EVALUATION OF SEED RATE, SOWING METHOD AND POULTRY MANURE FOR GROWTH AND YIELD OF FINGER MILLET (*Eleusine coracana* (L.) Gaertn)

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M. Gani[*] and C.P. Shinggu
Department of Crop Production & Protection, Federal University Wukari, PMB1020, Nigeria
[*]Corresponding author: musagani4@gmail.com;

Abstract: This research evaluated the effect of seed rate, sowing method and poultry manureon growth and yield of finger millet (*Eleusine coracana* (L.) Gaertn). The trials were conducted in the 2013 and 2014 wet seasons, at the Institute for Agricultural Research, Samaru in the Northern Guinea savanna agro-ecology of Nigeria. Treatments consisted of two sowing methods (broadcast, dibbling), three seed rates (3, 6, 9 kg ha^{-1}) and poultry manure (0, 2.5, 5.0 t ha^{-1}) NPK (90 kg N + 60 kg$P_2 0_5$ + 60 kg $K_2 0$ ha^{-1}). The experiments were laid out in a split plot design using three replications. A factorial combination of sowing method, poultry manure and NPK constituted the main plots, while seed rate constituted the subplots. The lower seed rate of 3 kg seed ha^{-1} produced significantly ($p<0.05$) higher leaf area plant^{-1}but distinctly gave lower grain yield ha^{-1} than the highest seed rate of 9 kg ha^{-1}. Dibbling method consistently produced better leaf area plant^{-1} and consequently out-yielded broadcasting method. Increasing the application of poultry manure rate from 2.5 to 5.0 t ha^{-1} and NPK fertilizer delayed days to 50% heading, days to physiological maturity and caused more lodged plant. The application of 2.5 and 5 t ha^{-1} poultry manure and NPK fertilizer positively influenced leaf area plant^{-1}, straw yield ha^{-1}, panicle yield ha^{-1} and grain yield ha^{-1}, compared to no fertilizer treatment. Also, the application of lower poultry manure rate (2.5 t ha^{-1}) produced optimum performance for leaf area plant^{-1} and yield characters for higher grain yield ha^{-1} comparable to the application of 5.0 t ha^{-1} and NPK fertilizer.The combinations of dibbling at 6 kg seed ha^{-1} and either poultry manure at 2.5 t ha^{-1}, 5.0 t ha^{-1} or NPK fertilizer, gave highest grain yield ha^{-1}. Based on the resultsofthis study, itis concluded that, sowing finger millet by dibbling at 6 kg seed ha^{-1} with application of 2.5 t ha^{-1} gave maximum grain yield ha^{-1}.

Keywords: Finger millet, grain yield, growth, poultry manure, seed rate, sowing method.

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertn.) called 'Tamba' in Hausa, originated in the highlands of Uganda and Ethiopia in East Africa (Anon, 1996). In Nigeria, the crop is grown mainly in the southern part of Kaduna state in the northern Guinea savanna and in the highland of Jos Plateau in North – central Nigeria (Glew *et al.,* 2008). It is one of the minor cereals known with several health benefits which are attributed to its high level of polyphenol, dietary fibre, minerals and essential amino acids. The high levels of iron and calcium make finger relevant to people of Northern Nigeria where the incidence of iron deficiency causes aneamia, particularly in pregnant women (Vanderjagt *et al.,* 2007), and calcium deficiency causes rickets in young children (Thacher *et al.*, 2000; Vanderjagt, 2001). The crop contains nutritionally important starch fractions (resistant starch) which are slowly digested and absorbed and are favourable in the diet pattern for metabolic disorders such as diabetes, hypertension, and obesity (Sharavathy *et al*., 2001).

Epidemiological studies have demonstrated that regular consumption of whole grain and their products can protect against the risk of cardio-vascular diseases, type II diabetes, obesity, gastro-intestinal cancers and a range of other disorders (McKeown, 2002). The by-product of finger millet from brewing has been reported to be a good source of fibre, minerals and protein and it is used especially in household poultry feeds and suitable for breeding stock (Obilana and Manyasa, 2002).

