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Effect of Transplanting on Yield and Growth of Grain Sorghum (*Sorghum bicolor* (L.) Moench)

* G.O. Agbaje & J.A. Olofintoye

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Summary

An experiment was carried out to study the effects of transplanting on growth and grain yield of three varieties of Sorghum bicolor*, 'Ilorin local', SK 5912, and SSV10. Seedlings from each variety transplanted at 2, 4 and 6 weeks after planting (WAP) were compared with directly seeded plants used as control. Results show that at 8 WAP with seedlings transplanted at 2 WAP were taller than the other transplants, but shorter than directly seeded plants. Transplanting caused delay in flowering, but at this stage, height of transplants was comparable to directly seeded plants in SK 5912 and SSV10, while in 'Ilorin local' the transplants were significantly shorter at P< 0.05. Dry matter accumulation and grain yield was comparable among transplants but lower than those of directly seeded plants. However, grain yield of seedlings that were transplanted at 2 WAP was statistically comparable with directly seeded plants at P< 0.05.*

Résumé

Effet de la transplantation sur la croissance et le rendement du sorgho (*Sorghum bicolor* (L.) Moench)

*Une étude sur l'influence de la transplantation de jeunes plantes obtenues 2, 4 et 6 semaines après semis (SAS) a été réalisée. Trois cultivars «Ilorin local', SK 5912 et SSV10» de sorgho (*Sorghum bicolor *(L.) Moench) ont été utilisées dans cet essai en comparant la croissance et le rendement des plantes transplantées avec ceux des plantes témoins (sorgho semé directement dans le champ). Les résultats obtenus après 8 semaines de transplantation ont montré que les plantes témoins étaient les plus grandes de tous les traitements étudiés et que le traitement 2 SAS était plus grand par rapport aux autres plantes transplantées. La transplantation était corrélée au retard de floraison. Au stade floraison, la hauteur des plantes transplantées des cultivars SK 5912 et SSV10 n'était pas significativement différente par rapport aux plantes témoins, tandis que les plantes d'Ilorin local étaient significativement (P< 0,05) plus petites. L'accumulation en matières sèches des plantes transplantées était significativement plus petite par rapport aux plantes témoins. Le rendement en grains était significativement plus élevé et comparables pour les plantes témoins et les plantes 2 SAS par rapport aux traitements 4 SAS et 6 SAS.*

Introduction

Yields of both indigenous and improved sorghum varieties (*Sorghum bicolor* (L.) Moench) are very low in Nigeria varying from 0.95 to 1.61 tons per hectare (9). The reason for low yield include poor crop establishment due to serious attack on dibbled seeds and emerging seedlings by various birds such as *Ploceus cuculatus*, *P. capitalis*, *Lamprotonis chalybaeus* etc. Also, the practise of transplanting sorghum seedlings of varying ages by farmers in the savannah areas of Nigeria linked to inadequate knowledge of the age at which seedlings should be transplanted, may contribute to low grain yield of the crop.

Transplanting as a method of crop establishment dates back to the early biblical times (400 BC) and is still an important worldwide system of production (7). Transplanting sorghum has been reported for India, Japan, Mali, Cameroon, Republic of Chad, Nigeria and Senegal (1, 2, 3, 5). Transplanted sorghum is popularly known as « Masakwa» or 'Firki sorghum' in Chad basin between Nigeria and Republic of Chad in West Africa (3).

Transplanting has been observed to cause growth retardation, yield reduction and physiological disorder

Department of Crop Production, Faculty of Agriculture University of Ilorin, Nigeria.

*Present address: Institute of Agricultural Research and Training Obafemi Awolowo University, PMB 5029, Ibadan, Nigeria.

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(4, 6, 10, 11). All transplants experience check in growth, which may kill plants under extreme condition or cause significant variability within the crop on the field (7). However, transplanting of seedling at early vegetative stage had been reported to reduce the detrimental effect of transplanting on grain yield (1, 8). This study seeks to establish the age at which sorghum seedlings can be transplanted with minimal effects on grain yield.

Material and methods

An experiment was carried out between July and December in 1987 at the Teaching and Research Farm of the University of Ilorin, Nigeria, in order to compare grain yield of sorghum from directly seeded plants to that established with transplants of different ages.

