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Research Article

Response of Fonio (*Digiteria spp*) to different Planting Methods under Rain-fed Condition

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Abstract

Fonio respond differently at different sowing conditions. Field experiment was conducted to assess effects of planting methods on Yield Components of Fonio (Digitaria spp) under rainfed condition in 2021 and 2022. Randomized complete block design with three replications was adopted for the experiment. The results revealed that planting methods (dibbling, drilling broadcasting and transplanting) used had significant effect on all the yield components and grain yield. Transplanting was leading in number of tillers per plant with an average of 13.8, surpassing dibbling and drilling. In days to 50% flowering, transplanted crops took longer (115.1) days to reach 50% flowering. However, fonio appears to mature earlier when drilling and transplanting methods are adopted. Taller plants, longer spikes, longer panicles, higher number of tillers and higher grain yield were observed when transplanting method was applied in fonio field cultivation. Therefore, transplanting method could be recommended for increased tillers, longer spikes and higher grain yield of fonio under rainfed condition.

Keywords: ***Fonio, Transplanting, yield components, Digitaria, drilling, dibbling, broadcasting***

Introduction

Fonio is known and called Acha in Nigeria, originated from western coast of Africa (Cruz and Beavogui, 2016). The cereal is cultivated under a wide range of environmental conditions, from tropical monsoon climate in Western Guinea to the hot and arid conditions of Sudan and Sahel in the chad basin (Sagbadja, 2010). Reports from Isong *et al* (2022) indicated that black fonio (*Digitaria iburua*) is one of the two cultivated species of acha in Nigeria. The species has great potentials for agriculture in marginal environments (Barnaud, *et al*., 2017; Ayenan *et al*., 2018), it contains desirable amount of thiamine (Vitamin B1), riboflavin (Vitamin B2), calcium and phosphorous (NRC, 1996). Inspite of the potential of fonio in food and nutrition, the crop is less recognized for improvement (Adoukonou-Sagbadja *et al*.,1996). Gupta *et al*., 2010 reiterated a yield figure of less than 1000kg/ha for fonio and other small millet diversity and was considered by Seetharam 1998 to be generally lower than other major cereals like rice and maize. Besides the parameters that affects duration of the flowering period,

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pollination behavior and seed set, good agronomic practice is regarded also as paramount for improved productivity and yield stability in fonio (Gupta *et al*., 2012). Amongst other factors that increase yield, Meleha *et al*., (2020) highlighted the importance of suitable planting methods. The authors further buttress that small seeded cereals like fonio, unsuitable planting method causes difficulty in field management**,** crop management, water management, resulting in eventual low output of the crop per hectare.

In West Africa, fonio farmers adopt broadcasting method mainly since it equires minimum labours. To have optimum plant population and regular seed distribution in unit area, Soomro *et al*., (2009) suggested that only a skilled person should broadcast the seeds for uniform scattering and the ploughed field should be in a perfect condition to trigger germination.

In Broadcasting, the seeds are broadcasted in a narrow strip and the sowing is completed strip by strip. To ensure a good and uniform population, it is better to broadcast on either direction. Fonio seeds are tiny, hence they are mixed with sand at a ratio of 1:6 to make it bulky and for easy handling according to NCRI (2022). After broadcasting, the seeds are covered gently either using a plough with a very shallow ploughing or some wooden planks (boards / levelers) are used to cover the surface. In some cases, tree twigs or shrub branches are used. However, this planting method is disadvantaged by the fact that all seeds broadcasted have no contact with the soil and one hundred 100% germination is not possible (NCRI, 2022). Also, enhanced seed rate is required and Seeds cannot be placed in desired depth, pronounced lodging is common in broadcasting method because desired depth ensures perfect anchorage.

Dibbling is also known as line sowing by Inserting seeds through a hole at a desired depth and covering the hole. Dibbling is practiced on plain surface and ridges and furrows or beds and channels. This type of sowing is practiced only under suitable soil condition. Both beds and channels, ridges and furrows come under line sowing. Earthing up is essential for proper anchorage of the root system. Advantages of line sowing include uniform population, better germination and reduced seed rate according to NCRI, (2022)

Drill sowing (or) Drilling is the practice of dropping seeds in a definite depth covered with soil and compacted (NCRI, 2022). Seeds are drilled continuously or at regular intervals in rows. In this method, depth of sowing can be maintained and fertilizer can also be applied simultaneously. It is possible to take up sowing of inter crops also, it requires more time, energy and cost, but maintains uniform population per unit area. Seeds are placed at uniform depth, covered and compacted. Reports by Tanveer *et al*., (2003) suggested that drilling is an advisable sowing method due to its uniform population per unit area. As seeds are placed at a uniform depth and covered with soil, high germination and uniform stands are expected

