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EFFECT OF INTER- AND INTRA-ROW SPACINGS OF PEARL MILLET (*PENNISETUM GLAUCUM* (L) R.BR) INFECTED WITH DOWNY MILDEW (*SCLEROSPORA GRAMINICOLA* (SACC) SCHROET ON GRAIN WEIGHT IN KANO STATE, NIGERIA

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ABSTRACT

Field trials were carried out at the Teaching and Research farm of Kano University of Science of Technology, Wudil with two pearl millet varieties in 2003, 2004 and 2005 rain seasons to investigate the effect of inter- and intra-row spacings of pearl millet infected with downy mildew on grain weight in Kano State, Nigeria. The experimental materials consist of factorial combinations of two varieties (SOSAT C88 and Zango), three inter-row spacings (50, 75 and 100cm) and four intra-row spacings (15, 30, 45 and 60cm). The treatments were laid out in randomized complete block design with three replications. Data collected on grain weight were subjected to analysis of variance and Duncan's Multiple Range Test (DMRT) was used for the separation of means at 1% and 5% levels of significance. Result shows that SOSAT C88 had significantly ($P \leq 0.05$ and $P \leq 0.01$) gave the heaviest grains than Zango pearl millet variety in 2003 and 2004 respectively while no significant difference among varieties in 2005. Millet varieties spaced out at 75cm inter-row had the heaviest grains than when spaced at either 50 or 100cm inter-row spacings which significantly ($P \leq 0.01$) produced pearl millets with lighter grains. Moreover, varieties planted at 30 and 60cm respectively had significantly ($P \leq 0.01$) heavier grains than those intra-spaced at 15 and 45cm which had the lighter grain weight. **I**nteraction shows that pearl millet varieties spaced out at 75 x 30cm and 75 x 60cm had significantly ($P \leq 0.01$) bore the heaviest grains than those planted in other spacings which gave the lightest grains. It is however, recommended to grow SOSAT C88 pearl millet variety as well as use 75cm inter-row and 30 or 60cm intra-row spacings respectively for heavier grains than wider or shorter spacings which resulted in having lighter grains.

Keywords: Downy mildew, Grain Weight, Inter-Row, Intra-Row, Pearl Millet.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L) R.Br.) has traditionally been an important grain, forage and stover crop primarily in the arid and sub-tropical regions of the world. It is the world's six most important cereal crop, providing diet to about five hundred million people in the arid and semi-arid tropics particularly in India [1-5]. Over 40 percent of land sown annually to cereals is devoted to millet [6]. Nwasike [7] reported that as the climate becomes drier pearl millet production exceeds that of sorghum due to its draught-tolerant character and the reverse is the case as rainfall increases. Being able to thrive where habitats are harsh, it is perhaps the best of all life-supporting grain [8]. This report further pointed out that it yields reliably well in regions too hot and too dry to consistently support good yield of maize or sorghum. Already, the crop is gaining ground into the hotter and drier part of Latin America, Central Asia, the Middle East, Australia and West Africa. The world area planted to millet is about 65 million hectares, with the major part in India and Africa. The area sown to the crop in West

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Africa is estimated at 12 million hectares, while in Nigeria, millet is cultivated on 5 million hectares, equivalent to 20.84 percent of the 23.99 million hectares of the country's total arable land.

Pearl millet production in Nigeria increased gradually between 1985 and 1994, reached a peak in 1988 and 1990, and then declined. The report further shows that the increase may be attributed to the cumulative effects of subsidies associated with National Food Production Programme, while the decline may be due to the effects of reduction of such subsidies. However, abiotic and biotic factors militate against meaningful millet production in Nigeria. Low and erratic rainfall leading to drought period of varying lengths, poor soil fertility and low water holding capacity, traditional practices such as low crop density were among the factors affecting millet production [9]. They further reported that other factors include none or low application of fertilizers, poor/zero tillage, lean household capital, poor credit and input provision (which limit the scope for improved management practices) and low genetic yield potentials of landraces which respond only minimally to improved management.

