

Millet Downy Mildew [*Sclerospora Graminicola* (Sacc.) Schroet.], Prevalence And Incidence Of The Disease In Rural Areas In The Municipality Of Ichirnawa

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Abstract

Background: Pearl millet ranks first among cereals produced and consumed in Niger. However, its production is hampered by multiple constraints, both abiotic and biotic. Among the biotic constraints, pearl millet downy mildew disease caused by *Sclerospora graminicola* is one of the most destructive diseases causing losses of up to 50% in rural areas. The objective of this study is to determine the prevalence of this disease on the one hand and to assess the incidence of pearl millet downy mildew in rural areas commune of Ichirnawa on the other.

Materials and Methods: A total of 100 fields in 20 administrative villages were surveyed. Five (5) fields per village were surveyed and in each field five (5) elementary plots composed of one hundred (100) pockets were materialized for the assessment of the prevalence and incidence of the disease.

Results: Out of a total of 50,000 pockets assessed, 13,627 pockets showed symptoms of the disease, representing an average overall incidence of 27.25% for the municipality and a prevalence of 98%. The lowest average prevalence was observed in Ganoua Haoussa (40.44%). In the northern zone of the municipality, the incidence of the disease varies from 4% in Barawa Haoussa to 17% in Barawa Kosga. In the center, it varies from 21% in Ganoua Bougagé to 45% in Bainaka and reaches 46% in Ichirnawa in the south of the commune. The study revealed that pearl millet downy mildew disease is present in all peasant fields in the municipality of Ichirnawa with a variability in the infection rate from one village to another and from one zone to another.

Keywords: Ichirnawa, Pearl millet, Downy mildew, Prevalence, Incidence

Date of Submission: 15-08-2024

Date of Acceptance: 25-08-2024

I. Introduction

Millet [*Pennisetum glaucum* (L.) R. Br.], is a major subsistence food crop in the Sahel region of West Africa where it constitutes the staple diet of several million people^{1,2}. Compared to other cereals, millet is drought tolerant and can survive in harsh environmental conditions and is often grown on marginal lands in several countries. In Niger, millet cultivation is practiced in all production zones and ranks first among cereals produced and consumed in the country³. The area and production of millet in Niger continue to increase from year to year. In 2022, 6,780,623 ha were harvested for a production of 3,656,958.05 tonnes against 6,743,482 ha resulting in a production of 3,508,902.54 tonnes in 2020⁴. Compared to India, Nigeria, China and even some other African countries, the millet yield in Niger is still low which is 539.32 Kg/ha in 2022 against 1395.97 Kg/ha in India, 970.61 Kg/ha in Nigeria and 2999.52 Kg/ha in China for the same year⁴.

The low yield of millet per hectare in Niger and other African countries can be attributed to several factors such as weather conditions, low use of improved varieties, low use of fertilizers, pests and diseases^{5,6,7}. The damage results in reduced growth or even destruction of the affected plant, depreciation of seed quality^{3,8,9}. Some fungal diseases can cause yield losses of up to 100% when susceptible varieties or cultivars are grown. Millet downy mildew caused by a fungus *Sclerospora graminicola*, has proven to be the most destructive disease^{10,11}. It causes stunted growth and partial or total transformation of the ear into leafy organs or total death of the plant^{11,12}. Annual losses in grain yield due to millet downy mildew are estimated at between 10 and 50% in rural areas^{13,14}. In Niger, Issa et al.¹⁵ found incidences that vary from 0.6 to 31.8% in rural areas.

This research work has a dual objective: to determine the prevalence on the one hand and the incidence on the other hand of millet downy mildew during cultivation in a peasant environment.

II. Materials And Methods

Study location: The study took place in the rural commune of Ichirnawa located in the Center East of the department of Kantché in the Zinder region of Niger. The municipality is bordered to the East by the municipality of Doungou and Droum, to the North by the municipality of Garagoumsa and Tirmini, to the West by the municipality of Kantché and Matameye and to the South by the municipality of Doungou and Matameye.

Located between 13°40'30'' and 13°24'00'' North latitudes and 8°28'00'' and 8°44'30'' East longitudes (Figure 1), it covers an area of 395.8 km² and has approximately 61,054 inhabitants¹⁶.