The transplanting method has two outstanding components, nursery and transplanting. This method is sometime refers to as indirect sowing method. In nursery, young seedlings are protected more effectively in a short period and in a smaller area. Prepared seeds are placed on the well prepared nursery bed, given mulching and moderately watering until there is germination. 10 days after planting, germination should be well feasible, mulch materials are removed. Management is easy and economical. Age of seedlings is about $1/4^{th}$ of the total duration of the crop, NCRI (2022) maintained that the seedlings are transferred to the field at about 28-30 days, during which the seedlings will have had at least 3 leaves each. The seedlings are dibbled in lines on a well prepared field or optimum tilth. The advantage of transplanting includes ensuring optimum plant population, sowing of main field duration, i.e., management in the main field is reduced and crop intensification is possible. According to Hobbs and Morris (2011), this method is one of the proven farming methods that improve efficiency in fertilizer use and reduce weed infestation and crop lodging.

Recent research in fonio have presented some new planting methods beside broadcasting that is indigenous to the farmers. Reports by Yu *et al*., (2010) and Dandan *et al*, (2013) has it that high seed placement and precision methods and better resources management methods are scarcely reported and adopted. Moreso, the understanding of the response of fonio grain yield and yield

components under different planting methods could bolster adoption, increase yields per hectare and widen productivity as suggested by Olaru *et. al*., (2008). Therefore, this investigation was to assess fonio yield and yield components, how they respond when subjected to field planting using different seeding methods under rainfed condition.

Materials and Methods

The experiment was conducted in 2021 and 2022 growing season at the Acha experimental fields in the National Cereals Research Institute, Badeggi. Badeggi is at longitude $006^0$14.342' and latitude $09^0$05.683' in a North Central State of Niger in the Southern Guinea Savanna belt of Nigeria. The experimental material employed was a pure line of Digitaria ibura (IBPL05-19-03).. The experiment was designed in Randomized Complete Block with three (3) replications under rainfed conditions for the two years. A total of four (4) sowing methods were adopted, three (3) (Transplanting, drilling and Broadcasting) were suggested by Abou-Khalifa et al (2021) and one (1) (Dibbling) was proposed by NCRI (2022).
Plot size of 3m x 3m ($6m^2$) was adopted. The drilling method had 30 cm inter row spacing while transplanting and dibbling methods, 20 x 30 cm intra and inter row spacing was also adopted. All the methods followed the guidelines as stipulated by NCRI (2022), Hobbs and Morris (2011) and Abou-Khalifa et al. (2021). Uniform seed rate of 20kg/ha was adopted and in transplanting, two seedlings per stand was transplanted. Cultural practice like weeding was followed according to standard recommendation for fonio. Fertilizer application was 15:15:15 NPK inorganic fertilizer, applied in two splits of 30kg N/ha, 30 kg P_2O_2 and 30 kg/ha K_2O at 4 and 8 weeks after planting (WAP), respectively. Birds were control using wired netting from the panicle initiation to maturity. Observations and data collection were made on days to 50% flowering (DFF), Number of tillers per plant (NTPP), Number of panicles per plant (NPPP), plant height (PH), spike length (SL), panicle length (PL), number of spikes per plant (NSPP), Days to maturity (DTM), and Grain yield (GY).

After two seasons of data collection and collation, analysis of variance (ANOVA) was carried out for each year and the combined ANOVA was administered for the two years using Statistical Tools for Agricultural Research (STAR, 2014). Means that showed significance were separated using Duncan Multiple Range Test (DMRT) and figures were design using Excel 2016.

Results and Discussion

The results are presented in the Tables 1, 2, 3 . While Table 1 is showing the days to 50% flowering, number of tillers per plant and number of panicles per plant in 2021 and 2022, Table 2 is on spike length, panicle length and number of spikes per plant in the same period. Table 3 however, shows the plant height, number of days to maturity and grain yield to different planting methods in 2021 and 2022. According to Table 1, significant difference was observed for days to 50% flowering, number of tillers per plant and number of panicles per plant for the two years at 5% probability, collaborating the reports by Umar et al., (2020). DMRT also indicated that days to 50% flowering for drilling, dibbling and broadcasting were statistically the same, but transplanting flowered late at 116.35 and 113.85 days in the two years respectively. Considering the days to 50% flowering across planting methods, it could be concluded that it takes longer days for fonio to reach 50% flowering when transplanting is adopted as seeding method. Transplanting was on a clear lead with an average number of tillers per plant of 13.8 surpassing dibbling and drilling whose average had no significant difference according to DMRT and the least was recorded in broadcasting method. Dachi *et al*. (2019) had earlier reported similar result, demonstrating the positive and superior response of drilling over broadcasting methods. Meleha *et al*. (2020) demonstrated better response of plant height over other planting methods like broadcasting, Dachi *et al*. (2019) further buttressed that positive and higher plant height for drilling over broadcasting method of sowing in fonio. However, in the current study, transplanting method could be said to encourage taller plants compared to dibbling, drilling and

