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# EFFECT OF SEED SOWING TYPE AND SEED RATE ON THE PRODUCTIVITY OF FONIO (*Digitaria exilis* L.) IN BOGORO, BAUCHI STATE, NIGERIA

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## ABSTRACT
Field experiment was conducted during the cropping seasons of 2017 and 2018 at the research farm of Bauchi State Agricultural Development Programme sub-zonal headquarters Bogoro, Bauchi State to determine the effect of seed sowing type and seed rate on the productivity of fonio (*Digiteria exilis*). The treatment consist of two seed sowing types (pure seed and seed mixed with sand) using broadcasting method and five different seed rates (50, 60, 70, 80 and 90kgha$^{-1}$). The two seed sowing type and five seed rates were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. Growth and yield characters studied were plant height, leaf area, stem diameter, number of leaves per plant, number of tillers per plant, days to 50% flowering, number of seeds per tiller, 1000-seed weight and seed yield (kg/ha). The results obtained showed that, the use of pure seed during seed sowing produced significantly (P< 0.05) taller plant, thicker stem diameter, wider leaves, higher number of tillers, higher number of seeds per tiller, heavier seed and seed yield (kgha$^{-1}$) than when seeds were mixed with sand before sowing. The seed rates also differed significantly (P< 0.05) in all the growth and yield characters, where sowing of 50kg seed was observed to produce significantly (P< 0.05) higher number of leaves, tillers, seeds per tiller, seed weight and seed yield (kgha$^{-1}$) than the rest of the treatments used. Sowing of 90kgha$^{-1}$ on the other hand, produced the least seed yield. Growing the crop in 2018 rainy season was observed to produce significantly (P< 0.05) higher numbers of leaves, seeds per tiller and seed weight than 2017 rainy season. It therefore, became clear that sowing fonio seeds purely without sand at the rate of 50kgha$^{-1}$ can be recommended to farners in the study area.

**Keywords:** Fonio, Sowing, Growth, Yield.

## INTRODUCTION
Fonio (*Digitaria exilis L.*) is one of the genus specie in the family of poaceae with over 300 species. Fonio originated in West Africa as far back as 7000 years ago and it thrives well in the sandy and rocky soils of the Sahel both drought and flood situations (Morales, 2003). It is probably one of the oldest African cereal for thousands of years. West African's have cultivated it across the dry savanna where in fact, it was their major food even though few other people have never heard of it (Philip, 2006). Despite its ancient heritage and widespread, its importance, evolution, origin, distribution and genetic diversity all remain scanty even within West Africa region itself. Fonio is grown in various parts of Nigeria, Sierraleon, Ghana, Guinea Bissau, Senegal, Togo, Mali, Benin Republic and Cote Devior. The crop is known by various communities in Africa such as "*findin"* in Senegal, '*findo*'' in Gambia, ''*Falio"* in Siere-leon, in Mali''*Foni*'' in Burkina Faso, ''*Kpendo*'' in Guinea, ''*Podgi*'' in Benin republic,*''pom/polin''* in Cote D"Iviore, acha in Nigeria and *hungry rice* in English. (Gyang and Wuyep, 2005). In Nigeria, Fonio is grown in commercial quantities in some States such as Bauchi, Kaduna, Kebbi, Plateau, Nasarawa, Niger, Gombe and FCT Abuja with Plateau being the highest producer with an estimated production of 20,000 ton per annum (Gyang and Wuyep, 2005). According to Gyang and Wuyep (2005) fonio contains about 7% crude protein that is high in leaucine (9.8%) methionine (5.6%) and saline (5.5%). It can be made into a number of dishes such as porridge and *cuscus.* It can be mixed with other ingredients to make bread, kamu, pastries, popped and beer. Fonio is highly recommended for diabetic patients by doctors, thus making the cereal very costly and unaffordable to many especially low income earners.

