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Assessing The Effects Of Downy Mildew Disease On Plant Height And Tillering Of Twelve Pearl Millet Genotypes In Yola, Adamawa State

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ABSTRACT

Downy mildew disease induced by Sclerospora graminicola is one of the most important limiting factors to pearl millet (Pennisetum glaucum) production in Nigeria, causing considerable yield loss of up to 70% particularly in high susceptible genotypes. This experiment was conducted to assess the effect of downy mildew disease on plant height and tillering of twelve millet genotypes in Yola Adamawa state in 2008 and 2009 cropping seasons. The objectives of the study were to determine the effects of downy mildew infection on plant height and tillering ability of these genotypes, to determine the yield of these genotypes under disease pressure and to identify genotypes that are relatively tolerant to the disease. The result revealed that all genotypes under study showed reduction in their respective heights indicating that downy mildew disease had a negative effect on plant height. Souna-3 recorded 2 m against 2.25 m described by Lake Chad Research Institute; ICMV-IS-89305 had 2 m against 2.5 m. Sosat 1.7m against 1.8 – 2.2 m. Excessive increase in tillering was also observed among the genotypes, indicating susceptibility. This was clearly observed in the Yola local genotype. Grain yield in 2008 trials was higher than that of 2009 cropping season. This may be due to accumulation of the downy mildew inoculum in the soil in the 2009 cropping season. Serious reduction in yield was observed in most of the genotypes under study. However, Sosat C88, yielded 3.1 t/ha, ICMV-IS-89305 and Souna-3 were relatively tolerant to the disease infection and appeared promising in terms of grain yield.

Keywords: *Genotypes, downy mildew, severity*

1. INTRODUCTION

Pearl millet [Pennisetum glaucum (L.) R. Br.] is the fifth most important cereal crop worldwide. More than 55 % of global millet production is grown predominantly in Africa and Asia as a staple food grain and source of food, fodder, fuel and construction materials in the hottest, driest, semi-arid and arid regions, where rainfall production is practiced [6]. It is supporting more than million people, thus poorest of the poor, hence, its being most important to national food security in Namibia and Nigeria [7]. Indeed, there is probability no better cereal to relieve the underlying threat of starvation and famine in the sahel, the Sudan, Somalia and other drylands of the sahara [10]. Agboola [1] reported that millet constitutes 87–98 % of cereals grain consumed in Nigeria's sahel and that most of the millet produced in Nigeria is used for human consumption.

Despite the importance of this cereal crop, its production is seriously hampered by some biotic and abiotic factors, thereby reducing its yield [5]. Among many of the biotic factors responsible for low yield is downy mildew induced by Sclerospora graminicola (Sacc.) Shcroet [13]. Zarafi et al. [14] also reported that the most important limiting factors to pearl millet production in Nigeria and most important of the pearl millet disease is downy mildew.

Yield losses due to downy mildew disease have been reported by many, but limited efforts are geared toward determining its effect on some plant characteristics. This experiment was undertaken to precisely determine the effect of downy mildew on plant height and tillering of pearl millet, to determine the yield of these genotypes under disease pressure and to identify genotypes relatively tolerant to the disease.

2. MATERIALS AND METHODS

This experiment was conducted at the Teaching and Research Farm of the Department of Crop Production and Horticulture, Federal University of Technology Yola on a downy mildew "sick plot" in 2008 and 2009 seasons. The experiment was carried out on an experimental field measuring 38 x 18 m with plot of 3 x 3 m. The treatments were laid out in a Complete Randomized Block Design (RCBD) replicated four times. The test materials were sown at inter and intra-row spacing of 75 x 25 cm (LCRI, 1998). Green ear sample of the diseased was crushed, moisten and mixed with the seeds of LCIC 9702 a susceptible genotypes and were sown between replicates and round the as the infector rows. This was aimed at increasing the quantity of inoculum available and to increase chances of natural infection. Five plants were tagged at random in the middle rows of each plot and observations carried out on them Data collected was subjected to analysis of variance (ANOVA) using the GLM procedure of SAS and means were separated using the Duncan's Multiple Range Tests.