broadcasting, confirming the reports of Meleha *et al*. (2020) in wheat, Bashir *et al*. (2018) in rice and Dachi *et al*. (2019) and Umar *et al*. (2020) in fonio. Significant differences were also observed among planting methods (dibbling, drilling, broadcasting and transplanting) in spike length, panicle length and number of spikes per plant. Transplanting method however responded with higher values of 14.23, 24.35 and 8.48 in Spike length, panicle length and number of spikes per plant respectively. Dibbling and broadcasting methods matures at similar time and were significantly different in days to maturity from drilling and transplanting methods. Transplanting method gave the highest grain yield of 884.76kg/ha followed by dibbling with the grain yield of 741.13kg/ha. NCRI, (2022) had earlier reported that transplanting at appropriate timing could be more promising in grain yield compared to other planting methods.

Conclusion and Recommendations

Fonio is a small seeded cereal where sowing and field management could be extremely difficult, whereby unsuitable planting method causes difficulty in crop management, water management, weed management and eventful low output of the crop. Different planting methods (dibbling, drilling broadcasting and transplanting) are associated with fonio cultivation in Nigeria. However, fonio appears to mature earlier when drilling and transplanting methods are adopted. Taller plants, longer spikes, longer panicles, higher number of tillers and higher grain yield were observed when transplanting method was applied in fonio planting for two seasons. Therefore, transplanting methods could be recommended for increased tillers, longer spikes and higher grain yield of fonio under rainfed condition.

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Table 1. Response of Days to 50% Flowering, Number of tillers per plant and number of panicles per plant in Fonio to different planting Methods in 2021 and 2022

Planting Method	Days to 50% Flowering			Number of tillers per plant			Number of Panicles per plant		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Dibbling	97.35[b]	96.68[b]	97.02[c]	10.46[b]	10.76[c]	10.61[b]	13.26[a]	9.22[b]	11.32[b]
Drilling	99.67[b]	100.54[b]	100.11[b]	9.62[c]	12.04[b]	10.83[b]	10.46[c]	9.42[b]	10[b]
Broadcasting	100.6[b]	102.52[b]	101.59[b]	7.85[d]	9.48[d]	8.67[c]	9.32[d]	7.76[c]	8.54[c]
Transplanting	116.35[a]	113.85[a]	115.1[a]	12.36[a]	15.24[a]	13.8[a]	12.65[b]	13.24[a]	12.93[a]
Mean	103.51	103.4	103.45	10.07	11.88	10.98	11.42	9.91	10.7
Max	116.35	113.85	115.1	12.36	15.24	13.8	13.26	13.24	12.93
Min	97.35	96.68	97.02	7.85	9.48	8.67	9.32	7.76	8.54
SE	4.34	2.89	1.17	0.94	0.26	0.37	0.92	0.16	0.65
Plting methd x Year			5.414*			1.91**			5.93**
LSD5%	8.38	7.08	2.56	0.33	0.64	0.78	0.65	0.38	1.38

Table 2. Response of spike length, Panicle length and number of spikes per plant in Fonio to different planting Methods in 2021 and 2022

Planting Method	Spike length(cm)			Panicle length(cm)			Number of spikes per plant		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Dibbling	13.88	12.32[c]	13.1[b]	20.84[c]	19.84[c]	20.34[d]	6.88[b]	6.46[d]	6.67[b]
Drilling	13.86	13.24[b]	13.55[b]	22.23[b]	22.23[b]	22.23[b]	6.84[b]	9.06[b]	7.95[a]
Broadcasting	14.06	13.12[b]	13.59[ab]	21.86[b]	20.86b[c]	21.36[c]	6.04[c]	7.04[c]	6.54[b]
Transplanting	14.22	14.24[a]	14.23[a]	24.02[a]	24.68[a]	24.35[a]	7.32[a]	9.64[a]	8.48[a]
Mean	14.01	13.23	13.62	22.24	21.9	22.07	6.77	8.05	7.41
Max	14.22	14.24	14.23	24.02	24.68	24.35	7.32	9.64	8.48
Min	13.86	12.32	13.1	20.84	19.84	20.34	6.04	6.46	6.54
SE	0.08	0.28	0.31	0.66	0.66	0.39	0.27	0.08	0.42
Plting methd x Year			0.65*			0.99**			2.46**
LSD5%	1.21	0.68	0.65	1.25	1.62	0.83	0.46	0.19	0.88