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As global population is projected to reach nine billion by 2050 coupled with the extinction of plant diversity and over exploitation of the cultivated species, special attention has to be directed towards research, cultivation and utilization of those plant species that are either neglected and or underutilized. Over 2000 crops that are native to Africa, grain crops such as rice, pearl millet, finger millet, sorghum and fonio (Acha) could be effective in fighting hunger in the continent (Abdullahi and Luka 2003). The world population, and in particular countries in Africa, will continue to depend on cereal grains (Wrigley *et al.*, 2004). With an estimate of 30% of the total population of Africa suffering from chronic hunger and malnutrition, looking into ways of salvaging food crisis remains a challenge to all stakeholders in and outside the region due to use of low yielding varieties, lack of knowledge on some agronomic practices such as seed sowing method, seed rate application, non-application and or under application of fertilizer, incidence of pest and diseases management among others. Despite the verse production area of fonio in the study area, it is discovered that farmers are not adequately using the recommended seed sowing type in order to obtain higher yield. The other main challenge facing fonio production in the study area is the seed rate which has resulted to varying amount of yield. One of the interventions to improving fonio production could be the use of recommended seed rate and seed sowing method practiced by the farmers which could bring about higher yields. Hence, with the numerous benefits derived from using improved fonio production technologies, so many farmers are still not aware of these technologies, Jideani (2011) revealed a severe decline in fonio production in fonio producing states of Nasarawa, Niger, Plateau and Bauchi due to problems of out-dated farming practices, parasitic weeds, pests and diseases. In view of the declining fonio production in Nigeria, it is pertinent to intensify efforts toward improving its production through the use of recommended seed sowing method, required seed rate and other agronomic practices. The increasing problems of food insecurity in Nigeria and the recognition of orphan crops like fonio as a potential buffer against famine are expected to stimulate the expansion of land area devoted to its cultivation in the country. However, available statistics demonstrates the reduction of fonio harvested area in several countries, except in Nigeria, Cote Divoire, and Guinea, implying the significance of the crop in the country. In year 2002, a total area of 347,380 hectares was devoted to hungry rice production in Africa (Cruz, 2004), with Nigeria alone providing almost half of that area (150,000 ha). In view of its economic importance for domestic and international application, there is need to vigorously research more into agronomic practices that could better its production. The study was therefore carried out to study the effect of seed sowing type on the growth and yield of fonio and determine the required seed rate on the productivity of fonio in the study area.

## MATERIALS AND METHODS

### Experimental Site

The experiment was carried out at the demonstration farm of Bauchi State Agricultural Development Programme (BSADP) Sub-Zonal Headquarters, Bogoro Local Government Area. The research was carried out during the wet seasons of 2017 and 2018. Bogoro is located in Southern part of Bauchi State with a total land area of 1,210,180 (people). About 80-95% of the population are farmer's involed in both crop and livestock production. Bogoro is located between latitude 9.300 and 1200 north of the equator and longitude 8.500 and the Greenwich meridian and located at an altitude of about 690.2m above sea level. The Local Government Area experience both rainy and dry seasons of the year. The mean annual rainfall is 680mm while temperature ranges from as low as 11$^{o}$C to as high as 40$^{o}$C.

### Soil Sampling and Analysis

Composite soil samples of the experimental site were collected at a depth of 0 – 30cm. A 'Z' pattern was used in collecting the soil samples following the procedure of IFDC (2003). It was then taken to the soil science laboratory of faculty of Agriculture Abubakar Tafawa Balewa University (ATBU) Bauchi for physical and chemical analysis using standard procedure as described by Black (1968) and Whingwiri *et al.* (1987).

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**Experimental Materials and their Sources**

The experimental material used was the fonio seeds. The seed is a caryopsis, which remains sorrounded by glumes and husks. Its size is very small, only 1.5mm (around 1000-2000 seeds to 1 gram) and brown in colour. The seeds were obtained from a local source in Bogoro Local Government Area, Bauchi. The variety sown is commonly called Chid wandad (*Digitaria exilis*), a medium maturity which can be harvested 80-120 days after sowing and potential yields are relatively stable, the yield average is currently 1t/ha.

**Treatments and Experimental Design**

The treatments consisted of two seed sowing types (pure seed and seed mixed with sand) and five seed rates (50kg, 60kg, 70kg, 80kg, 90kgha). The two seed sowing types and five seeding rates were factorially combined to give ten (10) treatment combinations and laid out in a randomized complete block design (RCBD) with three replications

**Data Collection**

In each of the experimental plots having gross plot size of 3m x 3m ($9m^2$), an area of 2m x 2m ($4m^2$) was earmarked as net plot from which 20 plants were randomly selected as sampled plants. The twenty (20) sampled plants from each plot were tagged with a white ribbon for easy identification from these samples. Data on growth phenology and yield components were collected.

**Data Analysis**

Data collected on growth and yield characters were subjected to analysis of variance (ANOVA) using statistical software GENSTAT Release 7.2 DE (LAT 2007). Significantly different means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability

## RESULT AND DISCUSSION

**Plant Height (cm)**

Table 1 shows the effect of seed sowing type and seed rate on plant height of fonio. The results revealed a significant ($P \leq 0.05$) difference at 4 and 6WAS where the use of pure seed produced taller plants than when the seeds were mixed with sand before sowing. This implies that, adoption of pure seed encourages earlier plant growth than when seed were first mixed with sand before broadcasting.