2.1 Sources of Experimental Materials

The treatments consisted of twelve (12) millet genotypes, eleven (11) of which were sourced from the Lake Chad Research Institute, Maiduguri. The remaining one was procured locally among the landraces

commonly grown within Adamawa state. The genotypes used are: Ex-Borno, ICMV-IS 92222, Sosat-C88, ICMV-IS 94206, PE 05461, Souna-3, Gwagwa, Zango, Zatib, PE 02650, ICMV-IS 89305 and Yola Local.

2.2 Agronomic Practices

The experimental field was cleared, ploughed, leveled and divided into plots. Sowing was done on 14th July 2008 and 2009 respectively, two weeks after the infector row was planted. The millet genotypes were sown at a spacing of 75 cm x 25 cm. Thinning was done at 14 days after sowing (DAS) to 2 plants per stand. Fertilizer was applied at the recommended rate of 60 kg/ha nitrogen in the form of urea, phosphorus in the form of P_2O_5 at the rate of 30 kg/ha and potassium in the form of K_2O at the rate of 30 kg/ha (Singh et al., 1983). Weeding was done manually using hand hoeing when the need arose.

2.3 Data Collected

2.3.1 Number of Tillers Per Plant

This was determined by randomly tagging ten (10) plants per plot from the three middle rows, and the number of tillers counted at 4 and 6 WAS. The average number of tillers per plant for each genotype was then determined.

2.3.2 Plant Height

Plant heights were measured in centimeters from soil surface to the tip of the tallest panicle at maturity from randomly tagged plants.

2.3.3 Panicle Length

The length of panicles was measured in centimeter from 10 randomly tagged plants stands in each plot and their length measured using a meter rule.

2.3.4 Total Grain Yield Per Genotype (Kg ha^{-1})

This was determined by harvesting and threshing all the panicles from the three middle rows in each plot and weighing was done separately to determine the average yield per plot/genotype and later expressed in kilogram per hectare (kg ha^{-1}).

3. RESULTS

3.1 Number Of Tillers For Twelve Pearl Millet Genotypes Assessed For Downy Mildew During 2008 And 2009 Rainy Seasons.

The results shows that there was highly significant difference (P=0.01) between the genotypes at 7 WAS in 2008 growing season. Yola Local recorded the highest number of tillers at 7 WAS with a mean of 14 tillers, followed by Souna-3 with 9 tillers, while Ex-Borno and Zango had 8 tillers each. The least number of tillers was recorded in PE05461 with 6 tillers (Table 2). In 2009 trials, Yola Local had 13 tillers, Zango had 10 tillers, ICMV-IS-94206 had 9 tillers, while Gwagwa, PE05461, Zatib and Souna-3 had 8 each and the rest of the genotypes had 7 tillers each.

3.2 Effect Of Downy Mildew On Plant Height For Twelve Pearl Millet Genotypes Assessed During The 2008 And 2009 Rainy Seasons.

Results on plant height in 2009 showed highly significant difference (P=0.01) between the average plant heights of the different pearl millet genotypes. At 10 WAS, it was observed that Yola local had the highest mean plant height of 265 cm, followed by ICMV-IS-94206 with 259 cm and Zango with 254 cm. Generally the mean height of the various genotypes was reduced in the second trial in 2009.Monitoring the height of these genotypes also revealed significant difference (P=0.01). Zango had 183 and was the tallest. Zouna-3 had 157 cm, Zatib had 151 cm, ICMV-IS-89305 (150 cm). The shortest genotype in 2009 was PE05461 with 99.75 cm. The rest of the genotypes ranged from 101 to 148 cm height (Table 3). Similarly, the result of the combined mean plant height at 10 WAS revealed Zango as the tallest genotype with 218.75 cm followed by Zatib and Yola local with 198 cm each, ICMV-IS-89305 with 198 cm, Souna-3 had 197 cm, PE02650 with 192 cm. The shortest genotype was PE05461, with a height of 159.75 cm. Sosat-C88 had 168.75 cm, while Gwagwa, Ex-Borno, ICMV-IS-92222 had mean height ranging from 177.38 to 187.38 cm (Table 3).

