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GERMPLASM EVALUATION OF PEARL MILLET [*Pennisetum glaucum* (L.) R. Br.] FOR DOWNY MILDEW INFECTION, AGRONOMIC TRAITS AND YIELD

Ati, M. H. and Ikpe, J. G.

Department of Crop Production and Protection, Federal University Dutsin-Ma, Dutsin-Ma, Katsina State, Nigeria

Authors email: *ahassna@fudutsinma.edu.ng ikpegodwinjude@gmail.com*

ABSTRACT

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the most suitable crop for arid and semiarid conditions because of its drought resistance compared to sorghum and maize. Farmers prefer the crop as low cost, low risk option not only by choice but also by necessity. The aim of the study was to characterize the millet varieties according to their performance, score for downy mildew and select those that are resistant to the infections, select for earliness and select varieties with the highest yield. The experiment was carried out in the Research Farm of the Department of Crop Production and Protection, Federal University Dutsin-Ma. Seventy-two new varieties of pearl millet collected from Niger Republic were sown during the rainy season. Randomized Complete Block Design was used for the field evaluation. The result from the research indicated that out of the seventy-two pearl millet varieties, forty-eight varieties were highly resistant (HR) to downy mildew, nine varieties were resistant (R) to downy mildew, twelve varieties were moderately resistant (MR) to downy mildew, while three varieties were moderately susceptible (MS) to downy mildew. Two varieties were extra early in maturity (65 days), three varieties were early maturing (70 days), and twenty-five varieties were mid-maturing (75 days), while forty-two varieties were late maturing (83 days). Seven varieties have low yield and did not perform well in the environment. Sixty-four varieties had average yield and variety (ISP 3974) had the highest yield. Therefore, they are recommended for advanced trials and subsequence breeding programmes.

Keywords: Resistant, Varieties, Pearl Millet, Downy Mildew, Yield, Susceptible.

INTRODUCTION

Among the millets, Pearl millet occupies 95% of the production (Yadav *et al*., 2012; Yadav and Rai, 2013; Agricultural Statistics, Government of India, 2014; Nedumaran *et al*., 2014). It is widely grown rain fed cereal crop in the arid and semi-arid regions of Africa and Southern Asia, and can be grown in areas where rainfall is not sufficient (200 to 600 mm/year) for the cultivation of maize and sorghum (National Research Council, 1996 in John *et al*., 2008). Pearl millet accounts for almost half of global millet production, with 60% of the cultivation areas in Africa, followed by 35% in Asian countries. European countries represent 4% of millet cultivation and North America only 1%, mainly for forage (National Research Council, 1996 in John *et al*., 2008). Today millet is a staple for more than 500 million people. Areas planted with pearl millet are estimated at 15 million hectares annually in Africa and 14 million hectares in Asia. Global production exceeds 10 million tons a year (National Research Council, 1996 in John *et al*., 2008). In sub-Saharan Africa, pearl millet is the third major crop with the major producing countries being Nigeria, Niger, Burkina Faso, Chad, Mali, Mauritania and Senegal in the West and Sudan and Uganda in the East (National Research Council, 1996). A significant portion of pearl millet grain is also used for non-food purposes such as poultry feed, cattle feed, alcohol extraction (Basavaraj *et at.*, 2010).

Downy mildew (DM) or 'green-ear' disease caused by *Sclerospora graminicola* (Sacc.) Schroet. occurs most destructively in Asia and Africa (Arya, and Kumar 1976; Nene and Singh, 1976; Rachieand Majmudar, 1980; Singh, 1995). The disease was considered of minor importance till 1970, as its incidence was sporadic on local cultivars. The first epidemic of downy mildew occurred in 1971 on the first popular pearl millet hybrid, HB 3, resulting in severe grain loss of about 4.6 million metric tons (Singh 1995), Singh *et al*., 1993). Because of continued large-scale cultivation of the susceptible hybrids, the disease caused serious epidemics during 1974, 1984, 1987 and 1988 (Arun *et al*., 2012). Millet has long been a staple for many civilizations, but research into its nutritional value and use is still new. (Railey *et al.*, 2001). Nutritional insecurity is a major threat to the world's population that is highly dependent on cereals-based diet, deficient in micronutrients. Next to cereals, millets are the primary sources of energy in the semi-arid tropics and drought-prone regions of Asia and Africa. Millets are nutritionally superior as their grains contain high amount of proteins, essential amino acids, minerals, and vitamins (Vinoth and Ravindhran, 2017).

The aim of the study was to characterize the millet varieties according to their performance, score for downy mildew and select those that are resistant to the infections, select for earliness and select varieties with the highest yield.

