International Research Journal of Natural and Applied Sciences
Vol. 3, Issue 5, May 2016 IF- 3.827 ISSN: (2349-4077)
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# YIELD RESPONSE OF FINGER MILLET *(ELEUSINE CORACANA* (L) GAERTN) TO TRANSPLANTING DATE, INTRA-ROW SPACING AND POULTRY MANURE IN BAUCHI, NIGERIA

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## ABSTRACT

*A field trial was conducted during 2009, 2010 and 2011 cropping seasons at the Teaching and Research farm of Abubakar Tafawa Balewa University, Bauchi (10$^o$ 17$^1$, 09 49E: 609m ASL) in the Northern Guinea Savannah of Nigeria to investigate the response of finger millet (Elensine caracana (L) Gaertn) to transplanting date, intra-row spacing and poultry manure. Split Split-plot design was used. Transplanting date, intra-raw spacing and poultry manure had significant effect on several characters tested. The results indicated that transplanting finger millet on 30 June, using 10cm intra-row spacing under 6t/ha poultry manure gave higher spike length and number of seeds/spikelet, leaf area index and consequent higher grain yield, respectively.*

**Keywords:** Finger millet, transplanting date, spacing, poultry manure, yield.

## INTRODUCTION

Finger millet is the second most widely grown millets on the continent of Africa. Finger millet accounts for about 10% of total production of all millets after pearl millet which accounts for 19 million hectares of area put to all millets in Africa (Obilana, 2002). In Africa, the yield of finger millet is generally low; this could be due to several production constraints which include: little research emphasis given to the crop by individuals and organizations, poor attitude to the crop, lack of improved varieties, lodging effect and moisture stress in dry areas of growth, non adaption of improved technologies, threshing and milling problems (Degu, *et al*., 2009). In Nigeria, finger millet is produced mostly in the Northern part of the country, especially Plateau and Kaduna States. However, there is no annual record of hectares cultivated because this is often combined with pearl millet and other related crops. Of recent, Shinggu, *et al*. (2009) recorded an average yield of 580 – 785 kg/ha under NPK fertilizer. This is still very low when considered vis-à-vis other mineral and organic fertilizers which have been used for improving crop yield (Tariq, *et al*., 2007; Babarick and Ippolito, 2003). In the last decade, most rural and urban farming communities have advocated for use of organic manure because organic manure after it is used in cropping often leaves the soil safer than when mineral fertilizers are used. Besides, organics such as poultry manure have been known for amending soils and providing nutrients especially nitrogen to crops (Cuevas, *et al.*, 2006). An understanding of crop and soil relationships is very important in crop production. Knowledge of the appropriate spacing for crop plants have as well served as means of crop improvement. Sarmezey (1978) reported superior plant height in finger millet spaced 45.0cm apart over those spaced 90.0cm. Similarly, Shinggu, *et al*. (2009) found out that narrow spacing in finger millet gave better yield and weed control than wider spacing. The timing of transplanting on its own part has either positive or adverse effect on crop performance. Safdar, *et al*. (2008) reported significant effect of transplanting date on yield, yield components and days taken to 100% flowering of fine grain rice genotype; they found out that transplanting carried out during 1 – 15 July was found to be most suitable for obtaining better yields than 15 May – 16 June or 16 July – 1 August. Due to early transplanting at 2 weeks after planting, Agbaje and Olofintoye (2002) obtained comparable yield to that of direct seeded plants. With this background, a field study was planned to determine the most suitable rate of poultry manure, intra-row spacing and appropriate transplanting date of finger millet grown in Bauchi, Nigeria for optimum productivity.

## Materials and Methods

A field study was carried out at Abubakar Tafawa Balewa University Teaching and Research Farm Bauchi, Nigeria ($10^o$ 17'$^N$, 09 49$^E$: 609m ASL) during 2009 – 2011 wet seasons. Split Split – plot design with three replications nested in date was adapted. Transplanting date was the main effect and there were three transplanting dates (30 June, 7 and 10 July) in 2009, 2010 and 2011, respectively. Transplanting date (main plot) was split into four row spacing (10, 15, 20 and 25cm) and spacing was further split into four poultry manure levels (0, 3, 6 and 9t/ha). Intra-row spacing and poultry manure were placed in the subplot and sub sub-plot, respectively. The sub sub-plot size was $3m^2$. The soil of the experimental site was sandy loam (Table 1) and the meteorological data recorded during the period of study is presented in Table 2 while the poultry manure composition is presented in Table 3.

