

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farmers in Nigeria apply the fungicide as dust on dry seed for dry seed treatment. This method, according to the manufacturers, gives uneven distribution and poor adhesion of the product on the seeds. Therefore, they do not recommend it.

The present study was conducted to assess the effects of two metalaxyl application methods (dry and slurry seed treatments) on downy mildew of pearl millet and on growth and yield parameters of some improved pearl millet cultivars.

2. Materials and Methods

A two-year field experiment was conducted during the 2014 and 2015 cropping seasons at the Research farm of the Department of Crop Protection, University of Maiduguri (Lat. 11.85 and Long. 13.16), Nigeria. Four improved pearl millet cultivars (Super sosat, Sosat-c88, LCIC 9702 and PEO 5984) and one popular local variety (Ex-Borno) were used for the experiment. Super sosat and Sosat-c88 are medium maturing, LCIC 9702 is early maturing and PEO 5984 is extra-early maturing cultivar. The cultivars were obtained from Lake Chad Research Institute, Maiduguri, Nigeria. Apron star 42 WS which contained 20 % metalaxyl was used for the seed treatment.

2.1.Seed treament methods

2.1.1. Slurry (pre-wetted) seed treatment

Twenty grammes of each cultivar was weighed in small polythene bags using a sensitive balance. To each of these 20 g, 0.5 ml of water was poured using a 2-ml hypodermal syringe to wet the seeds. Then, 0.1 g of Apron star was added as dust to the wetted seeds and shaken thoroughly to mix with the seeds.

2.1.2. Dust (dry seed) treatment

A separate batch of 20 g seeds from each cultivar was weighed using the same procedure. To each batch, 0.1 g of Apron star was added as dust on the dry seeds. These were shaken thoroughly to mix. A batch of 20 g from each cultivar was left untreated as control.

2.2. Sowing

The treated and the untreated seeds were sown on 9th July, 2014 and 21st July, 2015 in a split plot design with cultivar used as the main plot and seed treatment methods as sub plot. Each sub plot size measured 3×2 m^2 and inter- and intra-row spacing 75 and 50 cm, respectively were used. A two-finger pinch of the seeds, containing about 20 seeds were sown per hill. The plants were thinned to three per stand at two weeks after emergence. A compound fertiliser (NPK: 20-10-10) at the rate of 200 kg/ha was broadcast at three weeks after seedling emergence. Weeding was carried out after thinning and thereafter as often as required.

2.3. Data collection

2.3.1. Seedling emergence (%)

Number of emerged seedlings per hill was counted and then expressed as a percentage of total number of seeds sown per hole. This was determined ten days after seedling emergence (DAE).

2.3.2. Seedling establishment (%)

At 30 days after seedling emergence number of established stands per plot was counted and then expressed as a percentage of total number of stands per plot.

2.3.3. Disease incidence on main stands

The number of main stands in each plot infected with downy mildew was counted at dough stage. This was computed as the percentage of diseased plants over the total number of plants in each plot.

2.3.4. Disease severity

This was rated according to the severity classes described by Williams (1984) and modified by Mbaye (1994). Thus, 0 % no symptoms; 1 % only secondary tillers diseased; 2 % less than 50% of the primary tillers diseased; 3 % more than 50% of the primary tillers diseased; 4 % all tillers are diseased or the plant has died at seedling stage. The disease severity, representing the percentage of infection of individual plants is as follows:

$$\text{Disease severity (\%)} = S = \frac{\Sigma Y_i n_i}{4N} \times 100\%$$

where Yi is severity class, ni is the number of plants in each class and 4 is the highest
severity class.

The yield data were collected from the entire plots at maturity. Thus, the panicles
were cut, sun-dried and threshed to obtain the grains, and weighed.

2.4. Data Analysis

All the data collected from each cropping season were analyzed. Analysis of variance was performed on the data using STATISTIX 8.0 for windows (Analytical Software, Tallahassee, Florida, USA).

3. Results and Discussion

Metalaxyl application methods significantly ($P \leq 0.05$) affected downy mildew incidence in pearl (Fig. 1). Dust and slurry treatments reduced the disease incidence by 78.2 and 64.2 %, respectively over the control. Dust treatment reduced downy mildew severity by 79.5 % over the control. In a field trial, Singh (1983) tested two metalaxyl formulations and application methods as seed treatment and similarly found reduction in downy mildew with all fungicide treatments. He, however, noted that the higher the susceptibility of a cultivar to the disease, the more the fungicide or more treatment is needed to provide acceptable control.