In spite of the significant medicinal, nutritional and industrial potentials of finger millet, the crop is neglected by agricultural research donors organisations particularly in sub-Saharan Africa compared to the researches and grants lavished on other crops (Anon, 1996; Mgonja, 2005). The crop remains largely unknown and unstudied in Nigeria and this led to difficulties encountered during its production resulting in low yields and its becoming extinct. Report shows a progressive decrease in the few areas under production of finger millet since most of the local farmers go into the production of other cereal crops such as rice, maize and sorghum (Glew *et al.,* 2008). A low yield of 500-750 kg ha^{-1} observed on farmers' field in Nigeria and elsewhere, have been attributed to constraints such as inadequate knowledge ofproper sowing methods, seed rate and limited use of inputs (Kidoido *et al.*, 2002). In Nigeria, the traditional method of sowing finger millet is mostly by broadcasting, at best without adopting any recommendation on seed rate. This makes weeding operations labour intensive, tedious, time-consuming and uneconomical.

Also, soil fertility depletion is one of the major causes of declining crop yields in Nigeria. Local farmers in Nigeria grow finger millet without fertilizers application on the relatively poor soils due to high cost of inorganic fertilizer and poor knowledge on the use of organic manure (Ano and Agwu, 2006). This has led to very poor yields. The use of inorganic fertilizer has increased crop yield, but caused many environmental problems including soil, air and water pollution which can affect human health and making crop productivity unsustainable (Uwah *et al.*, 2012). The increasing costs of fertilizers prevent their use by resource-poor farmers (Adhikary and Gantayet, 2012). On the other hand, organic manure such as poultry droppings is available as a source of essential macro and micro-nutrients which are released to the crop slowly and steadily when applied (Uwah *et al.*, 2012). In addition, organic manure improves soil physico-chemical conditions for better crop growth and yield (Uwah *et al.*, 2011).

Therefore, the objective of this study is to determine the most appropriate sowing method, seed rate and optimum poultry manurerate for finger millet.

Materials and Methods

Description of the study area

Field trials were conducted in the 2013 and 2014 wet seasons, at the Institute for Agricultural Research, Samaru (N 11.1833^o, 07.6146^o E, 686 m above sea level) in the Northern Guinea savanna agro-ecology of Nigeria.

Treatments and experimental design

The treatments consisted of three seed rates (3, 6, 9 kg ha^{-1}), two sowing methods (broadcasting, dibbling) and three poultry manure rates [0, 2.5, 5.0 t ha^{-1}, NPK (90 kg N + 60 kg P_2O_5 + 49.8 kg K_2O ha^{-1})]. The experiment was laid out in a split plot design with three replications. A factorial combination of sowing method and poultry manure rate constituted the main plot, while seed rate occupied the subplots.

Cultural practices

The land was harrowed twice to obtain fine soil texture and made into beds. Poultry manure was applied two weeks prior to sowing on the 9th July, 2013 and 11th June, 2014. Seeds were mixed with fine sand at a ratio of 1:4 and sown manually. 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 and when due. Harvesting was done on the 3rd December, 2013 and 02th December, 2014, respectively, when the crop has attained physiological maturity. Harvesting was done by cutting the mature heads with a sharp knife and dried for 3 days before threshing using pestle and wooden mortar and winnowed to remove the straws, foreign materials and unfilled grains.

Data collection

Data were recorded on leaf area plant^{-1}, days to 50% heading, days to physiology maturity, lodging percentage, productive tillers plant^{-1}, number of fingers panicle^{-1}, straw yield, panicle yield ha^{-1}and grain yield ha^{-1}.

Statistical analysis

The General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) package (SAS, 1990) version 9.1 was used for statistical analysis of all the data collected and differences between the treatments means were compared using the Duncan's New Multiple Range Test (DMRT) (Duncan, 1955) at 5% level of probability.

Results and Discussion

Effects of seed rate on the growth and yield components of finger millet

Leaf area plant^{-1} differed significantly ($p<0.05$) with seed rate in both years and the mean (Table 1). In 2013 and the mean, the highest seed rate of 9 kg ha^{-1} produced significantly ($p<0.05$) lower leaf area plant^{-1} than 3 and 6 kg seed ha^{-1} which were at a par. However, in 2014, increasing seed rate from 3 to 9 kg ha^{-1} led to distinct decrease to a minimum in leaf area plant^{-1} at 9 kg seed ha^{-1}. The higher values for leaf area from the lower seed rates in this study might be due to less plant population with reduced intra-specific competition, enhanced the efficiency of utilisation of growth factors. The result wasin agreement with the findings of Caliaskan *et al*. (2004) who reported that low plant population generally results in abundant vegetative growth due to less interplant competition for light, nutrients, water and other growth factors.