Three varieties of sorghum, i.e. SK 5912 (V_1), SSV10 (V_2) and 'Ilorin local' (V_3) (Table 1) were established by direct seeding (T_0) and by transplanting at 2, 4 and 6 weeks of seedling age, called T_1, T_2 and T_3 respectively. The twelve treatment combinations were arranged in a randomized complete block design and replicated three times with an individual plot size of 6 x 3 m^2. Each plot had five ridges with a planting space of 0.20 x 0.75 m^2 at two plants per stand. The seeds of directly seeded plants were treated with Aldrex 40 (Aldrin insecticide) before planting to prevent birds from picking them on the field. Plants to be transplanted were established in the nursery on the same day the directly seeded were planted on the field. The nursery seedlings with their leaves detopped were transplanted at two seedlings per stand into the field at 2, 4 and 6 weeks after seeding. Three manual weddings were carried out post-planting at 2, 7 and 9 weeks after planting WAP and Nuvacron (monocrotophos insecticide) was sprayed after each weeding operation at 40 ml of chemical solution to 15 litres of water. Urea (46% N) and single super phosphate (18% P_2O_5) fertilizer was applied at the rate of 60 kg N and P_2O_5 per hectare, respectively. Fertilizer was applied to directly seeded treatments using a combination of 20 kg N and 60 kg P_2O_5 per ha at 2 WAP, and 40 kg N per hectare at flowering. In transplanted treatments, urea was applied in three split doses using 10 kg N per ha in the nursery, 20 kg N and 60 kg P_2O_5 per hectare at 3 weeks after transplanting and 30 kg N/ha at flowering.

Table 1

Characteristics of sorghum varieties used in the experiment

Varieties	Sources	Height	Photoperiod reaction
SK 5912 (V_1)	*IAR, Nigeria	Short	Neutral
SSV10 (V_2)	IAR, Nigeria	Short	Neutral
Ilorin local (V_3)	Ilorin market	Tall	Short-day

*Institute of Agricultural Research (IAR), Zaria, Nigeria.

Parameters recorded were height of plants at 8 weeks after first date of seeding, and at flowering, days to 50% flowering, dry matter at flowering and grain yield. Height was measured using a measuring tape from the plant's base to the tip of the tallest foliage and days to 50% flowering was obtained by visual assessment. Whole dry matter was measured by harvesting five plants per plot and drying them in the oven at 70 °C for two to three days until constant weight. Grain yield per hectare was obtained from harvesting the three middle rows and moisture content of the grain was corrected to 15%.

The data collected were subjected to statistical analysis using analysis of variance (ANOVA) technique and Duncan Multiple Range Test (DMRT) for mean comparison.

Results and discussion

Plant height

Height of transplants established at T_2 and T_3 are comparable and are both shorter than those of T_0 and T_1 at 8 WAP (Table 2). T_0 with a mean height of 1.21 m was reduced by 61.15% due to transplanting at T_1 and 72.0% at both T_2 and T_3 (Table 2). There was no varietal influence on height at this stage (Table 3). At 50% flowering, plant height was significantly influenced by variety, method of planting and their interaction (Table 3). The interactive effects are shown in Table 4, where Ilorin local showed a decline in plant height when seedlings are transplanted. In the other varieties, SK 5912 and SSV10, differences in plant height between transplanted and directly seeded plants were not significant at $P < 0.05$.

Table 2

Means of height at 8 WAP (HWAP, m), height at flowering (HF, m), days to 50% flowering (DF, day), dry matter yield at harvest (DM, g/plant), 100 seed weight (SW, g), grain yield (GY, t/ha) in three sorghum varieties under transplanting and direct seedling

Varieties	HWAP	HF	DF	DM	SW	GY
V_1	0.57a	2.13b	116.82a	102.40a	3.12a	1.41a
V_2	0.56a	2.26b	117.90a	94.67a	3.10a	1.34a
V_3	0.57a	3.81a	125.63b	106.31a	2.96a	0.93a
Planting method						
T_0	1.21a	3.04a	110.62b	158.52a	2.92a	1.72a
T_1	0.47b	2.71b	121.64a	95.40b	3.10a	1.32ab
T_2	0.35c	2.52b	123.16a	82.91b	3.02a	0.91b
T_3	0.33c	2.71b	125.13a	67.55b	3.10a	0.83b

Means in the same columns with same letters are not significantly different at 5%.