Table 1: Physiochemical properties of soil of the experimental site

| Soil property | Values at 0 – 30 cm depth | | |
|---|---|---|---|
| | 2009 | 2010 | 2011 |
| Physical Properties (%) | | | |
| Clay | 16.32 | 22.32 | 21.80 |
| Silt | 13.28 | 9.28 | 7.00 |
| Sand | 70.40 | 68.40 | 71.20 |
| Textural class | Sandy loam | Sandy loam | Sandy loam |
| Chemical properties | | | |
| Organic C (mgkg$^{-1}$) | 0.92 | 1.32 | 1.16 |
| Total nitrogen (%) | 0.09 | 0.18 | 0.21 |
| Available P (Mgkg$^{-1}$) | 8.64 | 10.11 | 9.21 |
| $P^H$ in 0.01 $Cacl_2$ | 5.10 | 5.90 | 5.39 |
| CEC (Cmol kg$^{-1}$) | 7.21 | 7.87 | 8.01 |
| Exchangeable acidity ($Al^{3+}$ $H^+$) | 1.36 | 1.14 | 1.18 |
| Electrical conductivity | 15.00 | 11.00 | 12.00 |
| Exchangeable Bases | | | |
| Ca (Cmol.kg$^{-1}$) | 2.67 | 3.16 | 3.12 |
| K(Cmol kg$^{-1}$) | 0.22 | 0.28 | 0.31 |
| Mg(Cmol kg$^{-1}$) | 0.59 | 0.62 | 0.68 |
| Na(Cmol kg$^{-1}$) | 0.18 | 0.14 | 0.17 |

Table 2: Monthly mean rainfall, temperature and days with precipitation during growth period of finger millet

| Month | 2009 | | | 2010 | | | 2011 | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of Days with Precipitation | Temperature $^oC$ | Rainfall (mm) | No. of days with Precipitation | Temperature $^oC$ | Rainfall (mm) | No. of days with Precipitation | Temperature $^oC$ | Rainfall (mm) |
| June | 06 | 33.0 | 211.08 | 09 | 29.6 | 226.06 | 07 | 32.02 | 138.08 |
| July | 18 | 32.0 | 158.09 | 20 | 28.8 | 146.20 | 17 | 28.09 | 142.02 |
| August | 19 | 29.4 | 364.00 | 23 | 28.5 | 340.30 | 21 | 29.0 | 334.08 |
| September | 10 | 30.9 | 166.05 | 18 | 29.3 | 182.08 | 16 | 31.00 | 142.02 |
| October | 03 | 32.0 | 82.02 | 04 | 32.0 | 80.01 | 04 | 32.00 | 82.00 |
| November | - | 34.00 | - | - | 33.1 | - | - | 34.00 | - |
| Total days with Precipitation | 56 | | | 74 | | | 65 | | |

The experimental plot was ploughed each year, harrowed twice at the beginning of each rainy season and marked into plots according to specifications. Composition of a composite sample of the poultry manure used in each year is presented in Table 3.

Table 3: Composition of Poultry Manure (%)

| Nutrient | 2009 | 2010 | 2011 |
|---|---|---|---|
| Organic carbon | 36.25 | 38.17 | 38.66 |
| Nitrogen | 3.86 | 3.80 | 3.87 |
| Phosphorous | 1.23 | 1.27 | 1.25 |
| Potassium | 2.72 | 2.80 | 2.79 |

The poultry manure was applied by hand and worked into the soil using a hand hoe one week before each transplanting was carried out. To maintain the same seedling age, finger millet seeds was earlier seeded in a nursery near the experimental site on 9, 16 and 23 June each year. At three weeks old, the seedlings seeded on 9, 16 and 23 June each year were carefully uprooted and transplanted on 30 June, 7 and 14 July each year, respectively. Two plants per stand were transplanted and later thinned to one plant per stand. All other agronomic, cultural and plant protection practices were kept normal and uniform in all seasons.