The influence of seed rate ondays to 50% heading was significant in 2013 and the mean (Table 1), where 9 kg seed rate ha^{-1} resulted in delay of days to 50% heading than the lower rates which had similar effect. However, in 2013, seed rate of 6 and 9 kg ha^{-1}had comparable days to 50% heading. Also the response of day to physiological maturity to seed rate was significant ($p<0.05$) only in the mean (Table 1), where 3 kg seed ha^{-1} caused a distinct delay in the number of days to physiological maturity compared to 9 kg seed ha^{-1}. However, the letter value at 9 kg seed ha^{-1} was comparable to the recorded value under 6 kg seed ha^{-1}. This was however, expected since increasing seed rates resulted in higher competition for scarce growth resources which then induced physiological stress that led to early heading and maturity. This was due to the lower plant population which had adequate growth resources which resulted in prolonged vegetative growth thereby leading to delayed maturity. This finding was in conformity with that of Larson and Thompson (2011) who reported that increase in seed rate of grain sorghum caused a decrease in the time for grain maturation.

In both years and the means, seed rate did not significantly ($p<0.05$) influence lodging percentage and number of finger panicle^{-1} (Table 2). Seed rate significantly ($p<0.05$) affected the number of productive tillers plant^{-1} (Table 2), where increasing seed rate from 3 to 9 kg ha^{-1} distinctly reduced the number of productive tillers plant^{-1} to a minimum at 9 kg ha^{-1} in both years, and the means. This indicates that under these conditions, the plants at lower populations were able to efficiently utilise available plant nutrients, moisture and radiation for the synthesis of carbohydrate for higher tiller production which translated into more productive tillers. This confirmed Opole (2012) report that lower seeding rate of 3.2 kg ha^{-1} produced higher tillers than seeding rate of 6.0 kg ha^{-1} in finger millet. Seed rate significantly ($p<0.05$) increased straw yieldha^{-1}in all years of the study and the mean (Table 3). In 2013, the use of 9 kg seed ha^{-1} produced significantly ($p<0.05$) higher straw yieldha^{-1} than 3 and 6 kg seed ha^{-1} which were at a par. However, in 2014 and the mean, increasing seed rate from 3 to 6 kg ha^{-1} and further increase to 9 kg ha^{-1} produced significantly ($p<0.05$) distinct increased in straw yieldha^{-1}. Also seed rate significantly ($p<0.05$) influenced panicle yield ha^{-1}in all the years and the mean (Table 3). In 2013, increasing seed rate from 3 to 6 kg ha^{-1} produced significantly ($p<0.05$) higher panicle yield ha^{-1}. Further addition to 9 kg seed ha^{-1} gave no significant ($p<0.05$) effect on panicle yield ha^{-1}. In 2014, the highest seed rate of 9 kg seed ha^{-1} produced significantly ($p<0.05$) higher panicle yield ha^{-1} than the lower rates which were similar. While in the mean data, varying seed rate from 3 to 9 kg ha^{-1} correspondingly increased panicle yield ha^{-1}.

In both years and the two-year mean, effect of seed rate differed significantly on grain yield (Table 3) where, increasing seed rate from 3 to 9 kg ha^{-1} resulted significantly in a corresponding increase in grain yield ha^{-1}. In this study, higher seed rate gave higher quantitative yield attributes such as straw yield, panicle yield and grain yield. This is attributed to higher plant population as well as more harvestable panicles per unit area which is a function of seed rate and the performance of individual plants, as well as the total number of plants grown on that area. Bellatore *et al*. (1985) and Kumpawt (1998) reported increased in straw yield with increased seed rate. Kumar *et al*. (2008) observed that seed rate increases plant density, and can compensate for reduction in plant productivity. Spanner *et al.* (2005) found that grain yield increased significantly (p<0.05) with increasing seed rate.

