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Yam production in Ghana: To stake or not to stake - A plant breeding perspective

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Abstract. Staking is the yam planter's main concern especially in the yam growing areas of Forest-Guinea Savannah Transition and Coastal Savannah of Ghana. Staking is not only laborious, but also very costly. The environmental degradation due to deforestation is also enormous. Various agronomic approaches such as the use of plastic mulch, varying length of stakes among others, have been recommended in the past to solve this problem. This paper presents a breeding perspective for solving the yam staking problem by assessing white yam (*D. rotundata*) and water yam (*D. alata*) genotypes under staking and non-staking conditions and discussing the environmental impact of staking.

Introduction

Staking is one of the yam-planter's main concerns (Degras, 1995). When yams are grown as a sole crop, yield is increased by staking by between 34 and 105% (Ndegwe *et al.*, 1990). An irregular response to staking has been found when yams are planted with other crops (Kole, 1995). Staking is not only laborious (20% of all work in yam production) but also very costly and scarce. Staking especially in the humid forest is carried out to help the twining yam stems display their leaves to attract adequate solar energy for efficient photosynthesis (Orkwor and Asadu,1998). In the forest zone of Nigeria, for example, staking is needed for maintaining high leaf area duration (LAD) and the associated high yield (Enyi, 1972b; Hahn and Hozyo, 1983). Staking also usually increases NAR (Enyi, 1973; Okigbo, 1973; Irvine,1940). There are varietal differences in response to staking, whilst in *D. rotundata* it is almost a must if significant yields are to be obtained, *D. alata* yams are rarely staked (Degras, 1986), and *D. cayenensis-rotundata* are grown in many parts of Africa without artificial staking. Yam production is characterised by clearing of new areas on yearly basis. Yam is estimated to occupy about 6.32% of total cropped area of Ghana hence such a land area is deforested and in the long run degraded through yam cultivation each year. It is also projected that growth rate for yams in Ghana is 2.75% per annum (MTADP, 1990) and that expansion in cultivated area is expected to be the main source of growth, contributing to 80% of the overall growth. The projected growth rate in the area of cultivation is 2% per annum with productivity growth (yield) expected to contribute the remaining growth with a growth rate of 0.75% per annum (PPMED, 1995). Farmers indicate that clearing of new lands is done in part to obtain stakes for staking their yams (personal communication). Traditionally, farmers either adopt the parkland system of farming or leave it non-staked especially when large acreages are involved. Alternatively, other agronomic measures to reduce the number or size of stakes to be used per hectare are being practiced by farmers. It is therefore imperative that studies are conducted to identify genotypes capable of tolerating no staking condition with little or no reduction in tuber yields. The objective of this paper therefore was to: discuss environmental impact of staking yams in Ghana, evaluate yam genotypes for high and stable yields with or without staking , and compare the performance of *D. rotundata* and *D. alata* under staking and non-staking conditions.

Materials and Methods

The experiment was conducted at 3 locations: Forest (Fumesua), Forest-Savannah transition (Wenchi) and Derived Savannah (Bawjiase) from 2000-2002 in Ghana. Two factors staking and genotypes were assessed. Staking had 2 levels: staking and non-staking and genotypes had 2 varieties: *D. rotundata* (60 testlines) and *D. alata* (73 testlines).

The experimental design used was Augmented RCB with 3 blocks and 3 replicated checks. Data was collected on the following parameters: pest and diseases (incidence and severity; scale of 1-5), weed biomass (12 weeks after sprouting- 5 weeks first weeding) and yield and its components. Quantitative data was analyzed using GLM and Mixed Models programmes of SAS, (1987) and qualitative data by SPSS Windows version 10. The environmental impact of staking was projected using secondary data.

Result and Discussions

Table 1 shows the results of GLM analysis of *D. rotundata* genotypes at Fumesua in 3 locations in 2 years under staking and non-staking conditions. Significant locational differences were observed with respect to stand at harvest, leafspot severity, virus severity and yield of *D. rotundata* (Table 1). Non-staking significantly increased leafspot severity and subsequently reduced the yield of *D. rotundata* genotypes. Staking and testline interaction of *D. rotundata* also had significant effect on leafspot and yields of *D. rotundata*. Table 2 shows the results of GLM analysis of *D. alata* yam genotypes in 3 locations in 2 years under staking and non-staking conditions.

