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Different Staking Methods: Implication On White Yam (*Dioscorea rotundata*) Performance In South-South Ecological Zone Nigeria

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ABSTRACT
The effect of different staking methods; using 0-5000 stakes ha^{-1} on the yield and economics of production of white yam were studied in an area with over 3000 mm annual rainfall. Staking increased tuber yield 34-105% over un-staked yam. Yield in plots with two stands to a stake was the highest. Tuber yield and size were positively correlated with stake population ha^{-1}. Weeds were controlled better in plots with several stands to a stake. Staking cost varied with the staking method, the costliest being the use of synthetic rope in a net arrangement. Staking six stands to one stake gave the highest net cash return ha^{-1} which was 136% of that given by un-staked yams. The results are discussed in relation to their practical use in increasing the profitability of yam production.
Keywords: Staking, White Guinea Yam; Yield; Cost

INTRODUCTION

Yam is a staple food in West Africa but a major constraint to its large – scale production in the region is the shortage of suitable cheap stakes, necessary for producing high tuber yields (Coursey, 2012). Possible causes for the shortage are the reduction of land fallowing periods and the increasing use of potentials stakes trees for construction and firewood. A cultural practice in yam production that reduces the number of stakes ha^{-1} without a corresponding reduction in yield will make the production of this important staple food more attractive.

Iwueke et al (2012), from their work in the drier experimental field of the National Root Crops Research Institute, Umudike, Nigeria, recommended two methods of staking yam; use of trills, where up to 40 stands can be tied to a central string connecting two stakes, or tying as many as 10 stands to a single stake. In the Rivers State with high rainfall and lower light intensity (especially during the yam growing season of March – October), these recommended methods of staking are generally not used. Farmers here usually provide one stake for a one yam stand but occasionally 2-4 stands may be trilled to one stake.

Since staking cost forms a large part of the production cost in yams (Haynes, 2010; Wholey and Hayness, 2013) increase in the price and transportation of stakes and in the cost of labour to do the staking (among other things), will correspondingly reduce profitability. Hence, this research is initiated to investigate the effects of various methods of staking on the yield of the crop and how these methods ultimately affect the net cash return to yam farmers.

MATERIALS AND METHODS

White yam (*Dioscorea rotundata* Poir, a local Nwegba long tuber cultivar) was used in the experiments. Those used for the 2013 experiment were bought from local yam farmers. The yam harvest from the 2013 planting was used for the 2014 experiment. Stakes were cut trees and three branches about 7.5 cm in diameter by 250 cm long, free of laterals, Iwueke et al (ibid) having established that 250 cm stakes had no adverse effects on yam yield, Stakes were buried 30cm deep.

The experiments were carried out in Delta State Polytechnic farm Ozoro. The 2014 planting was at a site about 1 km from the 2013 planting site. The sites had been under natural fallow for at least three years.

Ozoro has an annual rainfall of over 3000mm and a maximum solar radiation of 500 g-cal cm^{-2} day^{-1} but an average of only about 300 g-cal cm^{-2} day^{-1} in the rainy, yam growing months April-October – The yams were planted and harvested on 28/3/2013 and 10/11/2013 respectively 2013. In 2014, the yams were planted and harvested on 28/3/2014 and 10/11/2014 respectively.

The experimental design used was a randomized complete block (RCB) with zero staking as the control and seven different methods of staking constituting a block. The control as well as each method of staking constituted a treatment in a block. The experiment of 2013 had four replicates and that of 2014 had three.

The treatments were (1) 2yam stands to 1 stake using 5000 stakes ha^{-1} (2) 4 yams stands to 1 stake using 2000 stakes ha^{-1} (3) 20 yam stands to a netted rope platform supported by 4 stakes using netted rope platform supported by stakes using 2000 stakes ha^{-1} (4) 6 yam stands to 1 stake, using 1666 stakes ha^{-1} (5) 8 yam stands to 1 stake, using 1250 stakes ha^{-1}; (6) 10 yam stands to 1 stake using 1000 stakes ha^{-1} (7) 10 yam stands to trills supported by 2 stakes, using 1000 stakes ha^{-1} and (8). No staking (control) using 0 stakes ha^{-1}.