Figure 1: Geographical location of the commune of Ichirawa

The climate of the area is of the Sahelo-Sudanian type characterized by a long dry season from October to May and a rainy season from June to September. Precipitation varies between 350 and 650 mm of rain per year. The soils of the municipality are of tropical ferruginous types with sandy texture. Rainfed agriculture constitutes the main activity of the population. It is dominated by the cultivation of millet which is mainly done in association with sorghum or leguminous crops such as cowpea and peanut.

III. Methodology

A total of 100 peasant millet fields selected randomly from North to South were surveyed at the physiological maturity stage in twenty (20) administrative villages distributed as follows: six (6) villages in the North, nine (9) villages in the Center and five (5) villages in the South. The prevalence and incidence of millet downy mildew disease are assessed. At the level of each village, five (5) fields are surveyed and in each field, five (5) elementary plots are materialized using a W-shaped pattern¹⁷. Each elementary plot is made up of one hundred (100) millet pockets and the number of pockets showing symptoms of downy mildew is counted (Figure 2).

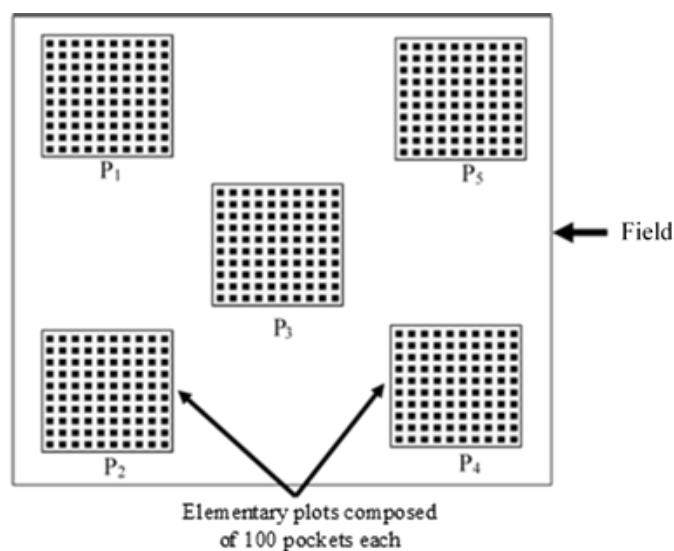


Figure 2: Arrangement of elementary plots in a field

Prevalence is the percentage of elementary plots that have at least one millet plant attacked by mildew. It is calculated using the formula below:

$$\text{Prevalence} = \frac{\text{Number of elementary plots with disease symptoms}}{\text{Total number of elementary plots observed}} \times 100$$

Incidence is the percentage of millet plants attacked by mildew. It is calculated using the formula below:

$$\text{Incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants}} \times 100$$

IV. Results

The majority of the prospected fields are sown with local varieties, only a few are sown with improved varieties from the National Institute of Agronomic Research of Niger (INRAN). Table 1 presents the geographical coordinates of the villages whose fields are prospected.

Zone	Villages	Altitude	Longitude
North	Angoal Gao	N13°40'31,99"	E8°38'13,80"
	Babadou	N13°39'43,32"	E8°36'46,56"
	Daratchama	N13°37'34,32"	E8°37'39,52"
	Barawa Haoussa	N13°38'46,04"	E8°33'22,25"
	Barawa Bougagé	N13°36'27,42"	E8°32'34,20"
	Barawa Kosga	N13°32'45,72"	E8°38'15,84"
Center	Alfa	N13°34'25,62"	E8°34'35,28"
	Dawan Marké	N13°34'28,92"	E8°36'10,26"
	Ganoua Haoussa	N13°33'39,72"	E8°31'56,28"
	Ganoua Bougagé	N13°31'33,72"	E8°37'50,76"
	Bainaka	N13°33'33,42"	E8°37'38,28"
	Falé-Falé	N13°30'55,14"	E8°35'33,04"
	Ganawa Haoussa	N13°31'34,42"	E8°37'48,26"
	Ganawa Bougagé	N13°31'16,00"	E8°37'3,01"
Tachéri	N13°30'32,52"	E8°37'25,87"	
South	Bossossoua	N13°40'40,14"	E8°31'48,33"
	Ichirnawa	N13°29'47,52"	E8°33'2,23"
	Marékou	N13°29'8,89"	E8°35'13,72"
	Tsannou	N13°28'28,47"	E8°40'17,61"
	Zongon Boutou	N13°27'49,12"	E8°38'27,94"

The cropping systems used by producers are pure millet cultivation and associated crops. Among the associations, the most common are millet-sorghum, millet-sorghum-cowpea, millet-peanut associations. The types of symptoms of downy mildew disease encountered at the maturity stage of millet are necrotic coloration, partial or total transformation of the ear into a witch's ballet shape (figure 3).