Effect of staking on pest and diseases occurrence on *Dioscorea* spp. Location and testlines significantly influenced anthracnose and virus severity as well as yield and single tuber weight of *D. alata* (Table 2). Staking, however, did not have any significant effect on yield and its components. The interaction

Table 1: Results of GLM analysis of *D. rotundata* genotypes in 3 locations in 2 years.

***Source	Stand at harvest		Leafspot severity		Virus severity		Yield t/ha	
	DF	MS	DF	MS	DF	MS	DF	MS
LOC	2	29.80**	2	5.34**	2	3.43*	2	403.05**
STAK	1	1.39	1	7.82**	1	0.67	1	214.86**
LOC*STAK	2	5.81	2	3.21*	2	0.32	2	55.25*
C	2	21.19*	2	0.61	2	0.38	2	28.98
LOC*C	6	7.14	6	0.84	6	0.19	6	30.57
X(C)	53	11.77	51	4.65*	51	0.34	51	139.82**
LOC*X(C)	93	6.28	90	5.64*	90	0.31	88	101.75**
YR*X(C)	48	10.73	45	4.47*	45	0.15	43	62.32*
YR*LOC*X(C)	27	5.46	12	3.64*	12	0.07	11	175.86**
STAK*X(C)	52	4.44	50	3.33*	50	0.23	50	67.23*
LOC*STAK*X(C)	89	4.52	69	0.53	69	0.30	69	93.59**
YR*STAK*X(C)	47	4.65	38	0.84	38	0.19	30	114.06**
YR*LOC*STAK*X(C)	22	5.86	0	.	0	.	1	63.76*

*** Loc, stak, c, x and yr refer to location, staking, checks, testlines and year respectively.

of staking and location was also not significant on all parameters measured (Figure 1). Most of the testlines of staked *D. rotundata* (73.3%) had no visible sign of leafspot while significantly low percentage (5.2%) of the non-staked testlines had no visible sign of the disease indicating a strong but negative association of non-staking and leafspot severity.

Anthracnose severity had no significant effect on *D. alata* testlines (Figure 2). Most of the testlines (both staked and non-staked) had high frequencies of testlines with no visible signs of the disease.

Effect of staking on weed biomass. Weed infestation was significantly high in *D. rotundata* fields but not in *D. alata* fields. Most (58.8 and 77.4% for staked and non-staked respectively) of the *D. rotundata* genotypes had weed biomass of between 1.1-2.0kg/4m^2, whiles very few (between 4.3 and 2.5% of staked and non-staked) *D. alata* genotypes had weed biomass of 1.1-1.5kg/4m^2. This supposes that in *D. rotundata*, weed biomass had strong and positive association with staking (Figure 3).

The overall results of the *D. rotundata* testlines in the various locations show that

Table 2: Results of Generalized Linear Model analysis of *D. alata* in 3 locations in 2 years.

Source	DF	Mean square			
		Anthracnose severity	Virus severity	Yieldt/ha	STWTkg
LOC	2	18.92**	15.7**	625.34**	15.87**
STAK	1	0.23	0.67	52.86	3.97
C	2	1.60**	12.6**	115.04**	4.6
X(C)	47	1.06**	4.27**	99.50**	11.95*
LOC*X(C)	86	0.75**	4.58**	29.16	1.17
YR*X(C)	41	0.76**	0.60*	66.49	1.4
YR*LOC*X(C)	33	0.77**	3.22**	27.66	1.36
STAK*X(C)	47	0.38	1.68	22.73	1.26
LOC*STAK*X(C)	84	0.29	0.16	18.00	0.65
YR*STAK*X(C)	40	0.51*	2.21**	23.57	1.45
YR*LOC*STAK*X(C)	28	0.62**	0.12	23.23	1.7

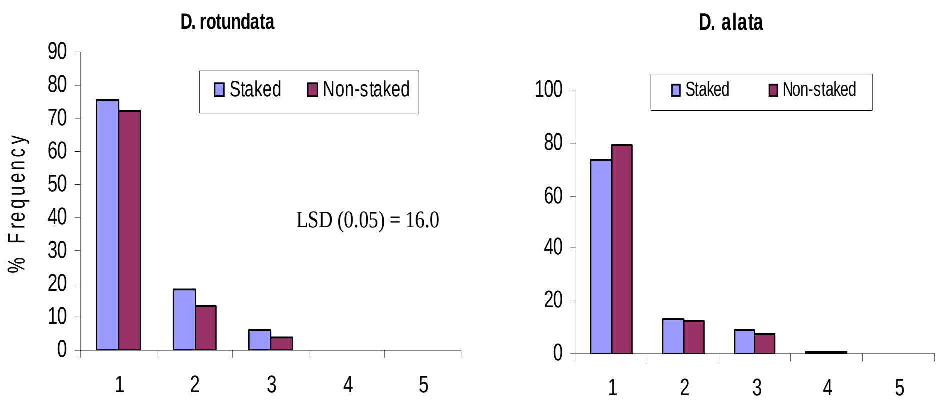

Figure 1: Effect of staking and non-staking on mean virus severity of *D. rotundata* and *D. alata* at 3 locations in 2 years.