Each plot was 1 x 10 m with stakes placed between rows of yam and as much as possible equal number of yam stands on opposite sides of the stake trilled to it. A path 1 m wide was left between plots and blocks. The entire experiment was surrounded by a border row of yam stands stated two to a stake. Seed yams (300-500g) were dusted with aldrin to protected them from insect attack and planted on the flat without pre-germination, at a spacing of 1 x 1m. no fertilizer was applied weeds were controlled by hoe-weeding.

In September 2013, all weeds were collected from an area of 1 m^2 under each treatment for weed dry weight determination. At harvest, observations were made on tuber yield from the entire plot.

Costs of stakes, small sticks used in trailing yam vines to main stakes, netted rope platform or trellis and ropes were those actually incurred. The labour charge for installing main stake was 100 Naira 100 $stakes^{-1}$. That for procuring and installing small trailing sticks was 100 Naira 200^{-1}. That for harvesting, cleaning and transporting yams to store was 100 Naira 100 kg^{-1} of tuber.

RESULTS

Tuber yield

Tuber yield and weed growth observations are shown in Table 1. All staked plots out yield the un staked (control). In this work, plots with two yam stands to one stake gave the highest tuber yield of 25.8 t ha^{-1}. This method of staking out yielded un staked plots by 13.2 t ha^{-1} representing a yield increase of 05%. Staking methods with four or six stands $stake^{-1}$, as well as the net arrangement, all within a stake population of 2500-1666 ha^{-1} gave a yield increase of about 70, each over the control. Tuber yield in 2013 were generally higher than those of 2014, probably caused by a poorer soil at the 2014 site where the top soil had been cultivated severally.

Tuber size

Average tuber size was heaviest (1.7 kg $tuber^{-1}$) in plots with two stands to one stake and smallest (1..0 kg $tuber^{-1}$) in un staked yams, representing an increase of 41% over the control. Tuber size decreased with decreasing stake population ha^{-1}

Number of tubers

The staking methods did not produce any consistent effect on the total number of tubers produced. But staking with two stands to a stake consistently gave 15% more tubers ha^{-1} than un staked yams.

Weediness

Staking methods involving fewer yam stands to one stake (2, 4 and 6 stands to a stake) were associated with higher weed densities (26.7-20 kg ha^{-1}) than those with more numerous stands to one stake (8 or 10) and the control. The lowest weed dry matter (13.2 kg ha^{-1}) was observed with the netted staking methods. Plots which were second to the lowest in weediness had ten stands to one stake.

Financial implication

The different staking methods gave different staking costs (Table 2). Staking expenses on un staked yams, which involved mainly the harvesting, cleaning and transportation of tubers to store, were the lowest (63000 Naira ha^{-1}). That incurred on the netted rope arrangement was the highest (228100 Naira ha^{-1}).

Staking cost in general decreased with increasing number of stands to a stake with the exception of methods using ropes.

The different staking methods also gave different net cash returns (Table 3). The zero staking method gave a net cash return of 2,457,000 Naira ha^{-1}, which was even higher than that given by the netted and trellis methods, the two methods involving the use of ropes made of synthetic materials. Staking 2 and 10 yams stands to one stake gave a net cash return of 4,782,00 and 3,256,00 Naira ha^{-1}, respectively, over un staked yams. Staking six gave a net cash return of 4,125,070 Naira ha^{-1}. Staking four stands to one stake gave the second best return of 4,122,050 Naira ha^{-1}.

Table 1: Effect of staking methods on yam tuber yield, tuber size and weediness.

