
Effect of Variety, *Metalaxyl* and Fertilizer Rate on Stand Establishment of Pearl Millet Infected With Downy Mildew at Bauchi and Maiduguri

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ABSTRACT

Downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet is a serious constraint to the cultivation and improvement of pearl millet in Nigeria. Therefore, a field trial was carried out during the 2014 rainy season at Bauchi (latitude 10°17' N, 9° 49' E) and Maiduguri (latitude 11° 51' N, 13° 05' E) located in the Northern Guinea Savanna and Northern Sudan Savanna of Nigeria, respectively. The aim was to evaluate the effects of variety, metalaxyl and fertilizer on stand establishment of pearl millet infected with downy mildew at Bauchi and Maiduguri. Randomized Complete Block Design was used with factorial arrangement of treatments, which comprised five nitrogen fertilizer rates (0, 15, 30, 45 and 60 kg N/ha), metalaxyl fungicide (treated and untreated) and two millet varieties (PEO 5984 and Super SOSAT). Results did not show significant ($p < 0.05$) difference in stand establishment between the two varieties, at both locations and assessment periods. In contrast, effects of fertilizer was significant at 6 and 9 WAS, and the best stand establishment was obtained with the highest fertilizer rate of 60 kg N/ha, closely followed by 45 kg N/ha, in both locations. Result indicated significant increase in stand establishment with each successive increase in fertilizer rate upto 45 kg N/ha. Similarly, fungicidal seed treatment also significantly increased stand establishment over the untreated check at 6 and 9 WAS in both locations. From the foregoing results, application of fertilizer at the rate of N60P30K30 and seed dressing with Metalaxyl at 2 g a.i/kg would be recommended for better crop establishment and control of downy mildew for both millet varieties, PEO 5984 and Super SOSAT in the Sudan and northern Guinea agro-ecologies of Nigeria.

Key words: Downy mildew, Metalaxyl, Fertilizer, Pearl millet.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br. is a major cereal food crop in northern Nigeria. The crop is cultivated on about 5.0 million hectares of land, with annual production of 3.4 million metric tonnes in Nigeria (FAOSTAT, 2011). Thus, Nigeria is the leading producer of pearl millet, with about 28% of the global production; however, downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet is a major threat to both the cultivation and improvement of pearl millet, as it causes over 65% loss in grain yield annually. Presently, metalaxyl is the most

effective and widely used fungicide for the control of downy mildew in pearl millet, mainly as seed dressing chemical. However, there are indications that varietal difference and nitrogen fertilization could affect the efficacy and fungicidal activity of metalaxyl (Zarafi, 2005).

Statement of the Problem

Pearl millet plays a significant role in the food security of the entire drier regions of northern Nigeria. Regrettably, its production is highly constrained by three major panicle diseases namely, downy mildew, smut and ergot. Downy mildew caused by the fungus, *Sclerospora graminicola* (Sacc.) Schroet is the most serious of these diseases. Furthermore, downy mildew disease has impeded progress in hybrid millet development, while several other improved cultivars have succumbed to the disease (Williams, 1984). Several degrees of losses arising from seedling mortality are responsible for the wide range of losses 15 - 65% reported from farmers' field. Such wide variations in losses mainly arise due to differences in cultivated varieties, fungicidal use and crop nutrition (fertilizer use) factors that are often overlooked in field research. However, disaggregating the effects of these factors would provide insights into the observed variation in losses.

Justification

Critical analysis of the biology of *S. graminicola* and pearl millet suggests the need for a well-articulated integrated approach for the control of the downy mildew disease (Haward and David, 2005). Downy mildew is a polycyclic (compound interest) disease in which several generations of the pathogen re-infects the crop within the same growing season. Primary infection starts from oospores existing in the soil from straw humus or seed borne mycelia, in which planted seedlings get infected as it emerges from the soil. Subsequently, sporangia released within the season results in secondary infection; thus, both oospores and sporangia contribute to disease epidemics. From the foregoing therefore, appropriate and well-matched options need to be adopted for control of the disease.

The nature of downy mildew infection suggests the need for integrated management options, aimed at providing continuous control throughout the entire crop establishment period. Such measures comprise the exploitation of newly developed varieties with durable genetic resistance. Fungicidal seed dressing with metalaxyl aimed at the reduction of primary infection by oospores in the first early three weeks of seedling growth. Fungicides equally control other diseases in the crop and thereby permit vigorous establishment of the crop, while different varieties react differently to infection by the diseases (Aliyu et al., 2011). Metalaxyl is very effective in the control of downy mildew of pearl millet. It is a systemic fungicide with both protective and curative action. When applied as seed dressing chemical, it protects the seeds against soil and seed borne inoculum, as well as seedlings (Aliyu et al., 2011). Further impetus to the present study stemmed from previous reports that fertilizer reduces the incidence of downy mildew disease (Ajayi et al., 1998; Zarafi et al., 2004). Fertilizers have also been reported to enhance crop establishment against diseases (Deshmukh et al., 1978). Hence, enhanced crop nutrition by fertilizer application aimed at minimizing the effects of the disease by boosting plant vigour has been recommended.

