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DETERMINATION OF SEED RATE, SOWING METHOD AND POULTRY MANURE ON THE PERFORMANCE OF FINGER MILLET [*ELEUSINE CORACANA* (L.) GAERTN.] AT BAGAUDA IN THE SUDAN SAVANNAH ECOLOGY OF NIGERIA

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Abstract

Two field trials were conducted during the 2013 and 2014 cropping seasons at the Teaching and Research Farm of the National Institute for Horticulture Bagauda (lat. 19^0 4^1 N, long 12^0 26^1 E, 721m above sea level) Kano in the Sudan Savannah ecology of Nigeria. The treatments consisted of three seed rates (3, 6 and 9 kg ha^{-1}), two sowing methods (broadcasting and dibbling) and poultry manure at (0, 2.5 and 5.0 t ha^{-1} and NPK (90:60:60 kg ha^{-1}). The experiment was laid out in a split-plot design with three replications. The combination of sowing methods and poultry manure constituted the main plot, while seed rate constituted the sub-plot. In this study, 9 kg seed ha^{-1} gave the highest germination count and grain yield. The 3 kg ha^{-1} seed rate significantly produced better growth attributes such as plant height, leaf area index, number of tillers $plant^{-1}$, crop growth rate and relative growth rate but lower grain yield. Dibbling method produced significantly higher growth parameters such as plant height, leaf area index; number of tillers $plant^{-1}$, crop growth rate and relative growth rate which consequently out-yielded broadcasting method. Application of poultry manure rate at 2.5 t ha^{-1} produced significantly optimum and similar performance of plant height, leaf area index, crop growth rate, relative growth rate and number of tillers which translated into higher grain yield comparable to the application of 5 t ha^{-1} of poultry manure and NPK. Based on the results obtained from this study, it can be concluded that broadcasting finger millet at 9 kg seed ha^{-1} or dibbling the crop at 6 kg seed ha^{-1} with the application of 2.5 t ha^{-1} gave significantly higher grain yield which was comparable to the application of NPK at (90 kg N, 60 kg P and 60 kg K ha^{-1}) in the Sudan Savannah Ecology of Nigeria.

Key words; Finger millet, seed rate, sowing method, poultry manure and grain yield.

INTRODUCTION

Finger Millet (*Eleusine coracana)* (L.) Geartn), belongs to the family Poaceae. It is native to Africa with its origin in the highlands of Uganda and Ethiopia. The world annual production is at 4.5 million metric tonnes of grain of which Africa produced 2 million metric tonnes from an estimated land area of 19 million hectares (Anonymous, 1996). In Nigeria, finger millet is grown in very few states, Kaduna and Plateau in the northern parts of the country with an average yield of 580-785 kg ha^{-1} (Anonymous, 1996). Finger millet is one of the minor cereals known with several health benefits. These benefits are attributed to its high level of poly-phenol, dietary fibre, minerals and essential amino acids. Epidemiological studies have demonstrated that regular consumption of whole grain cereals and their products can protect the body against the risk of cardio-vascular diseases, type II diabetes, obesity, gastro-intestinal cancers, anti-tumerogenic, atherosclerogenic effects, antioxidant and microbial properties and a range of other disorders (McKeown, 2002). The high level of iron and calcium content of finger millet has been found to be relevant to people living northern Nigeria where the

incidence of iron deficiency causes anaemia particularly in pregnant women and calcium deficiency causes rickets in young children (Glew *et al.*, 2008).

In Africa, finger millet can be processed into many dishes such as porridge, bread, malt, traditional beer, etc. Anonymous (1996) reported that, finger millet straw makes good fodder containing up to 61% total digestible nutrients better than pearl millet (*Pennisetum Americana*) wheat (*Triticum aestivum* (L.) or sorghum (*Sorghum bicolor* (L) Moench).

Despite the high medicinal, nutritional and industrial potential of finger millet, the crop has received little attention in terms of research and development. It has been reported that large neglect by national and international research centres has resulted into low research findings on the crop compared to other cereals particularly in the Sub-Saharan Africa (Anonymous, 1996; Mgonja, 2005). This problem led to the low yield ha^{-1} across producing countries in Africa for as low as 500-750kg ha^{-1} when cultivated sole (Takan *et al*., 2004). The area under finger millet production has decreased because most of the local farmers go into the production of other cereal crops (Oduori, 2005). The low yields on farmers' field in Nigeria and elsewhere have been attributed to poor agronomic management practices such as poor soil fertility, improper cultural practices such as optimum seed rate and proper planting pattern among others.