At maturity, the plants were harvested manually by cutting with a hand knife at about 10cm above ground level. Characters assessed included leaf area index (LAI) at 9 weeks after transplanting (WAT), spike length (cm), number of spikelets per spike, number of seeds per spikelet, 1000 grain weight (g) and grain yield (kg/ha).

Leaf Area Index: It was calculated as ratio of leaf surface area to the ground area occupied by a plant). LAI = leaf area/ground area.

Spike Length: This was measured with a tape from 20 randomly selected spikes at harvest from the middle of a row in each plot and the average recorded.

Number of Spikelets per Spike: From 20 sampled plants, the spikelets on each spike was carefully counted at harvest and the average taken per spike.

Number of Seeds per Spikelet: From 20 sampled plants that were consider, the seeds on each spikelet were carefully removed, placed in a container and carefully counted, averaged and recorded.

Seed Index: 1000-grains were counted first and weigh on an electronic balance after drying for unit seed weight.

Grain Yield: Weight (g) of grains harvested from two rows in the net plot was weighed and the results obtained were converted to kilogram/ha.

Data recorded were statistically analyzed using genstat 7.0 and the means were separated using DMRT.

**RESULTS AND DISCUSSION**

Leaf Area Index: Transplanting date did not affect leaf area index (LAI) in the three years. Intra-row spacing had significant effect on LAI. At 10cm intra-row spacing, maximum LAI (4.2) was produced (Table 4) as against the minimum (1.7) at 25cm intra-row. The trend of increase in LAI at the various intra-rows showed 10cm intra-row spacing was significantly higher than 15cm intra-row spacing which was higher than 15cm intra-row spacing which was higher than 20cm, which was in turn higher than 25cm intra-row spacing. The findings were in line with Gautam, *et al*. (1982) and Shinggu, *et al*. (2009) who reported increased LAI in finger millet to be due to narrow spacing. Graybill, *et al*. (1991) reported that increase in LAI of maize and rice was due to increased plant density resulting from narrow spacing.

LAI increased as poultry manure level increased up to 6t/ha. The increase due to 9t/ha of poultry manure was however at par to that resulting from 6t/ha manure. The highest (3.2) and the lowest (1.9) LAI were recorded under 9t/ha poultry manure and in control plot, respectively.

Fairly good rainfall and its distribution especially within the months of June and July (Table 2) might have enhanced good finger millet development. The uptake of nutrients released from the poultry manure coupled with good weather, good soil, pH and high cation exchange capacity might have been other reasons for the high leaf index recorded. Rangaraj, *et al*. (2007) had reported that increased plant growth as reflected in LAI was due to moisture availability and adequate fertilization.

Spike Length (cm): Transplanting date had significant effect on spike length. Finger millet transplanted on 30 June and 7 July produced statistically similar spike length but was significantly different from spikes produced from 14 July transplanting. Intra-row spacing did not affect spike length. The higher increase in spike length of 30 June and 7 July transplanting over 14 July transplanting could be due to the fact that finger millet transplanted early in the season probably had longer rainfall duration hence, longer vegetative period of growth which translated into longer spikes than late transplanting of 14 July. This finding agrees with Mohamed, *et al.* 2011) who found out that increased in spike length of bread wheat (Triticum aestivum L.) was associated with low soil moisture depletion level of 50% as against 60 and 75%, respectively. Poultry manure increased spike length significantly. Spike length increased at increasing levels of poultry manure.

Spikes recorded under 6 and 9t/ha poultry manure were however at par but significantly higher than when 3t/ha poultry manure was used. Control plot produced the lowest spike length.

Number of Spikelets per Spike: Transplanting date and intra-row spacing had non-significant effect on number of spikelet per spike. Poultry manure affected number of spikelets. Each increase in poultry manure level resulted in significant increase in number of spikelets produced. The highest number of spikelets (89.61) and the lowest (55.05) were recorded at 9 and 0t/ha poultry manure, respectively. The increase in number of spikelets could be due to effect of the nitrogen released from the poultry manure and its subsequent uptake by the finger millet for enhanced development of the spikelet. Tariq, *et al*. (2007) had reported that application of poultry litter amends soils, provides nutrients to crops; consequent, yield increase. The join effect of nitrogen released from the poultry manure, rainfall and warm temperature recorded (Table 2) during the period of study could be other reasons for the high number of spikelets produced.