Aims and Objective

The objectives of the study are to:

1. Assess the effects of variety, metalaxyl and fertilizer rate on stand establishment of pearl millet infected with downy mildew at Bauchi and Maiduguri
2. Assess the interactive effect of metalaxyl and fertilizer on stand establishment of two pearl millet varieties infected with downy mildew.

MATERIALS AND METHODS

Experimental Site

The trial was carried out during the 2014 rainy season in two sites: at Abubakar Tafawa Balewa University Teaching and Research Farm Bauchi (latitude 10° 17' N, 9° 49' E and 690.2m above sea level) in Northern Guinea Savannah and Research Farm of Lake Chad Research Institute (LCRI) in Maiduguri (latitude 11° 51' N, 13° 05' E and 315.5 m above sea level) in Sudan Savannah of Nigeria.

Sources of Experimental Materials and Description

Both compound (NPK 15:15:15) and Urea (46% N) fertilizers (Natore Plc brand) were procured from a reputable Agro-dealer in Bauchi. The two pearl millet varieties namely, LCIC-MV₄ (PEO 5984) and LCIC-MV₃ (Super SOSAT) were obtained from the germplasm bank of LCRI Maiduguri. The fungicide (metalaxyl) was obtained from a reputable Agrochemical store in Bauchi.

Field Preparation and Experimental Layout

The land was ploughed using a disc plough and harrowed twice to give a fine tilth. The harrowed land was then levelled and divided into three blocks (replicates). Pegs were used to demarcate boundaries between blocks. Each plot was 5.0 m x 4.5 m, and distance between blocks was 1.0 m, while plots were 50 cm apart. The total area for the experiment was 1697.25 m².

Infecter rows were established with a highly susceptible variety (7042S) obtained from the germplasm bank of LCRI Maiduguri between blocks, three weeks before the test varieties, to serve as a source of inoculum. Seeds of the susceptible cultivar were mixed with ground infected leaf containing oospores collected from the previous season at Bauchi and Maiduguri to ensure that maximum infection takes place during the trial. Five millet seeds were sown per hole at the beginning of the rainy season on 24th June 2014 and 26th July 2014 at Bauchi and Maiduguri respectively, at the depth of 3 – 4 cm, and at a spacing of 75 cm x 30 cm between and within rows, respectively. Seedlings were thinned to two plants per hole at two weeks after sowing. Weeding was done by hoe at three and six weeks after sowing.

Experimental Design and Treatments

The trial was laid out in a randomized completely block design (RCBD). There were 20 treatments, obtained by combinations of two varieties (PEO 5984 and Super SOSAT), five nitrogen levels (0, 15, 30, 45 and 60 kg N/ha), and two fungicide seed treatments (Metalaxyl-Untreated and Metalaxyl-treated).

Data Collection

Data were collected on stand establishment: Total number of stands within the four central rows (net plot) was counted at 3, 6 and 9 weeks after sowing. This was converted to percentage (%) based on the number of planted holes to arrive at % stand establishment.

Statistical Analysis

Data collected was subjected to analysis of variance (ANOVA) to determine the significance of treatments effects and their interactions. Means were separated using least significant difference (LSD) at 5% level of significance.

RESULTS

Table 1 shows the single effects of variety, fertilizer and metalaxyl on stand establishment at Maiduguri and Bauchi. Results did not show significant ($p < 0.05$) difference in stand establishment between the two varieties, at both locations and assessment periods. In contrast, effects of fertilizer was significant at 6 and 9 WAS, and the best stand establishment was obtained with the highest fertilizer rate of 60 kg N/ha, closely followed by 45 kg N/ha, in both locations. Result indicated significant increase in stand establishment with each successive increase in fertilizer rate upto 45 kg N/ha. Similarly, fungicidal seed treatment also significantly increased stand establishment over the untreated check at 6 and 9 WAS in both locations.