Diseases such as downy mildew, ergot, and smut are the most important diseases of pearl millet. Among these, downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet is the most serious in West Africa [10] as it receive higher ratings when compared to ergot and smut. Werder and Manzo [11] further mentioned that downy mildew, ergot and smut are the three most widespread and important diseases of pearl millet in Nigeria. Yield losses of up to 50 percent due to downy mildew have been reported in West Africa [12]. Jeger *et al* [13] reported that downy mildew can cause devastating yield losses in pearl millet and this is a major constraint to productivity. Zakari [14] reported an average annual yield loss in Nigeria of 17 percent. In spite of the high population growth rate of 3.2 percent in Nigeria, as well as high demand against lower production of the crop, it is expected that the projected production increase would erase any deficit by 2010, Bukar *et al* [15]. Moreover, there is increasing decline in millet productions due to series of attack by pests and diseases as earlier on mentioned. Efforts directed at increasing millet productions through the use of chemicals even though proved effective but for other side-effects of these chemicals, there is need for alternative economic and friendly control measures against these pests and diseases. Therefore, it is imperative to carry out this research with the aim of investigating the effect of inter- and intra-row spacings of pearl millet infected with downy mildew on grain weight in Kano State, Nigeria.

MATERIALS AND METHODS

The trial was carried out at the teaching and research farm of Kano University of Science and Technology Wudil (Latitude 10^{o} 33'S, Longitude 7^{o} 34'N to 9^{o} 24'E; elevation 427-428m) (KNARDA, 2003) in 2003, 2004 and 2005 rain seasons.

In this trial, two pearl millet varieties:- SOSAT C88 and Zango were used. They were choosen because, Zango (a local landrace and adopted) was the most susceptible to downy mildew in the previous screening exercise and SOSAT C88 (an improved and new to the present farmers) was moderately susceptible to downy mildew. The inter-row spacings used were 50cm, 75cm and 100cm while intra-row spacings were 15cm, 30cm, 45cm and 60cm. The experimental materials consist of factorial combinations of 2 varieties, inter-row spacings (3) and intra-row spacing (4). The treatments were laid out in randomized complete block design with three replications.

Each plot measured 4m x 4m ($16m^2$) and 1m pathway was left between the replications. Each pearl millet variety was planted using the different inter- and intra-row spacings in the plots. The number of pearl millet stands in each plot varies because of different inter- and intra-row spacings used. All the cultural practices of pearl millet and the inoculation procedures were carried out as in the fertilizer trial.

The land was prepared and all the cultural practices of pearl millet were carried out. Seeds were treated with Apron Plus at the rate of 30g/kg of the seeds before planting to control pre- and post-emergence damping-off of seedlings. Five millet seeds were planted in June (beginning of the rain season) at a spacing of 75cm x 30cm making 5 rows of pearl millet. Missing stands were supplied at seven days after sowing. The seedlings were thinned to two seedlings/hill two weeks after sowing. Super Plus 280 EC insecticide was sprayed two times (second and seventh week after sowing) against harmful insects that might attack the crop. The active ingredients for the insecticidal spray are cypermethrin 30g and dimethoate 250g. Downy mildew infected pearl millet were placed on the aerial parts of the plants for effective infection. Moreover, conidial suspension of the cultured pathogens (10^6 spores mL^{-1}) was sprayed on the plants at 7 days old to ensure that maximum infection took place during the trial. This method provides uniform distribution of sporangial inoculum throughout the test materials during the infection period (early seedling stage) in a natural manner.

Data were collected on grain weight by cutting and drying (under the sun) the heads (15) of pearl millet after maturity which were later threshed (with mortar and pestle) and weighed using an electric weighing balance machine from the each plot. Data collected for three years (2003, 2004 and 2005) were also combined and subjected to analysis of variance according to Gomez and Gomez (1984) and Duncan's Multiple Range Test (DMRT) was used for the separation of the means at 1% and 5% levels of significance.

RESULTS

Result on the effect of inter- and intra-row spacings of pearl millet infected with downy mildew on grain weight shows that SOSAT C88 had significantly (P≤0.05 and P≤0.01) gave the heaviest grains than Zango pearl millet variety in 2003 and 2004 respectively while no significant difference among varieties in 2005 (Table 1). The inter-row spacings show no significant difference among them in 2003. However, pearl millet varieties planted at 75cm apart inter-row spacing had significantly (P≤0.01) produced the heaviest grains than other two spacings which gave grains with the lightest weight in 2004 and 2005.

There was no significant difference among intra-row spacings in 2003, but pearl millet plants spaced out at 30 and 60cm intra-row spacing had significantly (P≤0.01) produced the haviest grains in 2004 and 2005 while both 15 and 45cm significantly (P≤0.01) produced the lightest grains in pearl millet plants in the same years.