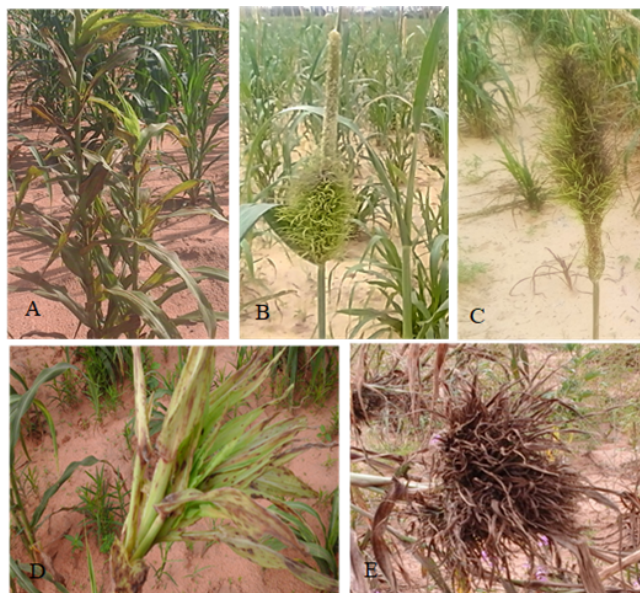


Figure 3: Symptoms of millet downy mildew at the maturity stage: A) Necrotic coloration of the plant, B) Partial transformation of the ear, C, D and E: Total transformation of the ear

All the fields surveyed are infested with millet downy mildew. The prevalence and incidence of the disease were determined for each field on 500 pockets. Only (6%) of the fields have a prevalence of less than 100%. The incidence of the disease varies from 1% in the fields of Babadou in the North to 64% in the fields of Ichirnawa in the South. Thirteen percent (13%) of the fields surveyed have an incidence of less than or equal to 10%, twenty-nine percent (29%) have a moderate incidence of between 10% and 20%, fifty-six percent (56%) of the fields have an incidence of between 20% and 50% and two percent (2%) of the fields have an incidence of more than 50% (Figure 4). During this survey, out of a total of 50,000 millet pockets examined, 13,627 pockets showed symptoms of the disease, representing an average overall incidence of 27.25% and an average prevalence of 98% for the municipality.

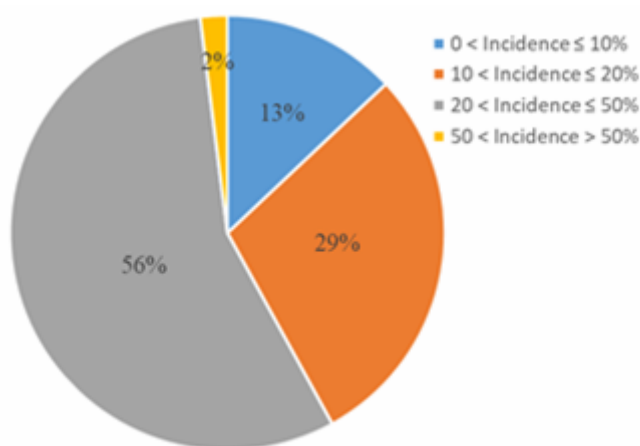


Figure 4: Percentage of fields surveyed according to millet downy mildew disease

Table 2 gives the incidences and average prevalences of the fields surveyed by village. The lowest average prevalences are observed in Ganoua Haoussa (40.44%) in the center of the municipality, in Babadou (60.24%) and in Angoal Gao (80.12%) in the North zone. The villages in the North zone have the lowest incidences of the disease which vary from 4% in Barawa Haoussa to 17% in Barawa Kosga. On the other hand, the villages in the center of the municipality recorded the highest incidences of the disease varying from 21% in Ganoua Bougagé to 45% in Bainaka. In the South of the municipality, the average incidence per village reaches 46% in Ichirnawa against 20% in Zangon Boutou.