3.3 Grain Yield For Twelve Pearl Millet Genotypes Assessed For Downy Mildew During The 2008 And 2009 Rainy Seasons.

The grain yield showed highly significant difference (P=0.01) among the different genotypes. The genotype ICMV-IS-89305 and Souna-3 had the highest yield of 3,900 kg ha^{-1} during the 2008 trial followed by Sosat-C88 with a yield of 3,775 kg ha^{-1}. However, PE04562 had the lowest yield of 1,375 kg ha^{-1} while Yola local recorded a yield o 1,800 kg ha^{-1} (Table 4). In 2009, there was highly significant difference (P=0.01) between the twelve genotypes. The result revealed that ICMV-IS-89305 had the highest yield of 2,725 kg ha^{-1}, followed by Souna-3 with 2,700 kg ha^{-1}. The genotype with the lowest yield was PE04561 which recorded 1,200kg ha^{-1} (Table 4). The result of the combined analysis indicated a highly significant difference (P=0.01) among the different genotypes. The result indicated that ICMV-IS-89305 recording the heights yield of 3,312.50 kg ha^{-1}, followed by Souna-3 with 3,300 kg ha^{-1}. The genotype with the lowest yield was PE04561 (1,287 kg ha^{-1}) and Yola Local with 1,600 kg ha^{-1} (Table 4).

Table 1: Effect of downy mildew severity on pearl millet genotypes during 2008 and 2009 rainy seasons

Genotypes	Severity of Downy mildew for 2008 (WAS)			Severity of Downy mildew for 2009 (WAS)			Yield (kg ha^{-1})	
	4	6	8	4	6	8	2008	2009
Ex-Borno	68.00ab	69.00abc	69.00ab	45.50ab	57.50a	91.50abc	2,400bcd	1,550d
Sosat C88	65.00ab	67.75abc	67.27	48.55ab	61.00a	81.00bc	3,775c	2,500ab
PE 05461	69.50ab	69.00abc	69.00ab	46.50ab	59.50a	82.00abc	1,375d	1,200d
Gwagwa	71.75a	72.25abc	73.25a	47.75ab	62.00a	93.00ab	3,075abc	2,025abcd
Zatib	69.00ab	73.00a	70.25ab	47.50ab	58.00a	95.50a	2,750abcd	2,075abcd
ICMV-IS-94206	66.00ab	70.50abc	69.00ab	49.25ab	62.50a	88.00abc	2,375bcd	1,625bcd
ICMV-IS-92222	69.50ab	69.00abc	71.50a	50.50a	59.50a	85.00abc	1,975cd	1,675bcd
ICMV-IS-89305	61.25ab	71.00abc	65.25ab	36.00ab	57.50a	91.00abc	3,900a	2,725a
Sauna-3	60.00b	65.25abc	62.50b	46.75ab	61.00a	90.50abc	3,900a	2,700a
Zango	60.00ab	62.50c	62.50b	43.50ab	64.00a	79.00c	2,375bcd	1,950abcd
PE 02650	71.00ab	73.25bc	73.00a	46.00ab	59.00a	94.00ab	3,250abc	2,250abc
Yola Local	61.50	68.83	63.00b	34.50b	47.50a	42.50d	1,800cd	1,400cd
CV	10.27	7.99	7.61	19.36	17.51	9.80	31.93	27.40

Means in the same column followed by the same letters are not significantly different (P=0.05) using Duncan's Multiple Range Test; CV= coefficient of variation, WAS= weeks after sowing

Table 2: Mean number of tillers produced per plant for twelve genotype assessed for downy mildew at 7 WAS in 2008, 2009 cropping seasons and combined