The result further revealed a significant ($P \leq 0.05$) variation amnong the different seed rates at 4, 6 and 10WAS except at 8WAS where no significantl ($P \leq 0.05$) difference was observed. Taller plants were obtained from 50kg seed rate throughout the study period but at per with 60kg at 10WAS. The significantly ($P \leq 0.05$) shorter plants were however obtained from the broadcasting of 90kg seed rate. The significantly ($P \leq 0.05$) higer plant height obtained with 50kg seed rate plots over higher densely seeded (90kg seed rate) could be attributed to the densely populated seeds grown on limited available nutrients and space. The result of this study is in line with that of Daichi *et al*. (2014), who obtained higher plant growth characters of Fonio (*Digiteria exilis L.*) under lesser density than densely populated method. Similarly, Ayo *et al.* (2010) reported that sowing method exhibits significant variations with respect to plant height. The two seasons also displayed significant ($P \leq 0.05$) difference between them at plant height where 2018 produced significantly ($P \leq 0.05$) taller plants than 2017 season. This could be due to variation in weather conditions as 2018 received higher amount of rainfall than 2017.

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**Table 1:** Effect of Seed Sowing Type and Seed Rate on Plant Height of Fonio

| | WAS | | | |
|---|---|---|---|---|
| **Treatment** | 4 | 6 | 8 | **10** |
| **Seed Sowing Type** | | | | |
| Pure seed | 20.11[a] | 40.17[a] | 65.02 | 82.31 |
| Seed with Sand | 19.57[b] | 38.10[b] | 63.63 | 82.15 |
| LS | ** | ** | NS | NS |
| SE± | 0.108 | 0.269 | 0.564 | 0.346 |
| **Seed Rate (kg)** | | | | |
| 50 | 24.28[a] | 43.26[a] | 65.97 | 85.46[a] |
| 60 | 19.62[b] | 40.58[b] | 65.87 | 84.23[a] |
| 70 | 19.22[b] | 39.33[c] | 64.38 | 82.41[b] |
| 80 | 18.31[c] | 37.01[d] | 62.54 | 80.24[c] |
| 90 | 17.79[d] | 36.18[d] | 62.86 | 78.81[c] |
| LS | ** | ** | NS | ** |
| SE ± | 0.171 | 0.426 | 0.892 | 0.548 |
| **Season** | | | | |
| 2017 | 19.38[b] | 37.60[b] | 61.14 | 81.59 |
| 2018 | 20.31[a] | 40.67[a] | 67.50 | 82.87 |
| LS | ** | ** | NS | NS |
| SE ± | 0.108 | 0.269 | 0.798 | 0.346 |
| **Interaction** | | | | |
| SR × SST | ** | ** | NS | NS |
| SST × SEASON | ** | NS | NS | NS |
| SR × SEASON | NS | NS | NS | NS |
| SR×SST×SEASON | NS | NS | NS | NS |

**LS** = Level of Significance. **SE**±= Standard Error. ** Significant at 0.01Level of Probability. **NS**= Not Significant. **WAS**= Week after Sowing

**Leaf Area**

Table 2: Showed the effect of seed sowing type and seed rate on leaf area of fonio. The result revealed a significant (P≤ 0.05) difference among the treatments used throughout the study period. The result further showed that, the use of pure seed was observed to produce significantly (P≤ 0.05) wider leaves than when seed were mixed with sand. This indicated that fonio plant produce wider leaves when pure seed type of sowing is adopted. Leaves are the primary food-making part of the plant through absorbtion of carbondioxide from the air, combine it with nutrient and water that comes from the roots of the plants to make food (glucose) and release oxygen into the air. It is therefore clearly believes that, anything that affect the leaf of a plant can affect the yield as well. The result further indicates a significant (P≤ 0.05) difference among the different seed rate used throughout the study period, where the use of 50kgha of seed was observed to produce significantly (P≤ 0.05) higher leaf area than the other seed rates, while the least was observed when 90kg seed rate was used. This could be as a result of optimum utilization of available nutrients, sunlight interception and other growth factors that resulted on wider leaves. This result collaborated with that of Ayuba *et al.* (2003) who reported that plant density is associated with wider leaves in rice (*Oryza sativa*).

The two seasons of the study on the other hand, differs significantly (P≤ 0.05) in terms of leaf area, where 2018 rainy season produced significantly (P≤ 0.05) wider leaf area than 2017. This shows that there was optimum utilization of rainfall, humidity, photosynthesis and other growth factors compared to 2017 season, except at 10WAS where no significant (P≤ 0.05) difference was observed among the seasons of study.

