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Effect of Planting Depth and Orientation on Germination of Yam (Dioscorea) Minisett

A.K. Arkoh[1], E.Y.H Bobobee[2],
[1]Department of Mechanical Engineering, [2] Department of Agricultural & Biosystems Engineering
[1] Takoradi Technical University-Ghana, [2] Kwame Nkrumah University of Science and Technology-Ghana

Abstract*: Adoption of yam minisett technology in mechanization call for a study to ascertain whether planting depth and orientation of yam (Dioscorea alata) in the soil affects germination, since much work has not been done in that regard. Knowledge of the effects of yam minisett planting depth and the orientation in the soil on germination provide useful information for the development of planter since minisett falling from planter could be at any position. A survey was conducted to investigate how germination affected by vary position of yam minisett. A rubber "pots experiment" were carried out within a period of 180 days after planting (DAP), under natural conditions of light, temperature and relative humidity. Minisett weighed 40g - 80g was subjected to seven (7) main treatments; planting depth and planting orientation which consist of four (4) and three (3) levels respectively. Planting depth (d1=5cm, d2=10cm, d3=15cm and d4=20cm) and planting orientation with the skin of the sett facing upward (SSU), skin facing side (SSS) and skin of the sett facing down (SSD). The experiment was laid out by complete randomized design (CRD) with three replications. There was significant difference (p<0.05) between the 5cm in planting depth variables for two germination parameters (GeT and GSI) as well as interaction with orientation observed. However, there was no significant effect (P>0.05) among planting depth and orientation variables on germination parameters (GeT and GSI). Minisett orientation and planting depth interaction had no effect on the germination (P>0.05) with the exception of 5cm depth. The higher rate germination setts were recorded SSS (44%) and planting depth 20cm (35%). Based on general results, yam minisett germination has no correlation with depth and orientation. Therefore, the use of mechanical yam sett planter is feasible, since placing the setts in any orientation with variable condition will germinate.
***Keywords*: Germination, Planting depth, Orientation, Minisett, Mechanical planter**

I. INTRODUCTION

Traditionally, ware yam production uses yam tuber weighed closer to 1500g [3] as 'seed yam'. With introduction of minisett which involved cutting of mother yam tuber in the form of ring and slice into a shape of a sector to form 'sett' weighing about 80g and used as planting material (minisett). This technology reduces the use of ware yam as planting material more than 40% production cost [3]. About three (3) tones of seed yam needed to plant 1 hacter of yam farm. About 25 to 50% of the harvest of yams is used as planting material. Thus, planting material cost increases the total production cost more than 33% [8]. Seed tubers used for planting materials yield bigger but produce bulky in shape, but adoption of minisett technology produces slimmer shape which is preferable to bulky tubers for export. The introduction of minisett technology needs expansion of land size to mitigate yield loss by using smaller size of planting material. The multiplication of planting materials from mother tuber requires mechanisation method for expansion and timeliness. To overcome difficulties in planting these lots, mechanising planting is necessary. The use of mechanical planter to plant yam sett requires a study of how variation of planting depth and orientation of minisett will affect germination since researcher has not come across much studies of this nature.