Table 3. Response of Plant Height, Number of days to maturity and Grain Yield in Fonio to different planting Methods in 2021 and 2022

Planting Methods	Plant Height (cm)			Days to maturity			Grain yield Kg/ha)		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Dibbling	129.74c	134.70^{ab}	132.22^{b}	142.55^{b}	148.55^{a}	145.55^{a}	763.83^{b}	718.44^{b}	741.13^{b}
Drilling	117.32^{d}	118.04^{c}	117.68c	136.67^{b}	139.67^{ab}	138.17^{b}	634.14^{c}	684.26^{b}	659.2^{c}
Broadcasting	135.64^{b}	128.87^{b}	132.25^{b}	151.2^{a}	144.84^{a}	148.02^{a}	591.73^{d}	606.82^{c}	599.27^{c}
Transplanting	146.43^{a}	140.62^{a}	143.53^{a}	140.65^{b}	134.52^{b}	137.59^{b}	964.26^{a}	805.26^{a}	884.76^{a}
Mean	132.28	130.56	131.42	142.77	141.9	142.33	738.49	703.7	721.09
Max	146.43	140.62	143.53	151.2	148.55	148.02	964.26	805.26	884.76
Min	117.32	118.04	117.68	136.67	134.92	137.59	591.73	606.82	599.27
SE	6.07	3.1	2	3.07	3.84	2.57	14.16	15.28	30.39
Plting methd x Year			46.40*			59.98**			12619.17**
LSD5%	9.17	7.59	4.26	4.3	9.4	5.4807	34.64	37.38	64.7793

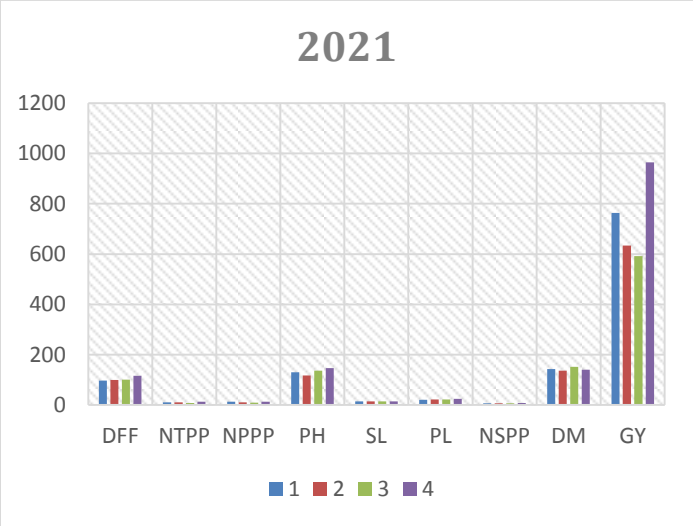

Figure 1. Response of yield and yield components in Fonio to different planting Methods in 2021

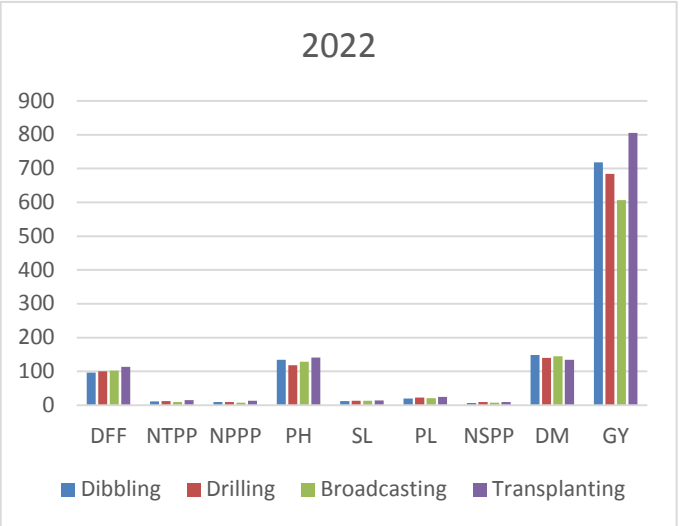

Figure 2. Response of yield and yield components in Fonio to different planting Methods in 2022