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**Table 2**: Effect of Seed Sowing Type and Seed Rate on Leaf Area of Fonio

| | WAS | | | |
|---|---|---|---|---|
| **Treatment** | 4 | 6 | 8 | 10 |
| **Seed Sowing Type** | | | | |
| Pure seed | 2.63 | 4.13[a] | 4.56[a] | 3.38 |
| Seed with Sand | 2.56 | 3.99[b] | 4.40[b] | 3.32 |
| LS | NS | ** | ** | NS |
| SE± | 0.021 | 0.036 | 0.018 | 0.040 |
| **Seed Rate (kg)** | | | | |
| 50 | 2.88[a] | 4.46[a] | 4.88[a] | 3.76[a] |
| 60 | 2.76[b] | 4.33a[b] | 4.77[b] | 3.56[b] |
| 70 | 2.65[c] | 4.23[b] | 4.60[c] | 3.37[c] |
| 80 | 2.38[d] | 3.71[c] | 4.13[d] | 3.08[d] |
| 90 | 2.31[d] | 3.57[c] | 4.03[e] | 2.98[d] |
| LS | ** | ** | ** | ** |
| SE ± | 0.033 | 0.057 | 0.029 | 0.063 |
| **Season** | | | | |
| 2017 | 2.47[b] | 3.92[b] | 4.37[b] | 3.34 |
| 2018 | 2.72[a] | 4.20[a] | 4.59[a] | 3.36 |
| LS | ** | ** | ** | NS |
| SE ± | 0.021 | 0.036 | 0.018 | 0.040 |
| **Interaction** | | | | |
| SR × SST | ** | NS | NS | NS |
| SST × SEASON | NS | NS | NS | NS |
| SR × SEASON | NS | NS | NS | NS |
| SR×SST×SEASON | NS | NS | NS | NS |

**LS** = Level of Significance. **SE**±= Standard Error. **= significant at 0.01Level of Probability. **NS**= Not Significant. **WAS**= Week after Sowing

**Number of Tillers per Plant**

The result in table 3 shows the effects of of seed sowing type and seed rate on number of tillers of fonio. The results revealed a significant (P≤ 0.05) difference among the treatments used. The result further showed that, the use of pure seed type produced significantly (P≤ 0.05) higher number of tillers per plant than when the seed were mixed with sand. The result also indicateed broadcasting of 50kg seed was observed to produce significantly (P≤ 0.05) higher number of tillers per plant than the other seed rates used. This could be attributed to lesser plant density that utilized the limited available nutrients and other growth factors which favored the development of tillers and vegetative growth of the crop. This result is in line with that of Dachi *et al*. (2014), who obtained higher number of tillers and yield characters of fonio (*Digiteria exilis* L) under drilling method of sowing than broadcasting method. Similarly, Ayo *et al.* (2010) reported that density exhibit significant variations in respect of all growth and yield parameters of wheat (*Triticum aestivum* L.).

**1000 Seed Weight**

The result in Table 3 also showed that, two seed sowing types significantly (P≤ 0.05) differed in terms of 1000-seed weight. The result further revealed that, use of pure seed to produced heavier 1000-seed than when the seed were mixed sand. Seed rate on the other hand, the result shows that 50kg produced significantly (P≤ 0.05) higher 1000-seed weight than all the other seed rate considered; while the least was obtained when 90kg seed rate was used. This could be attributed to lesser plant density that utilized the limited available nutrients and other growth factors that facilitates the vegetative growth of the crop which translated to the heavier seed weight.

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Among the season of the study however, significant (P≤ 0.05) difference was observed where 2018 recorded heavier seeds than 2017. This implies that, fonio productivity can be influence to produced heavier seed when there is higher amount of rainfall. This shows that there was optimum utilization of nutrients, maximum rainfall, humidity, photosynthesis and other growth factors which facilitate the crop during 2018 as compared to 2017.