Table 1: Effects of seed rate, sowing method and poultry manure onleaf area plant^{-1}(cm^2), days to 50% heading and days to physiological maturityof finger millet at Samaru in 2013 and 2014 wet seasons

Treatment	Leaf Area plant^{-1}at 9 WAS			Days to 50% Heading			Days to Physiological Maturity		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
Seed rate (kg ha^{-1}) (S)									
3	721.2a	921.3a	821.3a	102.1a	102.2	102.1a	130.1	130.0	130.1a
6	700.6a	719.8b	710.2a	100.9ab	102.0	101.5a	129.0	130.1	129.5ab
9	419.6b	517.5c	468.6b	100.1b	101.3	100.7b	128.1	129.3	128.7b
SE±	35.89	38.21	37.05	0.42	0.47	0.451	0.42	0.50	0.451
P (0.05)	*	*	*	*	NS	*	NS	NS	*
Sowing Method (M)									
Broadcasting	720.1b	618.8b	669.5b	101.3	102.0	102.6	129.3	129.8	129.6
Dibbling	822.8a	820.4a	821.6a	100.8	101.8	101.3	128.8	129.8	129.3
SE±	34.12	29.11	31.62	0.34	0.38	0.568	0.34	0.38	0.368
P (0.05)	*	*	*	NS	NS	NS	NS	NS	NS
Poultry Manure (t ha^{-1}) (P)									
0	281.1c	256.5b	268.8b	100.3	99.9c	100.1b	128.3	126.1d	128.1b
2.5	717.4b	852.3a	784.9a	100.8	100.2c	100.5b	128.8	128.2c	128.5b
5.0	826.7a	882.4a	854.6a	101.6	102.6b	102.1a	129.6	130.6b	130.1a
NPK	922.3a	903.4a	912.9a	101.5	104.8a	103.1a	129.5	132.6a	131.1a
SE±	37.29	37.12	37.21	0.48	0.54	0.520	0.48	0.53	0.521
P (0.05)	*	*	*	NS	*	*	NS	*	*
Interaction									
P x M	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x S	NS	NS	NS	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column and treatment group are not significantly different at p<0.05using Duncan's New Multiple Range Test (DMRT); NS= Not significant; * = Significant

Table 2: Effects of seed rate, sowing method and poultry manure on lodging percentage, productivetiller plant^{-1}and number of finger panicle^{-1} of finger millet at Samaru in 2013 and 2014 wet seasons

Treatment	Lodging Percentage			Productive Tillerplant^{-1}			Number of Fingers panicle^{-1}		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
Seed rate (kg ha^{-1}) (S)									
3	15.7	10.5	13.1	4.4a	5.7a	5.1a	7.1	7.5	7.3
6	13.2	12.6	12.9	3.6b	3.4b	3.5b	7.3	7.4	7.3
9	12.5	9.7	11.1	2.7c	2.0c	2.4c	7.3	7.5	7.4
SE±	1.70	1.61	1.67	0.20	0.33	0.27	0.17	0.18	0.17
P (0.05)	NS	NS	NS	*	*	*	NS	NS	NS
Sowing Method (M)									
Broadcasting	7.94	8.6	8.3	3.6	4.1	3.9	7.1	7.3	7.4
Dibbling	10.42	10.0	10.2	3.5	4.8	4.2	7.4	7.6	7.5
SE±	1.39	1.31	1.35	0.16	0.27	0.22	0.14	0.15	0.14
P (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	*
Poultry Manure (t ha^{-1}) (P)									
0	9.5b	9.1c	8.7b	2.6b	2.3b	2.5b	6.8b	7.4	7.1
2.5	10.5b	9.6c	8.8b	4.3a	5.6a	5.0a	7.8a	7.3	7.6
5.0	25.8a	27.3b	28.8a	3.7a	5.7a	4.7a	7.7a	7.3	7.5
NPK	30.9a	32.3a	33.7a	3.8a	5.2a	4.5a	7.4a	7.6	7.5
SE±	1.97	1.86	1.81	0.23	0.38	0.31	0.19	0.26	0.20
P (0.05)	*	*	*	*	*	*	*	NS	NS
Interaction									
P x M	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x S	NS	NS	NS	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column and treatment group are not significantly different at p<0.05 using Duncan's New Multiple Range Test (DMRT); NS= Not significant; * = Significant