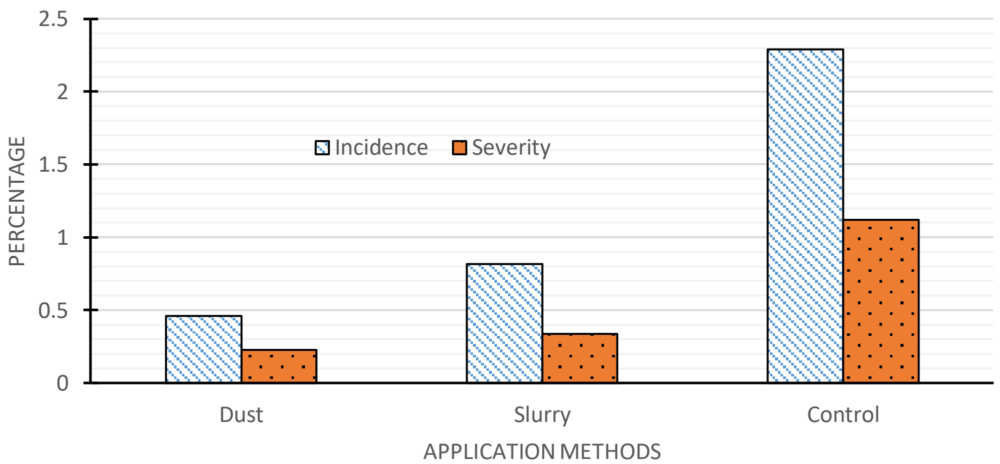

Fig. 1. Effect metalaxyl application methods on incidence and severity of downy mildew of pearl millet (mean across two seasons)

Metalaxyl seed treatment, irrespective of application methods, significantly (P≤0.05) affected, seedling emergence, growth, head weight and yield of pearl millet during (Table 1). The dust application consistently had higher growth and yield than slurry method. It increased seedling emergence, establishment, and grain yield, across the two years by 61.7, 17.3, and 22.6 %, respectively compared to control. Dust treatment increased yield by 181.2 kg/ha, representing 22.6 % increase over the control compared to the 21.9 % increase in yield by slurry treatment. The observed differences between the effects of these methods may not be unconnected with adherence of the fungicide to the treated seeds. Compared to the light contact in dust treatment, slurry treatment had more of the fungicide adhered to the seed surface resulting in inhibition of germination and/or seedling emergence. Singh (1983) had similarly observed that pearl millet germination was significantly reduced in all cultivars while seedling emergence was reduced in one of the four cultivars tested at higher rate of metalaxyl application suggesting possible phytotoxic effect. However, the differences between the effects of dust and slurry applications were not significant.

Table 1. Effect of metalaxyl application methods on growth parameters and yield of pearl millet (mean across two seasons)

Application method	Seedling emergence (%)	Seedling establishment (%)	Plant height (cm)	Grain yield (kg/ha)
Dust	62.1a	97.6a	214.6	984.6a
Slurry	60.6a	97.7a	208.2	979.2a
Control	38.4b	83.2b	204.6	803.4b
S.E. (±)	2.82*	1.64**	6.3ns	52.1**

Cultivar significantly (P≤0.05) affected both disease incidence and severity significantly (Fig. 2) as well as growth and grain yield of pearl millet (Table 2). The highest disease incidence was observed in the landrace Ex-Borno, while no downy mildew (0 %) was observed in the improved cultivar Super sosat. This was followed by Sosat-c88 and LCIC 9702. The disease severity was similarly highest in the Ex-Borno followed by PEO 5984. Sosat-c88 disease incidence was as high as that of a more susceptible cultivar LCIC 9702. It was reported to be resistant to downy mildew (Wilson et al. 2008; Jidda and Anaso, 2012), and was among the highest yielding entries irrespective of locations and years of trial (Wilson et al. 2008). However, the relatively high incidence of the disease on Sosat-c88 in the present study, showed that its resistance might have been breached. Its high yield despite the disease also suggest that the cultivar is tolerant to downy mildew (Ati et al., 2015).