Initial sprout development depends on successful seed germination, hypocotyl growth, and root emergence in the direction of gravity [12]. Seeds have a physiological ability to germinate and correctly orient themselves according to gravity, a process known as gravitropism [2]. Germination is the first developmental step in the life cycle of a plant to produce a new generation and the ability to accomplish this task is a prerequisite to start this cycle [9]. Low yield has generally been attributed to poor soil insufficient soil moisture, low soil temperature, crusts which reduce or retard seedling emergence [9]. Experiment indicated a possible relationship between sett orientation in the soil and planting depth on germination. Sett orientation in the soil and planting depth are the important factors in crop management practices. Rapid emergence, good germination, and good performance, seeds must be placed in a position and in an environment that ensures the availability of nutrients and water from the soil [9]. Mechanical factors, which affect seed germination and emergence, according to [11] are uniformity of depth of placement of seed; distribution of seed along rows and soil cover over the seed. Seed orientation affects greatly seedling emergence. The depth of sowing is important in maximising the potential of seedling emergence and crop yield [1]. Other researchers reported that increasing sowing depths can enhance crop establishment because of the higher soil-water content in the seed zone, resulting in better germination and emergence of seedlings [5]. Deeper planting also reduces the number of setts removed by mice. Information about planting depth and seed orientation improved initial growth, development and yield of crops [16]. Meanwhile, sett orientation during planting can affect the sett germination rate, seedling physiology, and morphology [10]. Many studies show that the orientation of yam setts does not affect their emergence since many parts of the setts will sprout under favourable conditions [4],[1]. Planting machines modify the pre-existing seed and soil conditions, and dictate seed placement within the seedbed. Since minisett planting depth and orientation provide useful information for the development of mechanical yam minisett planter, there is the need to establish relationship between variation in depth and placement of sett on germination. This study, therefore investigates the effects of minisett planting orientation and depth on the germination rate. This would assist in the determination of optimal seed orientation and planting depth for mechanical planter.

II. MATERIALS AND METHODS

A. *Study Area and Design*

The experiment was conducted at the School of Agriculture Research Farm, University of Cape Coast. The annual temperature is in the range of 23.2-33.2 ºC and a relative humidity in the range of 81.3% to 84.4% [13]. The study area experiences two rainy seasons namely the major season which starts from May to July ending and a minor season that starts around September and ends around mid-November before the dry harmattan season that runs to the end of March in the following year [13].

B. *Experimental Design*

The planting depth of the sett and sett orientation were the treatments. The treatments planting depth and planting orientation consist of four (4) and three (3) levels respectively. Planting depth (d1=5cm, d2=10cm, d3=15cm and d4=20cm) and planting orientation with the skin of the sett facing upward (SSU), skin facing side (SSS) and skin of the sett facing down (SSD) were observed. The experiment was laid out by complete randomized design (CRD) with three replications. Each treatment was randomly assigned to the experimental pots within replication. The diameter of single bucket was 32cm and has 53cm depth.

C. *Yam sett properties and curing*

The tubers were sliced into a range of 50g – 80g planting weight (figure 2). The slice setts were allowed for an hour for drying surfaces before ashes were applied on the surfaces before dropping to avoid rotting. Two parameters (orientation and planting depth.) were observed on the 15 days intervals after planting, was counted till 180 DAP. Sett germination ability was evaluated using, germination time (GeT), and germination percentage (GeP) [15]. Seeds were considered germinated when the cotyledons appeared above the ground level. The setts planted were surveyed daily for 180 days.

D. *Data Analysis*

The results were subjected to the analysis of variance (ANOVA) using Genstart 2.1 statistical software. Mean comparisons were done using least significance difference test at a probability level of 5% to identify significant differences among the means of the parameters examined; the difference between the three (3) setts orientation and between four (4) planting depths for both germination and percentage of germination.

III. RESULTS AND DICUSSION

A. *Results*

1) *Germination rate:* The observations carried out during planting indicate a very heterogeneous germination rate of the sett yams used according to the planting depth and the orientation mode. Generally, germination spread out in 150 time period. The germination rate for each treatment and percentage germination among treatments were presented in table 2, figure 3 and 4 respectively. Germination was observed to be 28%, 28% and 44% for sett orientation whiles for planting depth 6%, 28% and 33%; 33% percentage germination was observed. All germinations were noticed within 180 days after planting (DAP). The rate of sett germination were different among the treatment groups. The 15cm face down began to emerge at 22 days after planting, whereas the worst group is 10cm face down at 150 days after planting. Yam minisett parameters are presented in table 2.