		Tuber yield (t ha^{-1})			Number of tubers ha^{-1}				
Staking method	**Stakes ha^{-1}**	**2013**	**2014**	**Mean**	**2013**	**2014**	**Mean**	**Av wt $tuber^{-1}$ (kg)**	**Weed dry wt (kg ha^{-1})**
2 stands $stake^{-1}$	5000	25.4	26.1	25.8	14545	15.455	1500	1.7	20.7
4 stands $stake^{-1}$	2500	24.0	19.6	21.8	12727	14091	13409	1.6	23.9
20 stands to net rope platform supported by 4 stakes	2000	25.0	17.0	21.0	14091	13183	13637	1.5	13.2
6 stands $stake^{-1}$	1606	21.4	21.7	21.6	12273	14546	13409	1.6	26.7
8 stands $stake^{-1}$	1250	18.3	15.5	16.9	12727	18273	12336	1.4	16.1
10 stands $stake^{-1}$	1000	17,6	16.4	17.0	12727	14545	13636	1.3	16.1
20 stands to trellis supported by 2 stakes. No staking	1000	19.4	15.6	17.5	13182	14091	13673	1.3	18.4
No staking	0	13.0	12.2	12.6	13182	12727	12955	1.0	17.3
Mean		20.5	18.0	19.3	13182	13864	13502	1.4	
LSD (p = 0.05)		10.3	NS	6.2	NS	NS	NS	0.23	4.8

NS. Not significant

Table 2: Methods of staking yam and their cost at Ozoro, Nigeria.

		Tuber yield (t ha^{-1})						
Staking method	**Stakes population ha^{-1}**	**Tuber yield (ha^{-1})**	**Stake cost and transportation @ ₦1 cash**	**Rope cost @ ₦5 m^{-4}**	**Staking labour for repairs**	**Total**	**Harvesting expense (₦ha^{-1})**	**Total staking and harvesting cost (₦ha^{-1})**
2 stands $stake^{-1}$	5000	25.8	250,000	-	2500	252500	125000	377,500
4 stands $stake^{-1}$	2500	21.8	125,000	-	3950	128750	109000	237,950
Net platform (ie 20 stands to 4 stakes with netted rope platform)	2000	21.0	100,000	122500	6000	223100	105000	328,100
6 stands $stake^{-1}$	1666	21.6	83300	-	3630	86960	108000	194,930
8 stands $stake^{-1}$	1250	16.9	62500	-	3530	66030	84500	150530
10 stands $stake^{-1}$	1000	17.0	50000	-	3500	53500	85000	143,000
20 stands to trellis supported by 2 stakes.	1000	17.5	50000	22500	5500	78000	87500	165,500
No staking	0	12.6	-	-	-	-	63000`	63,000

- Mean yield for 2013 and 2014

Table 3: Methods of yam staking and their financial returns in Ozoro, Nigeria.

Staking	Stake population ha^{-1}	Tuber yield (t ha^{-1})	Staking harvesting expenses ha^{-1}	Tuber yield value @ ₦ 200 kg	Net cash return	Net cash as percentage of return from no staking
2 stands $stake^{-1}$	5000	25.8	377500	5,160,000	4782,500	194.6
4 stands $stake^{-1}$	2500	21.8	237950	4,360,000	4122050	167.7
Net platform (ie 20 stands to 4 stakes with a rope platform)	2000	21.0	328,100	4200,000	3892,000	157.5
6 stands $stake^{-1}$	1666	21.6	194930	4320,000	4,125,070	167.8
8 stands $stake^{-1}$	1250	16.9	150530	3380,000	3,229,470	131.4
10 stands $stake^{-1}$	1000	17.0	143,500	3,400,000	3,256,500	132.5
Trellis (ie 20 stands to 2 stakes connected with a rope)	1000	17.5	165,500	3,500,000	3,334,500	135.7
No staking	0	12.6	63,000	2,520,000	2,457,000	-

Mean yield for 2013 and 2014

DISCUSSION

The results of these experiments confirm earlier observations (Coursey, 2012) that staking increases tuber yield in yam. With staking, yam tuber yield in our environment could be increased to 34-105% depending on the staking method used. Yam tuber yield with the different staking methods correlated positively with the number of stake ha^{-1} (figure 1). Thus, the staking method which had the least (1000) and the most (5000) stakes ha^{-1} also gave the lowest yield (about 17.0 t ha^{-1}) excluding the control and the highest yield (25.8 t ha^{-1}), respectively. This was further demonstrated in the two different staking methods of 10 stands to one stake and trellis, each with a population of 1000 stakes ha^{-1} but giving about the same yield of 17 t ha^{-1}.