Table 3: Effects of seed rate, sowing method and poultry manure on straw yield ha^{-1}, harvest index and grain yield ha^{-1}of finger millet at Samaru in 2013 and 2014 wet seasons

Treatment	Straw Yield (t ha^{-1})			Panicle Yield (kg ha^{-1})			Grain Yield (kg ha^{-1})		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
Seedrate (kg ha^{-1}) (S)									
3	2.81b	2.72c	2.76c	2.29b	2.28b	2.28c	1.19c	1.28c	1.24c
6	3.19b	3.43b	3.31b	2.54a	2.47b	2.51b	1.44b	1.47b	1.45b
9	4.21a	4.04a	4.13a	3.20a	2.79a	2.10a	1.74a	1.83a	1.79a
SE±	0.178	0.210	0.202	0.694	0.726	0.785	0.339	0.477	0.435
P (0.05)	*	*	*	*	*	*	*	*	*
Sowing Method (M)									
Broadcasting	3.10b	3.24	3.17b	2.65	2.35b	2.47b	1.37b	1.41b	1.39b
Dibbling	3.70a	3.56	3.63a	2.75	2.68a	2.72a	1.59a	1.61a	1.60a
SE±	0.146	0.172	0.165	0.566	0.593	0.631	0.277	0.389	0.355
P (0.05)	*	NS	*	NS	*	*	*	*	*
Poultry Manure (t ha^{-1}) (P)									
0	2.70b	2.53b	2.61b	1.96b	1.60c	1.78c	1.17b	1.10b	1.17b
2.5	4.11a	4.11a	4.11a	2.86a	2.58b	2.72b	1749.0a	1.8a	1.79a
5.0	4.09a	4.00a	4.00a	3.13a	2.84a	2.98a	1823.3a	1.84a	1.83a
NPK	3.82a	4.00a	3.91a	3.10a	2.94a	2.99a	1751.3a	1.85a	1.80a
SE±	0.206	0.242	0.233	0.801	0.838	0.907	39.13	0.550	0.502
P (0.05)	*	*	*	*	*	*	*	*	*
Interaction									
P x M	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x S	NS	NS	NS	NS	NS	NS	NS	NS	*
M x S	NS	NS	NS	NS	NS	NS	NS	NS	*
P x M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column and treatment group are not significantly different at p<0.05 using Duncan's New Multiple Range Test (DMRT); NS= Not significant; * = Significant

Effect of sowingmethod on the growthand yield components of finger millet

In both years and the means, dibbling of seeds consistently produced higher leaf area plant^{-1} than broadcasting method (Table 1).The superior effect of dibbling method on leaf area over broadcasting method could be due to the proper placement of finger millet seed which gave effective utilization of growth factors. However, in broadcasting, crop stands were spatially and non-uniformly distributed which was characterised by over-crowding in some parts and sparseness in others. This overcrowding could have caused undue competition for resources (nutrients, water, light, etc.), while sparseness could have led to resource wastage to higher weed infestation. This supported Nyende (2000) who reported that row-planted finger millet had more vigorous growth and taller plants than broadcast-sown plant.

Sowing method did not significantly influence days to 50% heading and days to physiological maturity (Table 1), productive tiller plant^{-1}, lodging percentage and number of finger panicle^{-1} (Table 2). The effect of sowing method on straw yield, panicle yield and grain yieldis presented in (Table 3), where dibble-sown plots produced consistently higher straw yield ha^{-1} in 2013 and the mean, panicle yield in 2014 and grain yield in both years and the mean. Dibbled plots had superior yield components and consequently out-yielded broadcast-sown plots because of its ability to effectively utilized growth factors due to uniform distribution of crop stands, reduce weed pressure, and improve finger millet growth characters which positively influenced yield characters and grain yield. This finding is in line with Shinggu and Gani (2012) who observed that dibbling finger millet at a spacing of 10 and 15cm gave heavier unthreshed panicles with consequent higher grain yield in Samaru. In Eastern Uganda (Tenywa *et al*., 1999) observed that row-planted plots clearly had better finger millet growth and out-yielded broadcast-sown plots by about 13% for the best performing fertilizer treatments.