Pearl millet [Pennisetum *glaucum* (L.) R. Br.] Are the most widely grown crop and staple food and fodder crop of millions of poor rural families living in the northern part of Nigeria (FAOSTAT, 2007). The low yield of pearl millet in this area due to the incidence of downy mildew can lead to the shortage of food in the area. Therefore, there is a need for introducing new varieties that are resistant to downy mildew. This would reduce the level of losses caused by downy mildew in pearl millet farms and increase food availability in this part of the country. This research seeks to evaluate the germplasm of some varieties of pearl millet [Pennisetum *glaucum* (L.) R. Br.] From Niger Republic, in order to identify those that are resistant, those that are susceptible, as well as those that is higher yielding and early varieties. Downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet is the most widespread and destructive disease of pearl millet. The pathogen survives in soil for long duration and various downy mildew resistant hybrids released in past become susceptible. Due to this fact the disease has become a major limiting factor in the exploitation of high yield potential of hybrids in most countries (Sangwan, 2015; Arun and Manga, 2011).

MATERIALS AND METHODS

The material used in the study were germplasm of different varieties of pearl millet seeds collected from Niger Republic for preliminary study accessing their performance in the new environment (Dutsin-Ma, Katsina state, Nigeria).

Study Area

This research was carried out in the Department of Crop Production and Protection Research Farm of Federal University Dutsin-Ma Main Campus, Katsina State. Dutsin-Ma lies between latitude 12º 27’ 22’’N and longitude 7º 30’ 83’’E. The farm is situated within latitude 12^0 17’ 40’’N; and longitude 7^0 27’ 19’’E (Figure 1).

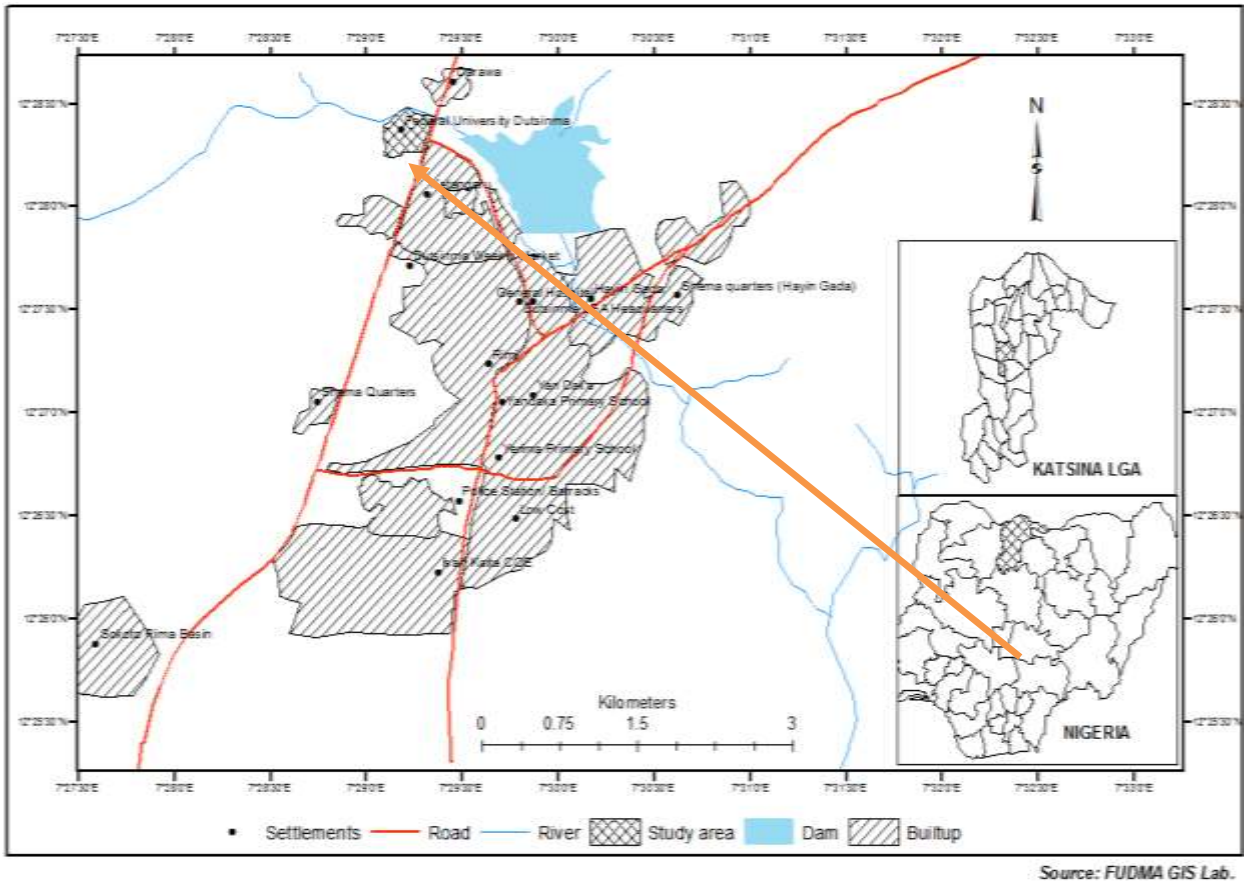

Fig. 1: Map of Katsina State showing Dutsin-Ma LG.A. /Federal University, Dutsin-Ma
Source: Modified from the Administrative Map of Katsina State.