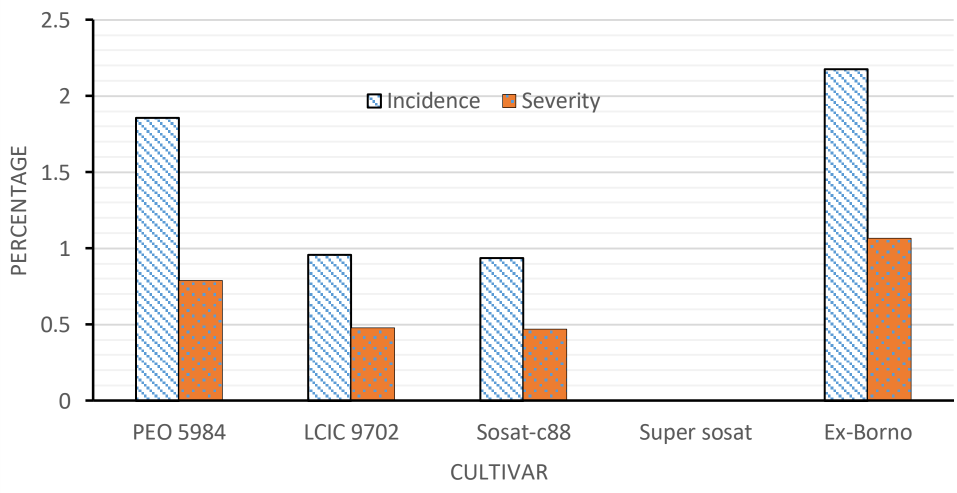

Fig. 2. Effect of cultivar on incidence and severity of downy mildew of pearl millet (mean across two seasons)

Table 2. Effect of cultivar on growth and yield parameters of pearl millet (mean across two seasons)

Cultivar	Seedling emergence (%)	Seedling establishment (%)	Plant height (cm)	Grain yield (kg/ha)
PEO 5984	63.2a	94.4	179.8c	797.5c
LCIC 9702	52.5bc	93.9	202.9b	795.0c
Sosat-c88	54.7b	91.0	213.2b	1012.2b
Super sosat	46.6c	93.2	235.1a	1214.8a
Ex-Borno	51.5bc	91.6	214.6b	792.5c
S.E. (±)	3.64*	2.12ns	8.18**	67.2**

The early maturing PEO 5984 had more emerged seedlings than the late maturing Super sosat. While Super sosat was the tallest cultivar, highest in grain yield and the least or no downy mildew developed cultivar. Wilson et al. 2008 reported that plant height and downy mildew resistance were most consistently correlated with pearl millet yield. Taller plants have the advantage of yielding higher (Bidinger and Raju, 1993) although other factors such as days to flowering may affect performance in certain production environments.

Pearl millet yield and yield components, as well as downy mildew incidence and severity varied significantly ($P \leq 0.05$) among the two seasons trial (Table 3). These parameters were significantly higher in 2014 than in the 2015 trial. Both disease and yield are affected by rainfall, relative humidity and atmospheric temperature (Sivakumar *et al*., 1993; EL-Mahi *et al.*, 1995; Gilijamse *et al.*, 1997; Gwary et al., 2006). High rainfall and humidity would encourage downy mildew development. Similarly, high and well distributed rainfall across the season leads to high yield. But where temperatures are higher and humidity lower, and where the rainfall is relatively lower, disease incidence would be less (Gwary et al., 2006).

Table 3. Effect of season on growth parameters, yield and downy mildew (DM) of pearl millet

Season	Seedling emergence (%)	Seedling establishment (%)	Plant height (cm)	Grain yield (kg/ha)	DM incidence (%)	DM severity (%)
2014	58.2a	92.4	215.8a	1182.2a	1.68a	0.84a
2015	49.3b	93.3	202.5b	662.6b	0.69b	0.28b
S.E. (±)	2.31*	1.34ns	5.17**	42.4**	0.48*	0.23**

Although slurry seed treatment is recommended by metalaxyl manufacturers for even distribution and good adhesion of the product on seeds, but this method has been found to be slightly phytotoxic resulting in reduction of seed germination and seedling emergence. Dust application of metalaxyl on dry seeds, on the other hand, reduced downy mildew incidence and improved growth and yield of pearl millet more than the slurry or pre-wetted seeds application method. To farmers who do not read or bother to read instructions or recommendations by manufacturers can apply the product as dust on the dry seeds since there may be little or no advantage of using the slurry method.

Super sosat and Sosat-c88 are high yielding medium maturing either resistant or tolerant cultivars that perform better in diverse ecological zones, are therefore, recommended to farmers. PEO 5984 and LCIC 9702 are susceptible to downy mildew but have the advantage of maturing earlier than the resistant cultivars. The farmers in the semi-arid zone of Nigeria therefore, have the choice to plant either the early maturing more susceptible cultivars or planting the late maturing more resistant ones depending on rainfall or weather prediction for the preceding season.

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