**Days to 50% Flowering.**

Table 3 also presented result on the effect of seed sowing type and seed rate on days to 50% flowering of fonio. The result showed that, among the seed sowing type, days to 50% flowering shows no significant (P≤ 0.05) difference among the method adopted. This implies that method of seed sowing does not influence days to 50% flowering and maturity period of the crop. The result also revealed a significant (P≤ 0.05) difference among the seed rate. The result revealed that densely populated fonio plant produces flowers first before the lesser populated ones. Broadcasting of 90kg seed rate was observed to produced significantly (p≤ 0.05) higher days to 50% flowers than all the other seed rate, while the lately days to 50% flowers were recorded when 50kg seed rate was used. It could be as a result of luxury or higher accumulation of biomass that affects the lesser populated plants to initiates flowering earlier compared to the densely populated ones. It further suggested that, less populated plant utilized the opportunity in developing more tillers than initiating flowers. Result from both seasons of study shows that there was no significant (P≤ 0.05) difference. Both produce flowers at 59.67 and 60.00 days the same time. This implies that fonio can initiates flower when the plant ascertains the required number after sowing.

**Seed Yield**

The result in Table 3 indicated that there was a significant (P≤ 0.05) difference among the two seed sowing types adopted throughout the study period. The result further showed that, the use of pure seed produced the highest seed yield than when the seed were mixed with sand. This could be as a result of wider spacing created when the seed were mixed with sand as a result of sparsely sown than when the seed were purely sown or broadcasted. This is in agreement with the findings of Idoko and Baba (2018) who reported a similar trend. Among the seed rate, it also indicated a significant (P≤ 0.05) difference throughout the study period. The use of 50kg seed rate was observed to produce significantly (P≤ 0.05) highest seed yield than the other treatment used, while the least was obtained when 90kg seed rate was used. This is as a result of lesser populated plants deriven the advantage of adequate utilization of available nutrients, photosynthesis and other growth factors that encourage plant vigor which translate to the seed yield obtained as highly populated plants gave lesser due to competition on the limited available nutrients. The result of this study lend support from the findings of Musa *et al*. (2008) who reported that competition resulted to reduced growth and decrease in final yield. Result from the season of study shows that, no significant (p≤ 0.05) difference was observed but the highest seed yield was obtained in 2018 season while the least was recorded from 2017 season. This reveals that rainfall and atmospheric condition plays significant role on fonio performance.

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**Table 3**. Effect of Seed Sowing Type and Seed Rate on Number of Tiller per Plant, 1000 Seed Weight, Days to 50% Flowering and Seed yIeld of Fonio

| **Treatment** | No. of tiller | 1000 Seed Wieght | Days to 50% Flowering | Seed Yield |
|---|---|---|---|---|
| **Seed Sowing Type** | | | | |
| Pure Seed | 129.90[a] | 0.99[a] | 66.33 | 129.90[a] |
| Seed with Sand | 119.20[b] | 0.90[b] | 66.60 | 119.20[b] |
| LS | ** | ** | NS | ** |
| SE± | 1.982 | 0.007 | 0.084 | 1.982 |
| **Seed Rate** | | | | |
| 50 | 174.33[a] | 1.13[a] | 75.83[e] | 174.33[a] |
| 60 | 161.58[b] | 101[b] | 70.17[d] | 161.58[b] |
| 70 | 141.50[c] | 0.92[c] | 65.67[c] | 141.50[c] |
| 80 | 83.42[d] | 0.87[d] | 60.83[b] | 83.42[d] |
| 90 | 61.92[e] | 0.80[e] | 59.83[a] | 61.92[e] |
| LS | ** | ** | ** | ** |
| SE ± | 3.134 | 0.011 | 0.134 | 3.134 |
| **Season** | | | | |
| 2017 | 121.00 | 0.89[b] | 66.47 | 121.00 |
| 2018 | 128.10 | 1.01[a] | 66.47 | 128.10 |
| LS | NS | ** | NS | NS |
| SE ± | 0.021 | 0.007 | 0.084 | 0.021 |
| **Interaction** | | | | |
| SR ×SST | NS | NS | ** | NS |
| SST × SEASON | NS | NS | NS | NS |
| SR × SEASON | NS | NS | NS | NS |
| SR×SST×SEASON | NS | NS | NS | NS |

**Field Survey;** 2017/2018 **LS** = Level of Significance. **SE**±= Standard Error. ** = significant at 0.01 Level of Probability. **NS**= Not Significant. **NTPP**= Number of Tiller per Plant. NLPP= Number of Leaf per Plant. NSPT= Number of Seed per Tiller

## CONCLUSION AND RECOMMENDATION

The results of the study clearly indicated the significance of sowing type and seed rate in fonio, where the use of pure seed without sand during sowing and at the rate of 50kgha produced higher yield than all the other treatments studied. Therefore, decision to be taken on the types of seed sowing on the quantity of seed to be used in fonio may not be over emphasized. From the results obtained, farmers in the study area could be advice to:

I. Use pure seed during fonio seed sowing.
II. Sow fonio at the rate of 50kgha

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