Days to 50% flowering and dry matter yield

Ilorin local variety being photoperiod-sensitive (2) attained 50% flowering about nine days later than both improved varieties (Table 2). Directly seeded plants (T_0) flowered 11 - 15 days earlier than transplants while flowering among transplants was attained between 121 - 125 days after seeding (Table 2). Dry matter yield was significantly influenced by planting method with yields of all transplants being comparable but lower than that of directly seeded plant (Tables 2 and 3).

Grain yield and 100 seed weight

100 seed weight ranged 2.9 – 3.1 g with no significant difference between treatments (Table 3). Total yield of 1.72 t/ha obtained from directly seeded plants was not different statistically from 1.32 t/ha obtained from seedlings established at 2 WAP. However, a decline of 51.74% and 47.09% in grain yield could be observed when seedlings transplanted at 4 and 6 WAP respectively is compared to directly seeded ones (Tables 2 and 3).

Table 3

Mean square (MS) of ANOVA of treatments in table 2

Sources of variation	Degrees of freedom	MS of					
		HWAS	HF	DF	DM	SW	GY
Block	2	0.001	0.04	15.75	2592.76	0.08	0.59
Variety (V)	2	0.001	10.46*	276.33*	429.67	0.11	0.88
Planting Method (T)	3	1.24*	0.36*	382.18*	14348.26*	0.09	1.42
Interaction (T x V)	6	0.01	0.37*	14.59	621.67	0.15	0.37
Error	22	0.21	0.09	29.93	1899.29	0.07	0.36
CV %		16.94	10.99	4.56	43.12	8.91	49.8

*Significant at 5% level, F – test.

From the results, shorter heights observed in transplants at 8 WAP could be due to transplanting shock experienced during uprooting from the nursery. Retardation in growth of transplanted crops such as tomato, rice and maize due to uprooting has been reported earlier (6, 7, 8, 10). However, transplants of varieties SK 5912 and SSV10 gave comparable heights to directly seeded plants at flowering (Table 4). This could be due to the ability of these varieties to easily regenerate new roots after transplanting and resume active nutrient uptake earlier than Ilorin local in which transplants remain shorter than directly seeded ones. Similar results in which some crop species have better ability to recover from transplanting shock by prompt regeneration of new roots after transplanting has been reported (7).

Table 4

Interactive effects between planting methods and varieties on plant height (m) of sorghum at 50 % flowering

Treatment	SK 5912	SSV 10	Ilorin local	Treatment mean
T_0	2.25a	2.19a	4.59a	3.00a
T_1	2.07a	2.35a	3.70b	2.70b
T_2	2.28a	2.01a	3.32b	2.50b
T_3	1.91a	2.48a	3.62b	2.70b
Variety mean	2.13a	2.48a	3.81b	

CV = 10.99%

Means in the same columns with same letters are not significantly different at 5% levels (DMRT).

Transplanted sorghum varieties came to 50% flowering later in time (Table 2) probably due to delay in resumption of other development processes in the plant after uprooting as result of transplanting stress. Other effects of transplanting on sorghum included reduction in dry matter content of the whole plant and a 47 – 52% reduction in grain yield of plants transplanted at 4 and 6 weeks of age. However, grain yield of seedling transplanted at 2 WAP was comparable to directly seeded ones at $P< 0.05$ (Table 2). Since only limited quantities of assimilates are available to be partitioned for grain yield due to low dry matter in transplanted seedlings and a decrease in grain filling period due to late flowering, reduced yields, in transplants are justified. However, due to early transplanting of seedlings at 2 WAP, a comparable yield was still obtained to that of directly seeded plants as grain filling related processes are still far off. This agrees with findings in which early transplanted rice and sorghum plants gave comparable yields to directly seeded plants (1, 8).

The present results imply that early transplanting of *Sorghum bicolor* seedlings at 2 WAP into the field can indeed be performed without causing prejudice to subsequent crop development.

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G.O. Agbaje, Nigerian, M.Sc. Crop Production Research Fellow, Institute of Agricultural Research and Training, Obafemi Awolowo University, P. M. B. 5029, Ibadan, Nigeria.

J.A. Olofintoye, Nigerian, Ph.D. Agronomy, Senior Lecturer, Department of Crop Production, University of Ilorin, P. M. B. 1515, Ilorin, Nigeria.