Zone	Village	Incidence (%)	Prévalence (%)
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North	Barawa Bougagé	16,00	100
	Barawa Kosga	17,00	100
	Barawa Haoussa	4,00	100
	Daratchama	15,00	100
	Babadou	8,00	60,24
	Angoal Gao	10,00	80,12
Center	Falé-Falé	42,00	100
	Ganawa Bougagé	41,00	100
	Ganawa Haoussa	41,00	100
	Tachéri	43,00	100
	Bainaka	45,00	100
	Dawan Marké	43,00	100
	Alfa	20,00	100
	Ganoua Haoussa	26,00	40,44
South	Zongon Boutou	20,00	100
	Marékou	35,00	100
	Tsannou	24,00	100
	Ichirnawa	46,00	100
	Bossossoua	28,00	100

For the zones, the prevalence of millet downy mildew disease varies from 90.06% in the northern zone of the municipality to 100% in the southern zone. The average incidence is 11.67% in the North against 35.78% in the Center and 30.60% in the South of the municipality (Table 3).

Zone	Incidence (en %)	Prévalence (%)
North	11,67	90,06
Center	35,78	93,38
South	30,60	100

V. Discussion

In Niger, millet plays a vital role in the daily survival of the population and their livestock. However, cultivation is hampered by biotic stresses and, with climate change, diseases caused by fungal, bacterial and viral microorganisms are likely to increase. Due to the lack of information on the occurrence and distribution of millet diseases, especially those of economic importance in Niger, this study was undertaken.

The study showed that the disease is present in all the fields surveyed with variability in the level of infestation. Indeed, the average prevalence of the disease at the village level varies from 40.44% to 100% with an overall average of 98% for the municipality. These results confirm those of Issa et al.⁹ who reported the presence of millet downy mildew in all millet production fields in Niger.

In this study, the incidence of millet mildew disease shows a variability ranging from 4% in Barawa Haoussa to 46% in Ichirnawa with an average of 27.25% for the municipality. Regarding zonal division, the fields of the villages of the North presented the lowest incidences varying from 4% in Barawa Haoussa to 17% in Barawa Kosga with an average for the zone of 11.67%. While the incidence of millet mildew disease reaches 45% in Bainaka in the center of the municipality with a zonal average of 35.78% and 46% in Ichirnawa in the South with a zonal average of 30.60%. Pande et al.¹⁸ reported a variability of the incidence of millet mildew disease in rural areas in Niger from 1% to more than 50%. Similarly, a survey carried out by Issa et al.¹⁵ on 39 fields in five (5) millet-producing regions in Niger in a farming environment showed that all fields are infected with millet downy mildew with an incidence ranging from 0.6 to 31.8%.

During this study, the incidence of the disease was low ($\leq 10\%$) in 13% of the fields surveyed. These fields are located in the northern part of the municipality. On the other hand, in 56% of the fields surveyed, mainly located in the center of the municipality, the incidence of this disease is between 20 and 50%. Only 2% of the fields, all in the southern part, particularly those in the villages of Tachérie (54%) and Ichirnawa (64%), have an incidence greater than 50%. Similar to this work, Sharma et al.¹⁹ reported that out of a total of 97 fields surveyed in farms in the districts of Uttar Pradesh in India, millet downy mildew disease was found in 86 fields (89%) with an incidence ranging from 2 to 100%. A study on the incidence of millet downy mildew disease in farming areas in Niger conducted by Issa et al.⁹ revealed that 58% of the surveyed fields have a low incidence ($\leq 10\%$) and 18.4% have a high incidence of this disease (incidence $>20\%$). The variation in the incidence of the disease observed from the North to the South of the municipality can be explained by the climatic conditions

(humidity and temperature), the South being more watered than the North. Issa et al.⁹ reported that humidity is a determining factor in the development of plant diseases, and that the decrease in the amount of rainfall in an area can disadvantage the development of plant diseases in general and that of millet downy mildew in particular.

VI. Conclusion

Management of millet downy mildew disease, particularly providing farmers with sources of genetic resistance to this economically important disease, will be critical to ensuring food security. Thus, this work, which is in addition to others, is important because once again, it provides millet researchers, students, funding agencies and the Government of Niger with a guide on the incidence, prevalence and “hot spots” (fields and locations with an incidence of more than 50%) where millet downy mildew disease can be assessed to identify sources of resistance. The study revealed that millet downy mildew disease is present in all farmers’ fields in Ichirawa municipality with variability in infection rate from village to village and from area to area.

Acknowledgements

The author thanks Mr Rabé Maman, Mr Amirou Oumarou and Mr Moussa Nouhou for their collaboration and support in data collection.

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