The daily minimum and maximum temperatures range from 32ºC to 43ºC. Dutsin-Ma, in Katsina State experiences unimodal rainfall pattern with an annual rainfall of about 1100 mm, with a single peak in August. Dry season lasts for a minimum of

seven months (November-May) while the wet season spans June to October.

Design of the Study

The experimental design used was Randomized Complete Block Design (RCBD). There were two replications and in each replicate there were four blocks with 18 plots per block. The seeds were allocated to plots using random number table.

Data Analysis

Downy mildew incidence was calculated as:

Downy mildew incidence is expressed in percentage of the disease plants to the total number of plant per plot was measured by counting the number of infected/disease plant divide by the total number plant hills per plot multiplied by 100. This

$$DMI=\frac{Number\ of\ diseased\ plant}{Total\ number\ of\ plant\ per\ plot}\times 100$$ where DMI =Downy mildew incidence

Downy mildew incidence data were analyzed using Statistical Analysis System (SAS, 9.1, 2003).

For classifying the pearl millet genotypes the rating scale of Ball (1983) was adopted:

0-5% disease incidence = Highly Resistant (HR)
5-10% disease incidence = Resistant (R)
10-25% disease incidence = Moderately Resistant (MR)
25-50% disease incidence = Moderately Susceptible (MS)
50-80% disease incidence = Susceptible(S)
>80% disease incidence = Highly Susceptible (HS)

RESULTS AND DISCUSSION

From Table 1, forty-eight varieties were highly resistant (HR) to downy mildew, nine varieties were resistant (R) to downy mildew, twelve varieties were moderately resistant (MR) to downy mildew, while three varieties were moderately susceptible (MS) to downy mildew. Plate 1 showed various manifestation of Downy Mildew symptoms seen on the plants. Similar symptoms were observed by Ati (2020) in her work on millet. Thakur et al. (2003) observed the effect of certain cropping sequences in reducing downy mildew incidence in pearl millet. Removal and complete destruction of infected plants from the field has been recommended for the control of downy mildew (Thakur, 1980). This can reduce secondary spread of disease during the same season (Singh and Williams, 1980). Pearl millet crop sown very early in the season generally has a chance to escape the infection from *S. gramminicola* that sown late in the season due to less inoculum (sporangial) buildup and low infection by soil-borne oospores (Chahal et al., 1978; 1994). TWO varieties (ISP 3972 and ISP 3963) were extra early in maturity, ISP 93, ISP 3887 and ISP 2494 were early, twenty-five varieties were mid-maturing while forty-two were late maturing varieties. One variety (ISP 3974) had the highest yield, sixty-four varieties had average yield, while seven varieties had the lowest yield.

As presented in Table 2 the seventy-two varieties of pearl millet used in this research showed various levels of disease incidence ranging from 0% (39 varieties) to 33.5% (ISP 2509). ISP 2509 (33.5%), ISP 1281 (32.15%) and ISP 2490 (26.05%) showed moderately susceptible (MS) for disease incidence but had average yields of (204g, 136g and 111g respectively) were considered to be tolerant to the disease, i.e. they were attacked by the pathogens to the same degree as others but they suffered less damage with regard to yield. ISP 3974 (751g) gave the highest yield. Out of the seventy-two varieties of pearl millet, ISP 3974 (5%) which had the lowest value of disease incidence with yield of 751g, followed by Chatti (4.5%) with a yield of 453.5g were considered to be tolerant to the disease, i.e. they were attacked by the pathogens to the same degree as others but they suffered less damage with regard to yield. This indicates either a shift in virulence of the pathogen or a shift in resistance of germplasm used in this research. Similar results were obtained in Ati *et al*. (2013 and 2015). According to Thakur *et al*. (2009) a major change in disease incidence of pearl millet line over time at the same location reflected virulence shift in the pathogen population. Downy mildew pathogen is heterothallic and frequent recombination leads to genetic diversity and evolution of new virulent population. Hence, identification of resistance to new virulence population is a prerequisite for resistance breeding (Thakur *et al*., 2009). Among the seventy-two pearl millet varieties, forty-eight (ISP 2514, ISP 3878, ISP 2494, ISP 3859, ISP 3830, ISP 3833, ISP 3870, ISP 3931, ISP 3897, ISP 25, ISP 2517, ISP 3954, ISP 3953, ISP 3963, ISP 3964, ISP 2523, ISP 2499, ISP 3971, ISP 2874, ISP 3973, ISP 3917, ISP 3978, ISP 3980, ISP 3984, ISP 3938, ISP 3997, ISP 3999, ISP 4022, ISP 3958, ISP 4030, ISP 3886, ISP 72, ISP 3846, ISP 1282, ISP 1290, ISP 3905, ISP 94, ISP 3918, Jirani, ISP 23., ISP 3873, ISP 22, ISP 3974, ISP 2510, ISP 91, ISP 3923, Chatti and ISP 27 respectively) of the varieties were highly resistant (HR) to downy mildew incidence, nine varieties (ISP 73, ISP 26, ISP 3892, ISP 3948, ISP 96, ISP 3832,

ISP 3989, ISP 3972, ISP 3969) respectively were resistant (R) to downy mildew, twelve varieties (ISP 2505, ISP 3891, ISP 93, ISP 3876, ISP 3887, ISP 3836, ISP 3837, ISP 4032, ISP 3965, ISP 4026, ISP 21, and ISP 75) were moderately resistant (MR), while three varieties (ISP 2490, ISP 1281 and ISP 2509) respectively were the only moderately susceptible (MS) varieties among the seventy-two varieties studied.