Effects of poultry manure on the growth and yield components of finger millet

Fertilisation significantly influenced leaf area plant^{-1} in both years. (Table 1). In 2013, poultry manure rate from 0 to 5.0 t ha^{-1} led to a distinct increase in leaf area plant^{-1}, but leaf area plant^{-1} from 5.0 t ha^{-1} was similar to NPK-fertilized plot. In 2014 and the mean, the untreated control gave lower leaf area plant^{-1} than all other fertilizer treated plots which were similar. Utilisation of applied nutrients from poultry manure and NPK increases leaf area plant^{-1} which apparently led to an increase in photosynthetic efficiency of the plant which translated into higher production of photosynthesis, thus an enhanced growth and grain yield of finger millet. The results are in agreement with the findings of Govindappa (2003) who reported that higher leaf area per plant was responsible for enhanced photosynthetic activity which in turn resulted in higher dry matter production of finger millet. Balasubramaniyan and Palaniappan (2001) reported that higher N application rate leads to more rapid leaf area development, prolonged leaf life, improved leaf area duration after flowering, and increased overall crop assimilation, thus contributing to increased grain yield.

Application of NPK fertilizer increased number of days to 50% heading in 2014 (Table 1), followed by 5.0 t ha^{-1} poultry manure, 2.5 t ha^{-1} poultry manure and control in distinctly decreasing order. However, the application of 5.0 t ha^{-1} poultry manure and NPK gave the same mean number of days to 50% heading, and these were significantly lower than the values recorded in plots treated with 2.5 t ha^{-1} poultry manure and control plots which had equal mean days to 50% heading. Also, the application of poultry manure significantly affected days to physiological maturity, except in 2013 (Table 1). In 2014, the application of NPK significantly increased days to physiological maturity, and this reduced distinctly with decreasing poultry manure rate to the earliest in control plots. While in the mean analysis, the application of 5.0 t ha^{-1} poultry manure and inorganic NPK gave similar days to physiological maturity and these were significantly longer than in lowerpoultry manure rate and control plots, which both gave similar and shorter days to physiological maturity. The delay in days to heading and physiological maturity of finger millet in response to increased poultry manure rates and NPK in this study, might be due to the fact that increasing nutrient status of the soil as well as nutrient uptake thereby lowered the period for photoactivities and thus, delayed heading and maturity. This result is in line with the findings of Getachew (2004) and Mekonnen (2005) who reported delayed heading at highest N fertilizer rate in wheat and barley than lowest N rate. Similarly, Temesgen (2001) found that N fertilizer delayed physiological maturity of tef (*Eragrostis tef*). In contrast to the results of the present study, Sewnet (2005) reported early flowering with an increased N application in rice.

Fertilizer application significantly ($p<0.05$) influenced lodging percentage in both years and the mean (Table 2). In 2013, the application of 5 t ha^{-1} poultry manure and NPK gave similar effects and these were significantly higher than in plots treated with lower poultry manure rate and control plots which gave similar but lower lodging percentage. In 2014, NPK fertilizer caused significantly more lodging compared to the control, and this decreased distinctly with decreasing poultry manure rate to the lowest in both lower poultry manure rates. Specifically, mean lodging percentages followed the same trend as recorded in 2013. Higherrate of poultry manure and NPK fertilizer increased the number of lodged plants across locations and years of study. This could be due to the profound effect of high N supplied from the applied poultry manure and NPK which led to increasing vegetative growth and plant weight, thereby leading to increased lodging. This is in line with Opole (2012) who reported that higher rate of fertilizer application and seeding rate increased lodging due to increased plant height and growth in finger millet.Increasing poultry manure rate and NPK fertilizer were distinctly superior in increase the numbers of productive tillers plant^{-1} in both years of the study, to the unfertilized control (Table 2) which consistently produced lower number of productive tillers plant^{-1}. The number of tillers significantly increased due to available nitrogen from applied poultry manure and NPK fertilizer in this study. The current result is in agreement with Genene (2003) who reported higher tillering and maximum percent tillers with increasing N application in bread wheat. Fertilizer application significantly affected the number of fingers panicle^{-1} only in 2013 (Table 2), where the control plot gave significantly lower number of fingers panicle^{-1} than poultry manure and NPK fertilizer which produced similar number of fingers panicle^{-1}.