Table 4: Yield and yield related character of finger millet as affected by Transplanting date, intra-row spacing and poultry manure

| Treatment | LAI 9WAT | Spike Length (cm) | Number of Spikelets/ Spike | Number of seeds/spikelet | 1000Grain wt(g) | Yield Kg/ha |
|---|---|---|---|---|---|---|
| Transplanting date | | | | | | |
| 30 June | 2.7 | 8.63[a] | 76.18 | 6.35[a] | 3.82 | 484.00 |
| 7 July | 2.6 | 8.57[a] | 74.06 | 5.35[b] | 2.29 | 428.00 |
| 14 July | 2.7 | 8.10[b] | 77.85 | 4.81[c] | 2.25 | 415.00 |
| SE± | 0.006 | 0.070 | 1.000 | 0.102 | 1.234 | 29.513 |
| Intra-row Spacing (cm) | | | | | | |
| 10 | 4.2[a] | 8.51 | 73.00 | 5.62 | 2.36 | 429.00 |
| 15 | 2.8[b] | 8.46 | 79.76 | 5.48 | 3.23 | 420.00 |
| 20 | 2.1[c] | 8.45 | 76.74 | 5.51 | 2.28 | 423.00 |
| 25 | 1.7[d] | 8.31 | 74.42 | 5.38 | 2.27 | 426.00 |
| SE± | 0.076 | 0.081 | 1.155 | 0.118 | 1.024 | 34.079 |
| Poultry Manure (t/ha) | | | | | | |
| 0 | 1.9[c] | 2.27[c] | 55.05[d] | 3.54[d] | 2.20 | 122.00[c] |
| 3 | 2.6[b] | 8.86[b] | 77.09[c] | 5.05[c] | 4.28 | 450.00[b] |
| 6 | 3.1[a] | 8.82[a] | 84.37[b] | 6.49[b] | 2.33 | 637.00[a] |
| 9 | 3.2[a] | 9.04[a] | 89.61[a] | 6.93[a] | 2.31 | 561.00[a] |
| SE± | 0.076 | 0.81 | 1.155 | 0.118 | 1.024 | 34.079 |

Means in a column followed by different letter(s) are significantly different at 5% level of probability using DMRT.

Number of seeds per Spikelet: Transplanting date had significant effect on seeds produced. The highest seeds were produced from 30 June transplanting with the least from 14 July transplanting. The decreased in number of seeds per spikelet from 30 June transplanting through 14 July transplanting could be due to delayed transplanting and delayed recovery from transplanting shocks with consequent low seeds. This finding is in line with Agbaje and Olofintoye, *et al.* (2002) who reported that delayed transplanting in sorghum reduced grain yield of two cultivars in drought prone area of West Africa. Intra-row spacing did not affect number of seeds per spikelet. Poultry manure affected number of seeds significantly. Number of seeds generally increased at increased level of poultry manure. The highest number of seeds (6.93) was recorded at 9t/ha manure with the lowest (3.54) in control plot. Number of seeds per spikelet was affected by both transplanting date and poultry manure. Gautam, *et al.* (1982) and Muthuswamy (1985) reported similar findings but associated it to increased nitrogen and phosphorus fertilization; the source in the study being poultry manure.

1000-grain weight (g): 1000-seed weight was neither affected by transplanting date, intra-row spacing or poultry manure in this study. This phenomena seems to suggest that see size of finger millet may not be affected by environment. This finding aligns with results reported by Mnyenyembe and Gupta (1998) that variability in mean grain yield of male fertile and male sterile finger millet was heredity.

Grain Yield (kg/ha): Transplanting date and intra-row spacing had no significant effect on finger millet grain yield. Poultry manure affected grain yield significantly. The increase in grain yield after applying 3, 6 and 9t/ha poultry manure was 268.9, 422.1 and 359.8%, respectively more than control. Sridhar and Ashwini (2006) reported increased growth and dry matter yield in finger millet to be due to application of pill millipede compost. Gautam, *et al*. (1982) elsewhere reported similar increase to be due to increased nitrogen and phosphorus uptake.

Conclusion

In this study, it can be concluded that finger millet be transplanted on 30 June, at 10.0cm intra-row spacing under 6t/ha poultry manure for enhanced growth and yield performance.

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