Seed germination, vigor and size (three aspects of seed quality) may influence crop yield through both direct and indirect effects. The indirect effects include those on percentage emergence and time from sowing to emergence. These influence yields by altering plant population density, spatial arrangement, and crop duration (Elis, 1991). From table 2, the varieties with high resistance to the downy mildew also had low yield and poor germination. The poor germination leading to low yield is probably due to the fact that these varieties are new in the environment and have not adapted to the soil type and the climate which are completely different from that of Niger Republic. These varieties were known to be high yielding and have high rate of germination in Niger Republic (personal conversation with Scientist and field observation in Niger Republic during a visit to Niger Republic).

Table 1: Mean Performance of Seventy-Two Varieties of Pearl Millet for Downy Mildew Incidence and Yield

Varieties	DB	NSE	SdVig	DMI	PLTHT	PanLt	PanExs	PanCir	Pancom	SdSet	NPH	PanWt/g	GWt/g	TH%
ISP 3905	79.00a	6.50b-f	1.50ab	0.00d	240.00a-d	63.00a-f	16.00ab	8.15a-d	3.00abc	2.50ab	1.50e	40.0c	18.5c	44.25a-e
ISP 2494	39.00bcd	6.00b-f	2.00ab	0.00d	217.00a-f	42.00c-h	11.50ab	10.15a-d	3.50abc	2.00ab	2.50de	65.5c	29.5c	22.50b-e
ISP 2523	83.00a	8.50b-f	3.00ab	0.00d	236.50a-e	55.50a-h	11.50ab	6.95a-d	2.00abc	1.00ab	1.00e	39.5c	16.0c	20.50de
ISP 3964	74.00ab	11.50b-d	4.50ab	0.00d	214.00a-f	57.75a-h	12.50ab	10.75a-d	4.50ab	3.50ab	16.00b-e	530.5abc	254.5bc	48.50a-e
ISP 3931	81.50a	11.00b-e	3.00ab	0.00d	214.00a-f	38.50d-h	8.50ab	8.70a-d	4.00abc	3.00ab	12.00b-e	321.0bc	155.0bc	40.00a-e
ISP 2514	78.00a	8.00b-f	3.50ab	0.00d	191.00a-g	37.00d-h	6.50ab	6.25bcd	3.50abc	3.00ab	16.50b-e	383.5bc	175.5bc	45.20a-e
ISP 26	74.00ab	11.00b-e	3.00ab	6.00cd	202.00a-f	44.50b-h	11.25ab	8.10a-d	3.00abc	2.00ab	8.50b-e	443.0bc	159.5bc	34.20a-e
ISP 3876	74.00ab	10.50b-e	4.50ab	11.10bcd	228.50a-f	62.00a-f	10.75ab	9.15a-d	3.00abc	2.00ab	20.00b-e	763.5abc	305.0bc	34.25a-e
ISP 2509	76.50a	10.00b-f	3.00ab	33.50a	215.50a-f	42.00c-h	6.50ab	8.40a-d	2.50abc	2.50ab	13.00b-e	358.0bc	204.0bc	54.70a-e
ISP 3837	76.50a	12.00a-d	5.00a	15.60a-d	207.50a-f	40.00d-h	11.00ab	7.30a-d	4.00abc	3.00ab	24.50bc	616.5abc	281.5bc	46.00a-e
ISP 72	76.00a	1.50f	1.50ab	0.00d	191.50a-g	37.25d-h	7.75ab	9.55a-d	1.50abc	1.00ab	1.00e	43.5c	17.5c	20.10de
ISP 23	74.00ab	7.50b-f	3.00ab	5.00cd	220.00a-f	49.25a-h	1.25ab	8.80a-d	3.00abc	3.00ab	10.50b-e	332.5bc	187.5bc	57.90a-d
ISP 3958	76.50a	3.50d-f	2.50ab	0.00d	186.00a-g	47.50b-h	10.00ab	9.25a-d	1.50abc	2.00ab	8.00b-e	229.0bc	100.0bc	43.50a-e
ISP 3873	75.00ab	7.00b-f	3.00ab	5.00cd	232.00a-f	44.00b-h	9.00ab	9.40a-d	5.00a	4.00ab	8.50b-e	369.0bc	200.5bc	54.65a-e