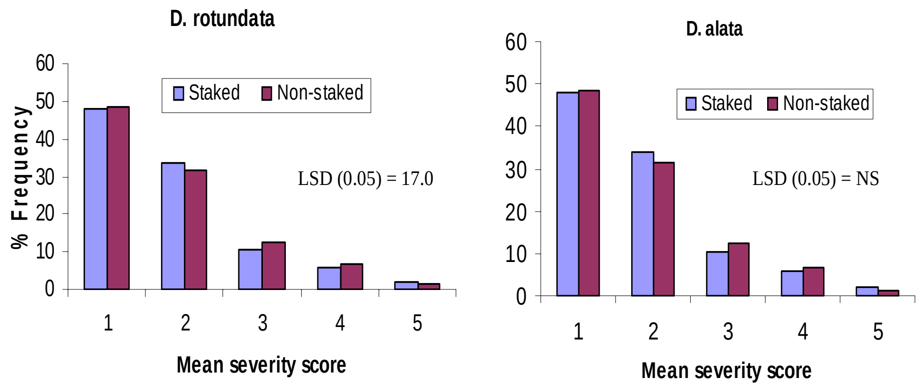

Figure 2: Effect of staking and non-staking on mean leaf spot disease (left) and anthracnose (right) severity of *D. rotundata* and *D. alata* at 3 locations in 2 years.

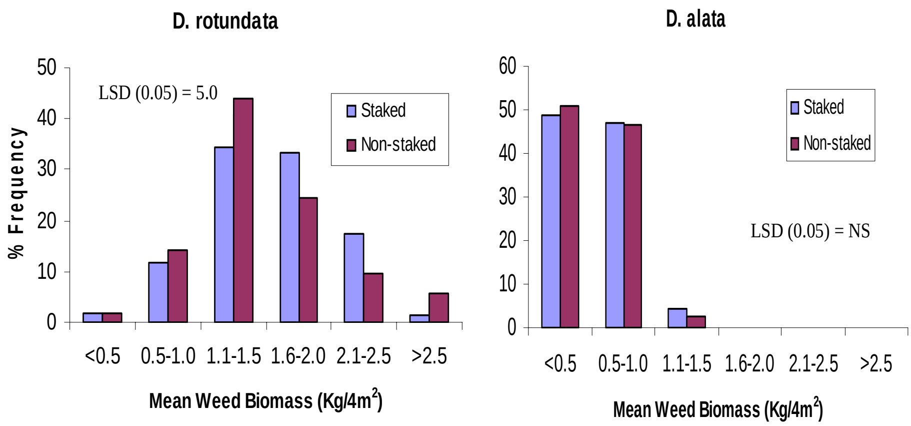

Figure 3: Effect of staking and non-staking on mean weed biomass at 12 weeks after sprouting (% weeks after first weeding) at 3 locations in 2 years on *D.rotundata* and *D. alata.*

testlines TDr95/19177, NKA2000/001 and Dorban proved adaptable in all 3 locations. This corresponded to low disease incidence and severity and low weed biomass confirming the assertion that both leafspot severity and weed biomass have strong but negative association with staking. Results of testlines Muchumudu, TDr89/02665, Tela, TDr96/01628 and KUP-2000/001 showed that to obtain the most performance, yams must be staked. Some other genotypes exhibited specific adaptation to non-staked conditions at Bawjiase, Fumesua and Wenchi.

In *D. alata* most of the genotypes had low pest incidence including weeds and disease pressure even under non-staked conditions resulting in good yields even under non-staked conditions. None of the testlines needs staking to express its full potential.

Conclusions and Recommendations

D. alata genotypes do better under no-staking conditions than *D. rotundata* genotypes. Some *D. rotundata* genotypes can be grown under non-staking conditions with no significant yield loss. Leafspot incidence and severity and weed biomass have strong and positive association with non-staking and can significantly reduce yield of *D. rotundata.*

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