2) *Effects of Planting Depth on Germination:* There was significant ($p < 0.05$) difference between 5 cm planting depth for two germination parameters (GeT and GSI) out of four orientation interaction studied. However, there was no significant effect ($P>0.05$) on 10 cm, 15 cm and 20 cm planting depth regarding the two germination parameters (GeT and GSI) table 4.
3) *Effects of sett orientation on germination:* On the part of orientation there was no statistically significant effect ($P>0.05$) on SSS, SSD and SSU regarding two germination parameters (GeT and GSI) table 3. Combination of sett orientation and planting depth has no effect on the germination ($P>0.05$) with the exception of 5cm depth.

B. Discussion

Germination is a process whose duration varies according to the type of seed physical properties, soil and environmental conditions to which the seed is exposed. The effect of the seeds orientation and planting depth on germination was reported by several authors [4],[1]. No significant effect ($P>0.05$) on germination was observed as a result of sett orientation and planting depth regarding the two germination parameters (GeT and GSI). Depth and orientation interaction studied as shown in (table 4) affirms studies by [4],[1], that the orientation of yam setts does not affect their germination and emergence since many parts of the minisetts sprout under favourable conditions. Tuber size variation may have different sprouting abilities. Result disagrees study by [10], which showed that germination time and germination speeds are longer with increasing depth of planting. Difference between 5 cm orientation interaction result could be attributing to the short depth from the sett position to the soil surface. The environmental factor as reported by [2], as well as soil which covers on the soil plays a role in crop germination. However, [10], was of the view that, rapid germination was recorded with shorter depth. Study by [2], demonstrates that seed-sowing orientation affects germination efficiency. Table 4 shows average germination time among the treatments from 0 day to 180 days. Amongst the sett orientation, skin face side up (SSU) produced the best average germination time (52.2) and planting depth, 15cm recorded the best germination time (52.6) and worst is 5cm (57.0) compared to the other treatment, which indicates that there is a close relationship between all treatments and germination [6]. Literature also reported several factors, which include minisetts cut from head, middle and tail portions of seed yam tubers with head region sprouting earlier and achieving 50% germination before those from the tail and middle. But to use a yam minisett planter, combinations of both factors are bound to occur and necessary.

Table 1: Agro-ecological characteristics of the study area and tool used

Characteristics	
Agro-ecological	Coastal savanna
Soil type	Sandy loam
Total annual rainfall (mm)	averaging109 mm/year
Temperature (^{o}C)	23.2-33.2
Relative humidity (%)	68.8
Location	UCC Teaching and Research Farm, 5^{0} $48^{''}$ N, 1^{0},14.9''W

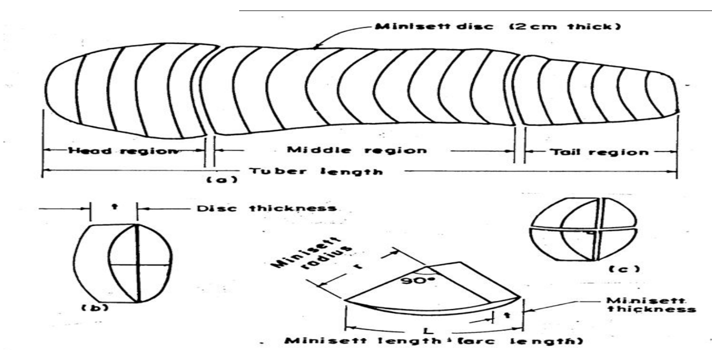

Figure 1: Nomenclature of yam minisett geometry [1]

Figure 2: Sliced setts

Table 2: Yam sett parameter

Yam sett size	Dimension
Arc length (l)	94.0 mm
Thickness	40.79 mm
Radius (r)	45.70 mm
Weight(w)	50 – 80 g
Angle of repose	56^0 to horizontal
Shape factor	474:1

Table 3: Germination rates after 180 DAP

Item	Treatment	Sett planted	Germination	%
1	Sett skin up (SSU)	9	5	55.5
2	Sett skin down (SSD)	9	5	55.5
3	Sett skin sideways (SSS)	9	8	88.8
4	5 cm	9	1	1.1
5	10 cm	9	6	66.6
6	15 cm	9	5	55.5
7	20 cm	9	6	66.6