ISP 3938	75.00ab	6.00b-f	2.50ab	0.00d	209.50a-f	44.00b-h	11.50ab	9.00a-d	3.00abc	3.50ab	8.50b-e	346.0bc	179.5bc	51.25a-e
ISP 22	71.00abc	8.50b-f	3.50ab	5.00cd	210.00a-f	50.50a-h	2.50ab	9.35a-d	1.50abc	2.50ab	22.00b-e	803.5abc	385.5bc	48.25a-e
ISP 3878	75.00ab	8.00b-f	2.50ab	0.00d	223.50a-f	45.50b-h	6.00ab	9.70a-d	4.00abc	3.00ab	18.50b-e	577.5abc	303.0bc	53.25a-e
ISP 3836	78.00a	6.50b-f	2.00ab	12.50bcd	211.00a-f	53.00a-h	15.50ab	11.60a-d	3.50abc	2.50ab	6.00c-e	221.5bc	98.0bc	48.00a-e
ISP 3980	78.00a	9.00b-f	2.50ab	0.00d	226.00a-f	32.00d-h	10.50ab	6.10bcd	2.00abc	1.50ab	10.50b-e	446.0bc	189.0bc	21.20c-e
ISP 4032	72.50ab	9.00b-f	2.50ab	16.50a-d	181.00a-g	31.25d-h	6.00ab	7.80a-d	2.50abc	2.50ab	11.50b-e	339.0bc	135.0bc	35.15a-e
ISP 3846	79.00a	7.00b-f	3.00ab	0.00d	282.50a	62.00a-f	5.00ab	11.10a-d	2.50abc	1.50ab	16.00b-e	546.5abc	181.5bc	33.10a-e
ISP 3891	69.00abc	8.00b-f	3.00ab	10.00bcd	212.50a-f	55.50a-h	9.00ab	11.10a-d	2.00abc	2.50ab	10.00b-e	515.0abc	220.0bc	44.20a-e
ISP 3973	73.00ab	5.50c-f	3.00ab	0.00d	201.50a-g	50.50a-h	9.00ab	9.60a-d	2.00abc	3.50ab	14.00b-e	497.5bc	289.5bc	54.50a-e
ISP 2505	78.00a	4.00d-f	1.00b	10.00bcd	241.50a-d	41.50c-h	5.50ab	7.65a-d	2.00abc	0.500b	1.50e	64.5c	29.0c	22.50b-e
ISP 4026	77.50a	8.50b-f	2.50ab	17.60a-d	225.00a-f	63.00a-f	18.00ab	10.80a-d	2.50abc	2.00ab	6.50b-e	213.5bc	100.0bc	40.00a-e
ISP 3984	78.00a	13.50abc	4.00ab	0.00d	220.50a-f	50.00a-h	18.75ab	9.20a-d	4.50ab	3.50ab	12.00b-e	423.0bc	204.0bc	50.25a-e
ISP 2490	78.00a	10.00b-f	2.50ab	26.05ab	182.00a-g	49.00a-h	6.50ab	6.55bcd	1.50abc	3.50ab	5.00c-e	199.5bc	111.0bc	56.25a-e
ISP 3969	76.50a	8.00b-f	2.00ab	8.50bcd	217.50a-f	58.00a-h	13.00ab	8.20a-d	5.00a	3.50ab	14.50b-e	620.0abc	324.5bc	50.00a-e
ISP 4030	76.50a	10.00b-f	3.00ab	0.00d	251.00abc	89.00a	20.25ab	8.05a-d	4.50ab	4.00ab	8.50b-e	429.5bc	250.5bc	58.20a-d
ISP 3923	78.00a	12.00a-d	4.00ab	4.55cd	216.50a-f	49.50a-h	12.50ab	8.80a-d	1.50abc	2.50ab	24.00bcd	889.0ab	366.5bc	40.70a-e
ISP 27	78.00a	8.00b-f	2.50ab	4.15cd	227.50a-f	59.50a-h	12.25ab	9.55a-d	3.00abc	3.50ab	10.00b-e	399.5bc	209.5bc	53.20a-e
ISP 3948	78.00a	10.50b-e	2.00ab	6.50cd	198.50a-g	49.00a-h	14.25ab	12.50ab	2.00abc	2.00ab	12.50b-e	386.5bc	171.0bc	43.00a-e
ISP 94	77.00a	5.00c-f	1.50ab	0.00d	229.50a-f	48.50a-h	4.00ab	7.60a-d	3.00abc	3.00ab	7.50b-e	260.0bc	121.0bc	41.60a-e
ISP 2510	78.00a	7.50b-f	2.50ab	5.00cd	194.00a-g	45.00b-h	21.00a	9.50a-d	4.50ab	4.00ab	9.50b-e	393.5bc	188.0bc	47.35a-e
ISP 73	76.50a	6.00b-f	2.00ab	5.55cd	249.00abc	66.00a-e	9.00ab	11.05a-d	4.00abc	2.50ab	5.50c-e	264.0bc	136.0bc	46.50a-e
ISP 3859	76.50a	10.00b-f	2.50ab	0.00d	217.00a-f	36.50d-h	7.50ab	8.10a-d	4.00abc	4.00ab	21.50b-e	655.0abc	355.5bc	54.50a-e

Table 1: Mean Performance of Seventy-Two Varieties of Pearl Millet for Downy Mildew Incidence and Yield (Continued)