In view of the foregoing challenges, this research is initiated to investigate the best sowing method, appropriate seed rate and optimum poultry manure rate which will enhance finger millet growth and yield. The study was therefore conceived with the following objectives; to determine the optimum seed rate, appropriate sowing method and optimum rate of poultry manure that would increase the growth and yield of finger millet in the Sudan Savanna ecology of Nigeria.

MATERIALS AND METHODS

Description of the Study Area

Two field trials were conducted during the 2013 and 2014 cropping seasons, at the Teaching and Research Farm of the National Institute for Horticulture (NIHORT) Bagauda (lat. 19^0 4^1 N, long 12^0 26^1 E, 721m above sea level) Kano in the Sudan savanna ecology of Nigeria.

Treatments and Experimental Design

The treatments consisted of three seed rates (3, 6 and 9 kg ha^{-1}), two sowing methods (broadcasting and dibbling) and poultry manure at (0, 2.5 and 5.0 t ha^{-1} and recommended NPK (90:60:60 kg ha^{-1}).The experiment was laid out in a split-plot design with three replication. The combination of sowing method and poultry manure constituted the main plot, while seed rate was in the sub-plot.

Cultural Practices

The land was harrowed twice to obtain fine soil texture; poultry manure was applied two weeks prior to sowing on the 20th July, 2013 and 9th June, 2014. Seeds were mixed with fine sand at a ratio of 1:4 and sown manually on prepared basins. Dibbling was done at 20 x 10 cm inter and intra-row spacing, respectively. NPK fertilizer at the rate of 90 kg N, 60 kg P and 60 kg K ha^{-1}, was applied by broadcasting. The N was applied in two equal split doses; at 3 WAS. NPK fertilizer (15-15-15) was used to supply P, K and half of N requirements. The second half dose of N, was top dressed at 6 WAS using urea (46% N). Manual weeding was carried out at 3 and 6 WAS. All other agronomic practices were executed as at when due. Harvesting was done on the 12th December, 2013 and 02th December, 2014, respectively, when the crop has attained a physiological maturity. Harvesting was done by cutting the mature heads with a sharp knife and dried for 3 days before threshing a using pestle and wooden mortar and winnowed to remove the straws, foreign materials and unfilled grains.

Data Collection

Germination count at 3 WAS, plant height at 9 WAS, Leaf area Index (LAI) at 9 WAS, crop growth rate (CGR) at 6 WAS, relative growth rate (RGR) at 6 WAS, number of tiller plant^{-1} at 9 WAS and grain yield ha^{-1}.

Statistical Analysis

Analysis of variance was performed using the GLM procedure of SAS Statistical Software Version 9.1. The data collected was subjected to analysis of variance (ANOVA) to test treatment effects for significance using the F-test; the significant means were separated using DMRT.

RESULTS AND DISCUSSION

In this study, increasing seed rate from 3 to 9 kg ha^{-1} correspondingly increased germination count. It is quite obvious to obtain higher stand densities at higher seed rate provided that seeds have similar viability. This finding is in accordance with the work of Geleta *et al.* (2002) who reported that increasing seed rates resulted in increased plants emerged. Also, increasing seed rate from 3 to 9 kg ha^{-1} correspondingly decreased plant height in 2013 and leaf area index in both years, while in 2014, 3 and 6 kg seed ha^{-1} produced significantly taller plants, than other rates which were at parity. Also, in 2013, 3 and 6 kg seed ha^{-1} gave significantly higher crop growth rate and in both years relative growth rate and number of tillers plant^{-1} were observed higher at 3 and 6 kg seed ha^{-1} than 9 kg seed ha^{-1}. This might be due to sufficient utilisation of growth factors such as light, space, nutrition, and soil moisture from less plant population as a result of reduced intra specific competition. The results are in agreement with the findings of Tollenaar and Auguilera (1992) who reported that narrow row spacing produced higher leaf area index (LAI), which result in more interception of solar radiation which translates into dry matter accumulation (DMA). Grain yield was significantly affected by seed rate in both years and combined (Table 3). In 2013, seed rates of 3 and 6 kg ha^{-1} gave higher grain yield ha^{-1}. While in 2014 and combined, increasing seed rate from 3 to 9 kg seed ha^{-1} correspondingly increased grain yield ha^{-1} of finger millet. This higher yield from higher seed rate is attributed to higher plant population unit^{-1} area which is a function of seed rate, evidently on the performance of individual plants, as well as the total number of plants grown on that area. This dense plant population further suppressed weed which translated into higher grain yield. In the north western Ethiopia, Bitew and Asargew (2014) reported that planting finger millet at the lowest seed rate of 10 kg ha^{-1} at 30 cm row spacing significantly gave the optimum grain yield of finger millet.