In both locations, poultry manure rate significantly increased straw yield ha^{-1}in all years of study and the means (Table 3). Also in both years and the mean, untreated control gave significantly lower straw yield ha^{-1}than all the applied poultry manure rates and NPK fertilizer which were similar. Poultry manure significantly influenced panicle yieldha^{-1} in all the years of study and the mean data (Table 3). In 2013, the unfertilized plot produced significantly lower panicle yieldha^{-1} than all the poultry manure rates and NPK fertilizer which were at a par. However, in 2014 and the mean data, increasing poultry manure from 0 to 5.0 t ha^{-1} produced distinct corresponding increase in panicle yield ha^{-1}to a maximum at which was 5.0 t ha^{-1} similar to NPK fertilizer.The application of poultry manure and NPK fertilizer significantly influenced grain yieldha^{-1}in both years and the mean (Table 3). Generally, fertilizer- treated plots produced similar grain yield ha^{-1} and these were slightly higher than in control plots.It was observed that the lower poultry manure rate of (2.5 t ha^{-1}) gave higher and similar values for most growth and yield characters such as number of finger, panicle and straw yieldha^{-1} with higher rate of (5.0 t ha^{-1}) poultry manure and NPK fertilizer which translated into higher grain yieldha^{-1}. This suggests that the poultry manure rate supplied sufficient and well-balanced nutrients for better performance of finger millet. The result is in line with Maman and Mason (2013) who reported that the application of 2 t ha^{-1} poultry manure increased pearl millet grain yield by 56% and stover yield by 53%. Factor interactions was only significant ($p<0.05$) between seed rate and sowing method (Table 4) and seed rate and poultry manure (Table 5) in the mean grain yield.

Effects of Factor Interactions

Seed rate and sowing method

The interaction of seed rate and sowing method were significant($p<0.05$) on grain yield ha^{-1} on the two-year means (Table 4), where dibbling finger millet at 6 kg seed ha^{-1} gave highest grain yield than all other combinations. This is in agreement with Hossain and Maniruzzaman (1992) who reported that proper seed rate and sowing method encourage nutrient availability, good soil environment for uptake of soil nutrients and water use efficiency for better crop vigour and yield.

Table 4: Interaction of seed rate and sowing method on grain yield (kg ha^{-1}) of finger millet in the mean at Samaru

Treatment	Seed Rate (kg ha^{-1})		
	3	6	9
Sowing Method			
Broadcasting	1237.1d	1501.8cd	1890.1b
Dibbling	1676.1bc	2199.9a	1800.9b
SE±		101.15	

Means within a row with the same superscript were not significantly different(p>0.05).

Table 5: Interaction of seed rate and poultry manure on grain yield (kg ha^{-1}) of finger millet in the mean at Samaru

Treatment	Poultry manure (t ha^{-1})			
	0	2.5	5.0	NPK
Seed rate (kg ha^{-1})				
3	506.8e	1472.2c	1424.8c	1539.7bc
6	955.8d	2096.1a	1840.1ab	2145.6a
9	700.8de	2170.2a	1988.2a	2125.7a
SE±		130.00		

Means followed by the same letter(s) are not significantly different at p<0.05 using Duncan's New Multiple Range Test (DMRT).

Seed rate and poultry manure

The interaction of seed rate and poultry manure was significant($p<0.05$) on the two-year means grain yield (Table 5), where the combination of 6 kg seed ha^{-1} and of 2.5, 5.0 t ha^{-1} poultry manure or NPK fertilizer resulted in a significant increase in yield attributes such as productive tiller, panicle length, panicle yield, and grain yield of finger millet. This could be due to the capacity of poultry manure and NPK to produce adequate amounts of plant nutrients which enhanced plant growth attributes and remitted higher yield attributes and grain yield of finger millet at this higher plant population. This further agrees with the findings of Opole (2012) who reported that 6 kg seed ha^{-1} combined with the application of 90 kg N ha^{-1} produced an average of 6 tillers $plant^{-1}$ and grain yield of 2.5 t ha^{-1} of finger millet.

Conclusion

Dibbling finger millet at 6 kg seed ha^{-1} with application of 2.5 t ha^{-1} gave maximum grain yield of finger millet than other combinations.

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