Genotypes	2008	2009	Combined
Ex-Borno	8.00bc	6.75b	7.25bc
Sosat C88	7.25bc	6.75b	7.75c
PE 05461	6.25c	7.50ab	6.88c
Gwagwa	6.50c	8.00ab	7.25bc
Zatib	7.25bc	8.00ab	7.63bc
ICMV-IS-94206	7.00bc	9.25a	8.13c
ICMV-IS-92222	7.00bc	6.00b	6.50c
ICMV-IS-89305	7.50bc	7.25ab	7.32bc
Sauna-3	9.00b	7.75ab	8.37c
Zango	7.75bc	10.25a	9.00b
PE 02650	6.75c	7.00ab	6.88c
Yola Local	13.75a	13.00a	13.37a
CV	7.83	8.25	8.04
Prob of F.	0.001**	0.01**	0.001**

Means in the same column followed by the same letters are not significantly different (P=0.05) using Duncan's Multiple Range Test; CV= coefficient of variation

Table 3: Mean plant height of the twelve pearl millet genotypes assessed for downy mildew infection at 10 WAS in 2008, 2009 cropping seasons and combined

Genotypes	2008	2009	Combined
Ex-Borno	233.75bcd	121.50ab	177.38ab
Sosat C88	236.00abcd	101.50b	168.75abc
PE 05461	224.75d	99.75b	159.75cd
Gwagwa	226.75cd	148.00ab	187.38bc
Zatib	245.25abcd	151.00ab	198.13aab
ICMV-IS-94206	259.75ab	123.75bc	191.75ab
ICMV-IS-92222	237.75abcd	124.50bc	181.13bcd
ICMV-IS-89305	244.50abcd	150.75abc	197.63ab
Sauna-3	236.25abcd	157.00ab	196.63ab
Zango	254.50abc	183.00a	218.75a
PE 02650	248.50abcd	134.50bc	191.00ab

Yola Local	265.25a	130.75bc	198.00ab
CV	242.52	128.94	185.00
Prob of F.	0.002**	0.001**	0.001**
Means in the same column followed by the same letters are not significantly different (P=0.05) using Duncan's Multiple Range Test; CV= coefficient of variation			

Table 4: Yield of twelve pearl millet genotypes assessed in 2008, 2009 cropping seasons and combined

Genotypes	2008	2009	Combined
Ex-Borno	2,400.00bcd	1,550.00d	1,975.00cdef
Sosat C88	3,775.00a	2,500.00ab	3,137.50ab
PE 05461	1,375.00d	1,200.00d	1,287.50f
Gwagwa	3,075.00abc	2,025.00abcd	2,550.00abcd
Zatib	2,750.00abc	2,075.00abcd	2,412.50bcd
ICMV-IS-94206	2,375.00bcd	1,625.00bcd	2,000.00cdef
ICMV-IS-92222	1,975.00cd	1,675.00bcd	1,825.00def
ICMV-IS-89305	3,200.00a	2,725.00a	3,312.50a
Sauna-3	3,200.00a	2,700.00a	3,300.00a
Zango	2,375.00bcd	1,950.00abcd	2,162.50cde
PE 02650	3,250.00cd	2,250.00abc	2,750.00abc
Yola Local	1,800.00cd	1,400.00cd	1,600.00ef
CV	31.93	27.40	30.27
Prob of F.	0.001**	0.008**	0.001***
Means in the same column followed by the same letters are not significantly different (P=0.05) using Duncan's Multiple Range Test; CV= coefficient of variation			