Varieties	DB	NSE	SdVig	DMI	PLTHT	PanLt	PanExs	PanCir	Pancom	SdSet	NPH	PanWt/g	GWt/g	TH%
ISP 3892	78.00a	7.50b-f	2.50ab	6.50cd	211.50a-f	37.50d-h	2.50ab	10.00a-d	3.00abc	3.00ab	6.00c-e	273.5bc	136.0bc	49.80a-e
ISP 1290	81.50a	6.00b-f	1.00b	0.00d	178.00a-g	29.00d-h	7.50ab	7.15a-d	0.50c	2.00ab	0.50e	9.0c	4.5c	25.00b-e
Jirani	65.00a-d	20.00a	5.00a	0.00d	171.00b-g	19.40gh	0.00b	11.80a-d	5.00a	4.00ab	50.00a	539.0abc	324.5bc	60.00a-d
ISP 3953	74.00ab	5.50c-f	2.50ab	0.00d	239.00a-d	51.50a-h	7.50ab	10.40a-d	5.00a	3.00ab	9.00b-e	305.0bc	183.0bc	59.90a-d
ISP 3965	76.50a	9.00b-f	4.50ab	17.00a-d	237.50a-d	64.50a-e	16.50ab	11.80a-d	3.00abc	4.00ab	17.50b-e	573.5abc	320.5bc	55.75a-e
ISP 21	78.00a	10.00b-f	3.00ab	20.20abc	231.50a-f	55.50a-h	9.50ab	12.30abc	2.50abc	3.50ab	16.00b-e	609.0abc	288.5bc	43.65a-e
ISP 3999	73.00ab	10.50b-e	3.50ab	0.00d	227.00a-f	67.00a-d	13.50ab	10.20a-d	4.50ab	4.50a	13.00b-e	415.0bc	286.5bc	66.20ab
ISP 1281	75.50a	9.00b-f	2.50ab	32.15a	220.50a-f	57.50a-h	2.50ab	7.60a-d	1.00bc	2.00ab	5.50c-e	238.0bc	136.5bc	28.70a-e
ISP 3989	81.50a	6.50b-f	2.50ab	7.15bcd	202.50a-f	42.00c-h	6.00ab	7.25a-d	1.00bc	2.00ab	5.00c-e	159.0bc	68.0bc	21.50c-e
ISP 3974	74.00ab	11.50b-d	4.00ab	5.00cd	225.00a-f	56.50a-h	18.50ab	8.80a-d	3.00abc	4.50a	28.00b	1306.5a	751.0a	57.50a-d
ISP 3917	76.50a	8.50b-f	3.00ab	0.00d	242.50a-d	61.00a-f	3.50ab	10.00a-d	4.50ab	4.00ab	4.50c-e	133.5bc	79.5bc	63.00a-d
ISP 3978	74.00ab	6.00b-f	2.50ab	0.00d	221.00a-f	56.50a-h	14.00ab	9.55a-d	5.00a	4.00ab	19.00b-e	649.5abc	349.0bc	48.65a-e
ISP 3832	74.00ab	10.00b-f	1.50ab	6.65cd	194.00a-g	44.50b-h	8.00ab	8.20a-d	1.00bc	1.00ab	8.50b-e	224.0bc	77.0bc	37.15a-e
ISP 3897	72.50ab	5.00c-f	1.00b	0.00d	225.00a-f	47.50b-h	8.00ab	9.30a-d	3.00abc	4.00ab	9.50b-e	401.0bc	219.5bc	54.55a-e
ISP 75	77.00a	5.50c-f	2.50ab	21.00abc	210.00a-f	51.00a-h	1.50ab	7.40a-d	1.00bc	0.50b	2.50de	98.0bc	25.0c	13.00e
ISP 3972	35.00d	7.50b-f	3.00ab	7.70bcd	130.00e-h	33.50d-h	5.00ab	4.55cd	3.00abc	2.50ab	15.00b-e	486.0bc	169.5bc	37.20a-e
ISP 25	78.00a	6.50b-f	2.00ab	0.00d	201.50a-g	56.00a-h	9.00ab	11.70a-d	1.50abc	2.00ab	4.50c-e	285.5bc	143.0bc	25.05b-e
ISP 2499	74.00ab	5.50c-f	2.50ab	0.00d	204.00a-f	25.50e-h	5.00ab	9.15a-d	4.00abc	2.00ab	2.50de	162.5bc	34.5bc	30.65a-e