Combine statistical analysis shows that SOSAT C88 pearl millet variety had significantly (P≤0.01) heavy weight grains when compared to Zango pearl millet which significantly (P≤0.01) had light grains. Millet varieties spaced out at 75cm inter-row had the heaviest grains than when spaced at either 50 or 100cm inter-row spacings which significantly (P≤0.01) produced pearl millets with lighter grains. Moreover, varieties planted at 30 and 60cm respectively had significantly (P≤0.01) heavier grians than those spaced at 15 and 45cm which had the lowest grain weight. Only inter- x intra-row combine interaction effect occurred.

Interaction effects were significant among variety x intra-row and inter- x intra-rows in 2004 and 2005. Result shows that both SOSAT C88 and Zango pearl millet varieties had significantly (P≤0.05) produced the heaviest grains when planted at different intra-row spacings except 15cm where the lightest grains were obtained from both varieties in 2004 (Table 2). Another interaction Table 3 in the same year shows that pearl millet varieties spaced out at 75 x 30cm and 75 x 60cm had significantly (P≤0.01) bore the heaviest grains than those planted in other spacings which gave the lightest grains.

Furthermore, in 2005, result on interaction effect between variety x intra-row spacing shows that SOSAT C88 variety had significantly (P≤0.01) produced the haviest grains when spaced at 30 and 60cm intra-row spacings while both SOSAT C88 and Zango spaced at 15cm gave grains with lightest weight (Table 4). In the same year, Table 5 shows that pearl millet varieties planted at 75 x 30cm spacing had significantly (P≤0.01) gave heavy grain weight in contrast with those spaced out at 50 x 15cm, 75 x 15cm and 100 x 15cm which produced lightest grains. Table 6 presents result on combine interaction effect between inter- x intra-row spacing combinations which shows that heaviest grains were significantly (P≤0.05) obtained from pearl millet varieties spaced out at 75 x 30cm and 75 x 60cm respectively than other spacing combinations where lightest grains were produced.

Table 1. Effect of inter- and intra- row spacings on grain weight (g) of two pearl millet varieties infected with downy mildew in three years

Variety	Grain weight (g)			
	2003	**2004**	**2005**	**Combine**
SOSAT C88	279.56_a	329.78	597.54_a	402.29_a
Zango (Check)	178.89_b	299.92	360.50_b	279.11_b
S.E. ±	27.35	19.72	20.46	23.72
Inter-row spacing (cm)	*	NS	**	**
50	257.11	262.70_b	317.26_b	279.02_b
75	222.34	432.22_a	823.54_a	492.70_a
100	208.22	249.63_b	296.27_b	251.37_b
S.E. ±	33.49	24.14	25.06	29.05
Intra-row spacing (cm)	NS	**	**	**
15	261.70	262.47_b	73.97_c	199.38_b
30	252.95	356.76_a	729.73_a	446.48_a
45	212.28	262.68_b	396.38_b	290.45_b
60	189.96	377.48_a	716.01_a	427.81_a
S.E. ±	38.70	27.90	28.96	33.55
Interaction	NS	**	**	**
Variety x inter-row	NS	NS	NS	NS
Variety x intra-row	NS	*	**	NS
Inter- x Intra-rows	NS	**	**	**
Variety x inter- x intra row	NS	NS	NS	NS

Means followed by the same letters within the same column and treatment are not significantly (P≤0.01 and P≤0.05) different according to Duncan's Multiple Range Test (DMRT), * = Significant at 5% probability, ** = Significant at 1% probability, NS = Not significant

Table 2. Interaction effect between pearl millet variety infected with downy mildew and intra-row spacings on grain weight (g) in 2004

Variety	Intra-row (cm)			
	15	**30**	**45**	**60**
SOSAT C88	251.44_{cd}	320.38_{abc}	328.71_{abc}	417.59_{a}
Zango	273.50_{bcd}	393.14_{ab}	195.66_{d}	337.37_{abc}
S.E. ±		39.44		

Means followed by the same letters are not significantly (P≤0.05) different according toDuncan's Multiple Range Test (DMRT)

Table 3. Interaction effect between intra-and inter-row spacings of pearl millet variety infected with downy mildew on grain weight (g) in 2004

Intra-row (cm)	Inter-row (cm)		
	50	**75**	**100**
15	270.08_{b}	249.97_{b}	267.37_{b}
30	319.08_{b}	550.92_{a}	200.28_{b}
45	283.33_{b}	293.87_{b}	210.85_{b}
60	178.28_{b}	634.13_{a}	320.02_{b}
S. E. ±		48.30	

Means followed by the same letters are not significantly (P≤0.01) different according to Duncan's Multiple Range Test (DMRT)