Table 1. Effect of variety, metalaxyl and fertilizer rate on stand establishment (%) of pearl millet infected with downy mildew at Bauchi and Maiduguri

Treatment	Bauchi			Maiduguri			Combined locations		
	3 WAS	6 WAS	9 WAS	3 WAS	6 WAS	9 WAS	3 WAS	6 WAS	9 WAS
Variety (A)									
PEO 5984	100	95.57	94.43	100	97.05	93.50	100	96.31	93.96
Super SOSAT	100	95.59	93.43	100	96.89	93.78	100	96.24	93.60
LSD _{0.05}	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Fertilizer (B)									
0 kg N/ha	100	87.83	84.82	100	91.24	81.94	100	89.54	83.38
15 kg N/ha	100	94.95	92.18	100	96.53	92.51	100	95.74	92.35
30 kg N/ha	100	96.94	95.56	100	98.07	96.67	100	97.50	96.11
45 kg N/ha	100	98.74	97.92	100	99.30	98.06	100	99.02	97.99
60 kg N/ha	100	99.43	99.16	100	99.72	99.02	100	99.59	99.09
LSD _{0.05}	Ns	1.15	1.95	Ns	1.73	3.09	Ns	1.01	1.82
Fungicide (C)									
Untreated	100	93.67	91.89	100	95.67	90.61	100	94.67	91.25
Treated	100	97.48	95.97	100	98.27	96.66	100	97.88	96.32
LSD _{0.05}	Ns	0.73	1.23	Ns	1.10	1.96	Ns	0.64	1.15
Interaction									
A x B	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
A x C	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
B x C	Ns	**	**	Ns	*	*	Ns	**	**
A x B x C	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Ns = Not significant at 5% probability of the F-test; **, * = Significant at 1 and 5% probability of the F-test, respectively.

WAS = weeks after sowing

Interaction effect of fertilizer x fungicide on stand establishment was significant ($p < 0.05$) at 6 and 9 WAS in both locations and the combined (Table 2). Seed treatment significantly improved stand establishment at lower N-rates (0 - 15 kg N/ha) at early growth stage, and even up to 45 kg N/ha at mid-growth stage (6 WAS) over the untreated control; but at the highest N-rate of 60 kg/ha stand establishment was at par, with or without fungicide.

Table 2. Interaction effect of fertilizer x fungicide on stand establishment (%) at 6 and 9 WAS, at Bauchi, Maiduguri and Combined

N-rates	Fungicide	
	Untreated	Treated
6 WAS Stand establishment		
Bauchi		
0	82.93	92.73
15	92.97	96.93
30	95.83	98.05
45	97.77	99.72
60	98.87	100.00
LSD _{0.05}		1.6220
Maiduguri		
0	87.77	94.72
15	95.30	97.77
30	97.25	98.88
45	98.60	100
60	99.43	100
LSD _{0.05}		2.4489
Combined		
0	85.35	93.72
15	94.13	97.35
30	96.54	98.47
45	98.18	99.86
60	99.15	100
LSD _{0.05}		1.4339
9 WAS Stand establishment		
Bauchi		
0	79.40	92.73
15	90.57	96.93
30	93.90	98.05
45	96.97	99.72
60	98.60	100
LSD _{0.05}		2.7520

			Maiduguri
0	74.17		89.72
15	88.88		96.13
30	95.30		98.03
45	96.68		99.43
60	98.03		100
LSD _{0.05}		4.3752	
			Combined
0	76.78		89.98
15	89.73		94.97
30	94.60		97.63
45	96.83		99.15
60	98.32		99.86
LSD _{0.05}		2.5794	

WAS = weeks after sowing

DISCUSSION

Fungicides and fertilizers play significant role on stand establishment thus quantification of their effects is of paramount importance in crop protection and nutrition. The present study evaluated the effects of variety, fertilizer rates and metalaxyl fungicide on stand establishment of two pearl millet varieties in two diverse ecologies.

The present findings showed location differences with respect to millet stand establishment which were higher at Maiduguri than Bauchi. Earlier reports revealed that plant stand establishment is a strong indicator of crop adaptation in an environment (Sathya *et al.*, 2013; Ezeaku *et al.*, 2014). Thus, the higher stand establishment at Maiduguri than Bauchi could be an indication that millet is better adapted to the Sudan than Guinea savannah. This could be because millet tends to have higher adaptation to drier environment, due to its drought tolerance ability. Thus, it is not surprising that crop establishment was higher at Maiduguri with lower rainfall than Bauchi.

Result of the present study however, revealed that the effects of fungicide on stand establishment differed significantly under the fertilizer regimes. Thus, seed treatment was more effective at lower N-rates (15 - 30 kg/ha), especially during early growth, but the effects of seed treatment diminished at higher N-rates (45 - 60 kg/ha), especially during mid and terminal growth.

CONCLUSION

It can be concluded that combination of seed dressing with Metalaxyl at 2 g a.i/kg and N₆₀P₃₀K₃₀ were effective against downy mildew and for better crop establishment of both pearl millet varieties.

RECOMMENDATIONS

From the foregoing results, both evaluated millet varieties, PEO 5984 and Super SOSAT could be recommended for cultivation in the Sudan and northern Guinea agro-ecologies of Nigeria. In addition, both combination of seed dressing of PEO 5984 with Metalaxyl at 2 g a.i/kg and N₆₀P₃₀K₃₀ is recommended for better crop establishment and control of pearl millet downy mildew.

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