ISP 3997	72.50ab	10.50b-e	3.50ab	0.00d	234.50a-e	47.50b-h	7.50ab	9.95a-d	4.50ab	3.00ab	16.50b-e	579.5abc	222.5bc	41.80a-e
ISP 3918	76.50a	8.00b-f	2.00ab	0.00d	195.50a-g	55.50a-h	9.00ab	10.10a-d	3.00abc	4.00ab	9.50b-e	338.0bc	165.0bc	49.70a-e
ISP 3886	76.50a	11.00b-e	3.00ab	0.00d	225.00a-f	57.50a-h	13.00ab	12.45ab	2.00abc	4.00ab	15.50b-e	576.5abc	301.5bc	52.00a-e
ISP 3887	39.00bcd	4.50d-f	1.50ab	12.50bcd	97.00gh	23.00f-h	12.00ab	4.05d	0.50c	2.00ab	3.00c-e	130.0bc	75.0bc	29.00a-e
ISP 2517	76.50a	2.50ef	1.00b	0.00d	145.00c-h	39.50d-h	11.50ab	11.65a-d	2.50abc	2.00ab	3.50c-e	162.0bc	75.0bc	40.70a-e
ISP 3870	74.00ab	7.00b-f	2.00ab	0.00d	181.50a-g	33.75d-h	1.50ab	7.35a-d	3.00abc	4.00ab	6.50b-e	183.5bc	110.5bc	71.10a
ISP 1282	75.00ab	9.50b-f	3.00ab	0.00d	243.50a-d	84.00ab	12.50ab	6.20bcd	3.00abc	3.00ab	7.00b-e	280.0bc	116.5bc	44.55a-e
ISP 2874	73.00ab	9.50b-f	2.50ab	0.00d	203.00a-f	38.00d-h	12.00ab	7.55a-d	4.00abc	4.00ab	8.00b-e	228.0bc	116.5bc	51.60a-e
ISP 4022	74.00ab	12.00a-d	3.00ab	0.00d	184.50a-g	34.00d-h	2.75ab	5.95bcd	2.50abc	3.50ab	18.50b-e	510.5abc	256.5bc	49.20a-e
ISP 3833	78.00a	7.00b-f	1.00b	0.00d	197.00a-g	46.00b-h	5.50ab	6.00bcd	1.00bc	2.50ab	2.00e	92.5bc	52.5bc	28.50a-e
Chatti	65.00a-d	14.50ab	4.50ab	4.50cd	137.00d-h	20.00gh	0.00b	14.60a	2.00abc	4.50a	53.50a	757.0abc	453.5ab	60.35a-d
ISP 91	74.00ab	9.00b-f	3.00ab	4.55cd	223.00a-f	63.50a-f	13.50ab	9.65a-d	3.00abc	3.00ab	19.00b-e	512.5abc	244.0bc	46.50a-e
ISP 3830	74.00ab	8.00b-f	3.00ab	0.00d	189.00a-g	61.00a-g	6.50ab	6.25bcd	2.50abc	4.00ab	12.50b-e	328.5bc	166.0bc	49.50a-e
ISP 3954	78.00a	8.00b-f	3.50ab	0.00d	241.50a-d	54.50a-h	8.00ab	10.55a-d	5.00a	4.00ab	17.00b-e	576.0abc	331.0bc	57.55a-d
ISP 96	78.00a	7.00b-f	1.50ab	6.50cd	253.50ab	40.50d-h	12.25ab	10.60a-d	3.50abc	3.00ab	11.00b-e	176.5bc	127.5bc	65.05abc
ISP 3971	76.50a	5.50c-f	3.00ab	0.00d	242.50a-d	81.50abc	11.50ab	12.80ab	3.00abc	4.00ab	8.00b-e	459.5bc	245.5bc	53.65a-e
ISP 3963	37.50cd	8.00b-f	2.50ab	0.00d	127.00f-h	19.00h	10.50ab	7.90a-d	2.50abc	2.00ab	10.00b-e	457.0bc	235.5bc	26.00b-e
ISP 93	37.50cd	6.00b-f	1.50ab	10.00bcd	70.00h	30.00d-h	0.00b	6.45bcd	2.50abc	1.00ab	4.50c-e	211.5bc	95.0bc	22.50b-e
SE±	10.295	2.525	1.021	5.521	30.041	11.532	5.856	2.201	1.071	1.005	6.133	231.126	118.286	12.465