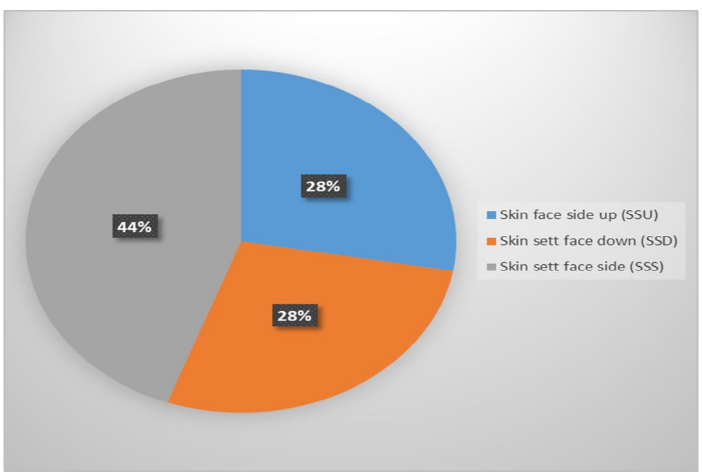

Figure 3: Percentage germination based on orientation

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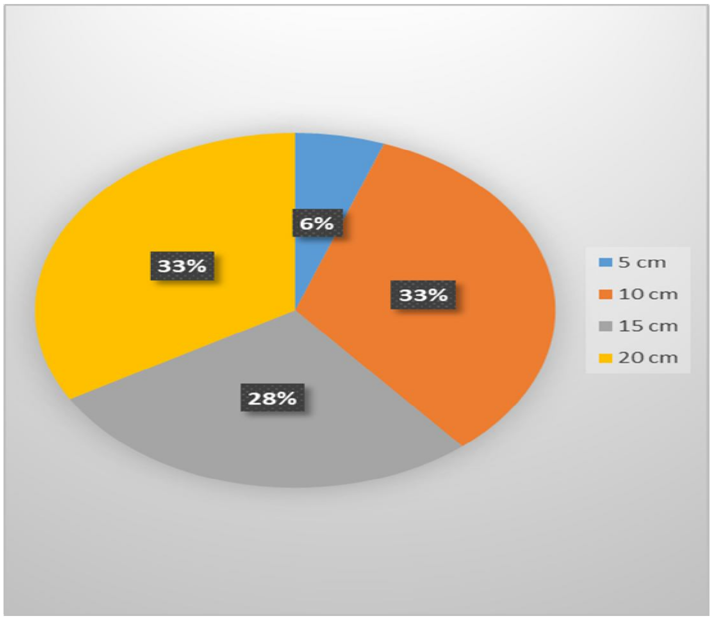

Figure 4: Percentage germination based on planting depth

Table 4: Relationship between sett planting orientation and depth and their interaction on germination

Source of variation	d.f	s.s	Fpr.
Planting_depth_cm	3	8516.7	0.056
Planting_orientation	2	3295.5	0.101
Planting_depth_cm.Planting_orientation	6	9631.8	0.055

Table 5: Average germination time

Item	Treatment	Average germination time (days)
1	Skin face side up (SSU)	52.2
2	Skin sett face down (SSD)	52.4
3	Skin sett face side (SSS)	58.8
4	5 cm	57.0
5	10 cm	55.3
6	15 cm	52.6
7	20 cm	56.8

IV. CONCLUSIONS

For each production system, cultural practice is an essential factor which can influence the yield in a given environment. This study has showed that, germination of yam sett does not matter on orientation and planting depth. The results obtained confirm the possibility to use mechanical yam minisett planter since orientation of sett on any side by planter would not affect germination. Meanwhile, planter could be adjusted to suit planting depth of yam sett. Also, results establish that planting depth and orientation in the soil had no effects on the germination, which conclude yam minisett germination affected other factors and not positioning.

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