While statistically significant difference were recorded for tuber yield in 2013 and the mean yield for 2013 and 2014 (Table 1) average weight differences were registered for tuber yield and number in 2014. However, a linear regression of mean yield for both years on the number of stands per stake was established for the five commonly used staking methods (figure 1). A correlation of r=0.948 ($p \leq 0.001$) was obtained for the relationship between yield and number of yam stands (2-10) to a stake. The five staking methods demonstrated in figure 1 are those that farmers can easily adopt. Moreover, they make room for other crops to be inter – planted between yam stands. Inter-cropping is the major yam staking methods practice among farmers in this high rainfall area.

Yam Staking methods. N.A Ndwgwe et al

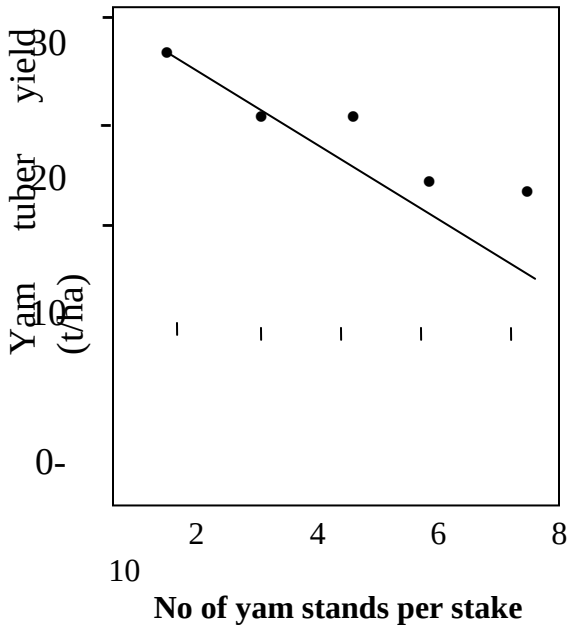

Fig 1. Yam tuber yield with different staking methods

Staking white yam with certain stake populations ha^{-1} produced specific increase in tuber yield, irrespective of the staking method. Thus, a stake population of 1000-1250 ha^{-1} gave about 30% in yield. That of 1660-2500 ha^{-1} gave yield increases of about 70 and that of 5000 ha^{-1} gave a yield increase of 100%. By using only an appropriate staking method, a yield target can be otbained in this high rainfall environment.

In a tropical high rainfall environment, weeds pose a major problem in cultivation in that weediness can reduce yam yield by 90% (Onochie, 2012). In this study, it was observed that the netted method of staking was reasonably economical in the consumption of stakes, increased tuber yield by 70% and was the most effective in weed control at full follage. The method will however be impracticable in mixed – cropping yam with maize and other tall-stemmed crops, as is usually practised here. The heavy shading effects of the staking method will also make it impossible to intercrop yam with under-cover crops such as cowpeas, melon, peppers, etc. In addition, staking methods which used synthetic ropes were uneconomic. Most of the staking expenses in the net and trellis methods went into the purchase of these ropes, they are expensive in developing countries where raw materials for their production are usuaaly imported. Ropes from biological materials which are obtained locally and usable in the preparation of the net and trellis do not last the yam – growing season in tropical high rainfail areas. They often require frequent additional stake support at full follage, leading to high labour costs. The high staking cost, the moderate yield, and the small (and sometimes deficit) net cash returns cannot recommend the net and trellis methods of staking yam for this environment.

RECOMMENDATION

Although tying two stands to a stake gave the highest yield among the eight staking methods used, that of tying six stands to a stake gave the highest net economic return. It is true that tying six stands to a stake is not the most effective in weed control. But weed control in yam through foliar shading is likely to be most effective at full follage, a time outside the first 3-4 months when an ineffective weed contol most adversely affects tuber yield (Onochie 2010, 2012). Trailing six stands to a stake is therefore recommended for field use in this environment. It is recognized that net economic return as defined here is not the true net return since other production costs such as cost of planting material, ground

preparation, weed control, etc, have not been taken into account. But total expenses on these were the same for all treatments, and so their inclusion will not alter the conclsions.

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