Table 4. Interaction effect between pearl millet varieties infected with downy mildew and intra-row spacings on grain weight (g) in 2005

Variety	Intra-row (cm)			
	15	**30**	**45**	**60**
SOSAT C88	96.92_{cd}	875.68_{a}	547.29_{b}	870.28_{a}
Zango	51.01_{d}	583.78_{b}	245.48_{c}	561.73_{b}
S.E. ±		40.93		

Means followed by the same letters are not significantly (P≤0.01) different according to Duncan's Multiple Range Test (DMRT)

Table 5. Interaction effect between intra-and inter-row spacings of pearl millet variety infected with downy mildew on grain weight (g) in 2005

Intra-row (cm)	Inter-row (cm)		
	50	**75**	**100**
15	65.45_{c}	71.37_{c}	85.08_{c}
30	391.20_{cb}	1477.82_{a}	320.17_{b}
45	450.87_{b}	434.73_{b}	303.55_{b}
60	361.52_{b}	1310.23_{b}	476.27_{b}
S. E. ±		50.12	

Means followed by the same letters are not significantly (P≤0.01) different according to Duncan's Multiple Range Test (DMRT)

Table 6. Combine interaction effect between intra-and inter-row spacings of pearl millet variety infected with downy mildew on grain weight (g)

Intra-row (cm)	Inter-row (cm)		
	50	**75**	**100**
15	199.25_{b}	182.72_{b}	216.17_{b}
30	327.29_{b}	761.61_{a}	250.54_{b}
45	338.53_{b}	321.38_{b}	211.43_{b}
60	251.01_{b}	705.09_{a}	327.34_{b}
S. E. ±		58.11	

Means followed by the same letters are not significantly (P≤0.01) different according to Duncan's Multiple Range Test (DMRT)

DISCUSSION

The research shows that SOSAT C88 pearl millet had heaviest grain weight than Zango in 2003 and 2004 having similar situation with the combine result. This also pointed out the good quality of SOSAT C88 as an improved variety when compared with a local Zango pearl millet. The inter-row spacing of 75cm used which is the recommended spacing for pearl millet produced heaviest grain weight than other inter-row spacings in 2004 and 2005 with the same result from the combine analysis. Pearl millets intra-spaced at 30cm (recommended spacing) and 60cm had heaviest grains

unlike those intra-spaced at 15 and 45cm respectively which had least grain weight in 2004 and 15cm in 2005. The combine result also showed the same situation above among the intra-row spacings on grain weight. Moreover, the interaction effect between variety x intra-row spacing in 2004 shows that SOSAT C88 pearl millet had heaviest grain weight when intra-spaced at 30, 45 and 60cm and Zango at 30 and 60cm respectively, while both varieties had least grain weight when intra-spaced at 15cm and again Zango pearl millet at 45cm. In 2005, another interaction effect between variety x intra-row spacing showed similar result as above, but here only SOSAT C88 pearl millet had heaviest grains when intra-spaced at 30 and 60cm while Zango pearl millet variety had least grain weight at 15cm intra-row spacing. This pointed that when both varieties spaced at 30, 45 and 60cm intra-row spacing, produced heaviest grains, but when intra-spaced at 15cm and Zango alone at 45cm produced lighter grains. Another interaction effect between inter - x intra - row spacing combination in 2004 and combine interaction effect showed that using 75 x 30cm (recommended spacing) and 75 x 60cm produced pearl millet with heaviest grains than using other spacing combinations which produced pearl millets with lightest grain weight. Moreover, similar result was obtained from the interaction between inter- x intra-row spacing in 2005 but only 75 x 30cm spacing combination which gave heaviest grain weight and 15cm lightest grain weight. The result shows that recommended inter- and intra-row spacings (75 and 30cm respectively) proved best in giving out pearl millet varieties with the heaviest grain weight including 60cm intra-row spacing. This further supports Mehrotra and Aggarwal [16]. That distance between plants influence the incidence and severity of certain diseases which at the same time affects grain weight

CONCLUSION

It is concluded that planting SOSAT C88 pearl millet variety for heaviest grain weight was favorable. Moreover, using 75 inter-row spacing as well as 30 and 60cm intra-row spacings respectively resulted in obtaining heaviest grains.

RECOMMENDATIONS

It is however, recommended to grow SOSAT C88 pearl millet variety as well as use 75cm inter-row and 30 or 60cm intra-row spacings respectively for heavier grains than wider or shorter spacings which resulted in having lighter grains.

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