4. DISCUSSION

Tillering is one of the most important components of yield in cereals particularly millet [4]. Tillering is controlled by environmental factors such as disease and internal factors (physiological make up) at the seedling stage. Also the research work has agreed with the statement of Mehrotra and Aggarwal [8] which stated that, downy mildew infected plant becomes dwarfed because of shortening of the internodes which also triggered excessive tillering. Gupta and Singh [3] also reported increase in aerial tiller number with increase in disease grade. This is because most of the genotypes, exceeded their tillering capacities as reported by ICRISAT [7]. ICMV-IS-89206, Souna-3 and Sosat C88 had been reported to have an average of 4 tillers each, but the findings of this study revealed that ICMV-IS-89206 had average tillers of 8, Souna-3 (8), and Sosat C88 had 6 tillers [6]. The local genotype, Yola local had the highest number of tillers of up to 14 and is the most infected genotype by the disease. Hence it has the highest number of tillers among the genotypes which is one of the symptoms of severe infection of downy mildew. Onwueme [11] reported that tillers of infected plant showing signs of secondary infection grow very little and form few or no head. However, Carberry et al. [2] reported that pearl millet exhibits considerable plasticity in this response to population density with adequate management and environmental condition, grain yield reaches a plateau over the range of 15-40 plant per meter square. Therefore, considerable reduction in plant population is recorded when tiller die off or produce no head at all leading to significant loss of yield. Since tillers are components of yield as expressed by Harper [4] and highly infected plants by downy mildew produces excessive tillers that die-off later to produce no head at all. Therefore, significant loss of yield was recorded owing to the severe infection observed in this study. Mogle and Mayee [9] attributed the positive correlation between downy mildew infection and straw yield of pearl millet as noticed due to increase tillering induced by the disease.

Similarly, record of average plant height revealed that there is considerable variation amongst the height of these genotypes at different weeks after sowing and also with the second trials. The combined analysis of variance showed that Yola local, Souna-3, Zatib and ICMV-IS-89206 were the tallest genotypes whilePE05461 was the shortest genotype with 159.75 cm. The variation ranges from 160-198 cm. According to Harper [4], plant heights which is component of plant growth analysis is valuable in explaining response of plants to changes in the environmental factors, in this study, disease is the environmental factor under consideration which caused reduction in height in pearl millet. Gupta and Singh [3] recorded gradual but significant differences in plant height and straw yield in highly infected plants. Production of auxins was lowered in downy mildew infected tissues and this might have contributed to the difference in the plant heights. Mogle and Mayee [9] reported drastic alteration in metabolic regulation which causes morphological abnormalities

might have been responsible for the significant reduction in vegetative growth.

However, it is interesting to note that one of the symptoms of downy mildew on pearl millet according to Mehrotra and Aggarwal [8] is stunted growth or dwarfism due to shortening of the internodes and the leaves have brown streaks. This research has agreed with this fact because all of the genotypes descriptive heights have not been attained. For instance, ICMV-IS-92222 was said to have 250 cm in height, Souna-2 (225 cm) and Sosat C88, 220 cm as reported by ICRISAT (1992). However, during the study ICMV-IS-92222 measured 181 cm, Souna-3 (196 cm) and Sosat –C88 recorded 169 cm in their respective combined results. These reductions in heights could be attributed to disease infection as reported by ICRISAT [6] as against the findings of this study. Souna-3 was said to have 225 cm height as against 196 cm recorded in this study and Sosat–C88 which was reported to have 180-220 cm in height but measured 169 cm in the combine result of this study. Therefore, downy mildew can be considered to have negative effect on plant height.

This study revealed that downy mildew has severe effect on plant height and cause profuse tillering effect. Thus reducing the plant height and increasing the tillering of pearl millet. The local genotype Yola local gave the highest number of tillers followed by Zango and Souna-3. Nevertheless, the remaining genotypes gave similar level of tillering effect in relation to the disease. However, some genotypes despite the disease pressure gave appreciable yield, probably owing to their level of tolerance to the disease or their ability of possession of disease recovery traits. ICMV-IS-89305, Souna-3 and Sosat C88 gave the highest yield while the local genotype and one with the highest number of tiller gave a low yield. In terms of plant height, Zango was the tallest followed by Zatib, ICMV-IS-89305 and Souna-3 respectively. Even though there were reductions in the various heights of these mentioned genotypes, little effect of the disease was observed on their respective yields.

From the above observation, the following recommendations are made; ICMV-Is-89305, Souna-3 and Sosat C-88 should be put to further trials to ascertain their level of tolerance or otherwise to the disease in the study area as they appear promising in terms of yield despite the disease pressure. The local genotype, Yola local could be considered for breeding work with the view of incorporating resistance to the disease and also owing to its level of reaction to downy mildew in terms of establishment, height and tillers.

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