The means followed by the same letter(s) along the same column are not significantly different (Duncan's Multiple Range Test at P< 0.05).

Where; SE± = standard error, DB = days to 50% blossom, NSE = number of seedling established, SDVig = seedling vigor, DMI = downy mildew incidence, Pltht = plant height, PanLt = panicle length, PanExs = panicle exersion, PanCir = panicle circumference, PanCom = panicle compression, SdSet = seedset, NPH = number of panicle harvested, PanWt/g = panicle weight/grams, GWt/g = grain weight/grams, TH% = threshing percentage. Means with the same letter (s) within the same column and variety are not significantly different at 5% level of probability using Duncan's multiple range tests.

Plate 1: Downy Mildew manifestations

Table 2: Mean Performance of Seventy-Two Varieties of Pearl Millet for Downy Mildew Rating and Yield

S/N	Varieties	DMI	DMI Rating	GWt/g
1	ISP 3905	0.00d	HR	18.5c
2	ISP 2494	0.00d	HR	29.5c
3	ISP 2523	0.00d	HR	16.0c
4	ISP 3964	0.00d	HR	254.5bc
5	ISP 3931	0.00d	HR	155.0bc
6	ISP 2514	0.00d	HR	175.5bc
7	ISP 26	6.00cd	R	159.5bc
8	ISP 3876	11.10bcd	MR	305.0bc
9	ISP 2509	33.50a	MS	204.0bc
10	ISP 3837	15.60abcd	MR	281.5bc
11	ISP 72	0.00d	HR	17.5c
12	ISP 23	5.00cd	HR	187.5bc
13	ISP 3958	0.00d	HR	100.0bc
14	ISP 3873	5.00cd	HR	200.5bc
15	ISP 3938	0.00d	HR	179.5bc
16	ISP 22	5.00cd	HR	385.5bc
17	ISP 3878	0.00d	HR	303.0bc
18	ISP 3836	12.50bcd	MR	98.0bc
19	ISP 3980	0.00d	HR	189.0bc
20	ISP 4032	16.50abcd	MR	135.0bc
21	ISP 3846	0.00d	HR	181.5bc
22	ISP 3891	10.00bcd	R	220.0bc
23	ISP 3973	0.00d	HR	289.5bc
24	ISP 2505	10.00bcd	R	29.0c
25	ISP 4026	17.60abcd	MR	100.0bc
26	ISP 3984	0.00d	HR	204.0bc
27	ISP 2490	26.05ab	MS	111.0bc
28	ISP 3969	8.50bcd	R	324.5bc
29	ISP 4030	0.00d	HR	250.5bc
30	ISP 3923	4.55cd	HR	366.5bc
31	ISP 27	4.15cd	HR	209.5bc
32	ISP 3948	6.50cd	R	171.0bc
33	ISP 94	0.00d	HR	121.0bc
34	ISP 2510	5.00cd	HR	188.0bc
35	ISP 73	5.55cd	HR	136.0bc
36	ISP 3859	0.00d	HR	355.5bc

Table 2: Mean Performance of Seventy-Two Varieties of Pearl Millet for Downy Mildew Rating and Yield (Continued)

S/N	Varieties	DMI	DMI Rating	GWt/g
37	ISP 3892	6.50cd	R	136.0bc
38	ISP 1290	0.00d	HR	4.5c
39	Jirani	0.00d	HR	324.5bc
40	ISP 3953	0.00d	HR	183.0bc
41	ISP 3965	17.00abcd	MR	320.5bc
42	ISP 21	20.20abc	MR	288.5bc
43	ISP 3999	0.00d	HR	286.5bc
44	ISP 1281	32.15a	MS	136.5bc
45	ISP 3989	7.15bcd	R	68.0bc
46	ISP 3974	5.00cd	HR	751.0a
47	ISP 3917	0.00d	HR	79.5bc
48	ISP 3978	0.00d	HR	349.0bc
49	ISP 3832	6.65cd	R	77.0bc
50	ISP 3897	0.00d	HR	219.5bc
51	ISP 75	21.00abc	MR	25.0c
52	ISP 3972	7.70bcd	R	169.5bc
53	ISP 25	0.00d	HR	143.0bc
54	ISP 2499	0.00d	HR	34.5bc
55	ISP 3997	0.00d	HR	222.5bc
56	ISP 3918	0.00d	HR	165.0bc
57	ISP 3886	0.00d	HR	301.5bc
58	ISP 3887	12.50bcd	MR	75.0bc
59	ISP 2517	0.00d	HR	75.0bc
60	ISP 3870	0.00d	HR	110.5bc
61	ISP 1282	0.00d	HR	116.5bc
62	ISP 2874	0.00d	HR	116.5bc
63	ISP 4022	0.00d	HR	256.5bc
64	ISP 3833	0.00d	HR	52.5bc
65	Chatti	4.50cd	HR	453.5ab
66	ISP 91	4.55cd	HR	244.0bc
67	ISP 3830	0.00d	HR	166.0bc
68	ISP 3954	0.00d	HR	331.0bc
69	ISP 96	6.50cd	R	127.5bc
70	ISP 3971	0.00d	HR	245.5bc
71	ISP 3963	0.00d	HR	235.5bc
72	ISP 93	10.00bcd	R	95.0bc

The means followed by the same letter(s) along the same column are not significantly different (Duncan's Multiple Range Test at $P< 0.05$).

Where; *S =Susceptible, HS= highly susceptible, MS= moderately susceptible, MR= moderately resistant R = Resistant.* DMI = downy mildew incidence, DMI Rating = downy mildew rating, GWt/g = grain weght/gram.

CONCLUSION

The study was a preliminary trail to assess the performance of seventy two millet varieties from Niger Republic in Dutsin-Ma environment. Of the seventy two varieties fifty seven which were classified as highly and resistant respectively were selected. In selecting for earliness, two varieties that were extra early in maturity and three varieties that were early maturing were selected and characterized as early maturing. Twenty-five varieties were characterized as mid-maturing, while forty-two were late maturing varieties. Selecting for yield, one variety had the highest yield and was selected. Also, sixty-four varieties had average yield and were selected. Thus six-five were selected for yield. Those that are selected as highly resistant with good germination percentage, seedling vigor, seed set and yield are considered to have the best performance and can be selected for further evaluation while those with the lowest yield due to poor germination, downy mildew infection and poor seed set were rejected. The selected varieties are best suited for the Dutsin-Ma environment.

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