In 2013, dibbling method produced significantly higher leaf area index, crop growth rate and relative growth rate in both years and number of tillers in 2013. However, in 2014 broadcasting method gave more number of tiller plant^{-1} (Table 1). This could be attributed to uniform and equal distribution of growth factors which was utilised by the crop. This was similar to Nyende (2000) in Uganda that row planting gave rise to more vigorous crop growth and taller plants than broadcasting method. Dibbling method out-yielded broadcasting method consistently throughout the years and combined. This is because, dibbling method resulted in better finger millet growth characters which positively influenced yield characters and the grain of the crop. This finding is in line with Shinggu and Gani (2012) who observed that dibbling finger millet on the 25th June and 9th July at a spacing of 10 and 15cm significantly gave heavier panicles which consequently produced higher grain yield.

Application of poultry manure significantly influenced all the growth parameters evaluated in this study (Table 1and 2). The control produced shorter

plants in 2013, lower leaf area index in 2014, lower crop growth rate and relative growth rate in 2013. While in 2014, increasing the application of poultry manure rate from 0 to 5 t ha^{-1} correspondingly increased plant height and leaf area index. While in 2014, application of NPK produced significantly higher relative growth rate than the control; this was followed by the application of 2.5 and 5 t ha^{-1}

.The applied poultry manure increased both major and minor essential nutrient elements as well as organic matter content in the soil which improved moisture and nutrient retention. The results are in agreement with the findings of Govindappa (2003) who reported that higher leaf area $plant^{-1}$ was responsible for photosynthetic activity which in turn resulted into higher dry matter production of finger millet. Haruna (2011) indicated that plant growth attributes such as plant height, number of branches $plant^{-1}$, stem girth, number of leaves $plant^{-1}$ as well as total dry matter yield were increased as a result of applied poultry manure. It was also observed in the present study that poultry manure rate of 2.5 t ha^{-1} gave similar and higher performance of growth characters which translated into higher grain yield comparable to the application of 5 t ha^{-1} poultry manure and NPK. This suggested that this rate supplied sufficient and well balanced nutrients for a better performance of finger millet. The results are in agreement with the findings of Pornparn *et al.* (2009) who reported that yield obtained by the use of organic manures competed favourably with that obtained from inorganic fertilizer in addition to some extra benefits of improving the soil pH, organic matter, phosphorus, potassium, minor elements and high microbial biomass carbon.

Interaction between seed rate and sowing method on grain yield ha^{-1} was significant in combined (Table 4). The combination of 6 kg seed ha^{-1} with dibbling method and 9 kg seed ha^{-1} with either of the sowing methods gave significantly higher grain yield ha^{-1}. The result is in agreement with Hossain and Maniruzzaman, (1992) who reported that proper seed rate and sowing method encourage nutrient availability, proper sunlight penetration for photosynthesis, good soil environment for uptake of soil nutrients and water use efficiency, all are necessary for crop vigour and yield.

CONCLUSION

Based on the results obtained from the combined interaction in this study, it can be concluded that dibbling finger millet at 6 kg seed ha^{-1} and with the application of 2.5 t ha^{-1} gave higher grain yield which was comparable to the application of NPK in the Sudan savanna ecology of Nigeria.

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Table 1: Effect of Seed Rate, Sowing Method and Poultry Manure on growth parameters of finger millet at Bagauda during the 2013 and 2014 cropping seasons

	Stand Count		Plant Height		Leaf Area Index	
Treatment	2013	2014	2013	2014	2013	2014
Seed Rate (S) (Kg ha^{-1})						
3	50.3c	33.0c	23.5a	17.1a	2.13a	2.18a
6	72.9b	81.2b	21.0b	15.7ab	1.98b	2.00b
9	87.2a	105a	18.4c	15.4b	1.75c	1.75c
SE±	2.66	6.45	0.70	0.48	0.028	0.029
Significance	*	*	**	*	*	*
Sowing Methods (M)						
Broadcasting	74.2	80.6	20.19	16.22	1.88b	1.89b
Dibbling	72.7	85.9	21.74	15.89	2.04a	2.06a
SE±	2.18	5.27	0.579	0.392	0.023	0.023
Significance	NS	NS	NS	NS	*	*
Poultry Manure (P) (t/ha)						
0	76.3	76.5	18.0b	10.6c	1.05d	1.73b
2.5	70.4	72.83	23.9a	16.0b	1.74c	2.09a
5	71.56	91.2	22.5a	18.2a	2.09b	2.30a
90:60:60 NPK	76.6.	92.4	24.5a	17.33a	2.34a	2.26a
SE±	3.08	7.45	0.826	0.555	0.032	0.032
Significance	NS	NS	**	*	*	*
Interaction						
P x M	NS	NS	NS	NS	NS	NS
P x S	NS	NS	*	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS
P x M x S	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT) *= Significant NS= Not significantly different at P = 0.05 * = Significance at P0.05, **=Significant at 1% level of probability, NS= Not significant

Table 2: Effect of Seed Rate, Sowing Method and Poultry Manure on growth parameters of Finger millet at Bagauda during the 2013 and 2014 cropping seasons

	Crop Growth RATE		Relative Growth Rate		Number of Tillers plant^{-1}	
Treatment	2013	2014	2013	2013	2013	2014
Seed Rate (S) (Kg ha^{-1})						
3	3.83a	4.54	0.451a	0.11	4.8a	3.8a
6	3.23ab	6.18	0.422a	0.15	4.0a	3.9a
9	2.64b	4.40	0.367b	0.13	1.7b	2.0b
SE±	0.296	0.824	0.013	0.017	0.36	0.19
Significance	*	NS	*	NS	*	*
Sowing Methods (M)						
Broadcasting	2.79b	4.75	0.374	0.14	3.7b	6.7a
Dibbling	3.68a	5.32	0.402	0.12	5.0a	4.0b
SE±	0.242	0.673	0.010	0.014	0.23	0.39
Significance	*	NS	NS	NS	*	NS
Poultry Manure (P) (t/ha)						
0	2.13b	4.75	0.362b	0.14	1.3b	1.5c
2.5	4.36a	6.19	0.427a	0.13	4.2a	3.4b
5	4.0a	3.34	0.431a	0.13	5.3a	3.2b
90:60:60 NPK	4.43a	5.87	0.433a	0.11	5.4a	4.4a
SE±	0.345	0.952	0.015	0.020	0.39	0.32
Significance	**	NS	**	NS	**	*
Interaction						
P x M	NS	NS	NS	NS	NS	NS
P x S	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS
P x M x S	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT) NS= Not significantly different at P = 0.05 % * = Significance at P 0.05 %, **=Significant at 1% level of probability NS= Not significant

Table 3: Effect of Seed Rate, Sowing Method and Poultry Manure on grain yield of finger millet at Bagauda during the 2013 and 2014 cropping seasons

	Grain Yield kgha^{-1}		
Treatment	2013	2014	Combined
Seed Rate (S) (Kg ha^{-1})			
3	1641.5b	1321.7c	1356.6c
6	1796.1a	1696.7b	1683.9b
9	1873.2a	2188.7a	2031.0a
SE±	47.59	78.274	65.16
Significance	*	*	*
Sowing Methods (M)			
Broadcasting	1581.5b	1730.5b	1572.6b
Dibbling	1890.0a	2409.9a	2159.3a
SE±	63.91	70.22	68.30
Significance	*	*	*
Poultry Manure (P) (t/ha)			
0	1164.1b	1427.7b	1295.9b
2.5	1835.0a	2294.9a	2063.7a
5	1881.4a	2316.0a	2098.7a
90:60:60 NPK	1939.5a	2267.8a	2103.6a
SE±	54.95	90.38	75.24
Significance	*	*	*
Interaction			
P x M	NS	NS	NS
P x S	NS	NS	**
M x S	NS	**	**
P x M x S	NS	NS	NS

Means followed by the same letter (s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT) NS= Not significantly different at P = 0.05 % * = Significance at P 0.05 %, **=Significant at 1% level of probability NS= Not significant

Table 4: Interaction between seed rate and sowing method on grain yield of finger millet in the combined at Bagauda during the 2013 and 2014 wet seasons

	Seed rate Kg ha^{-1}		
Sowing Method	3	6	9
Broadcasting	1237.1d	1501.8c	1890.1b
Dibbling	1676.1c	2199.9a	1800.9b
SE±		101.15	

Means followed by the same letter (s) within a column are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT)