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Growth Performance Of Yam (*Dioscorea Alata L.)* Tuber Segments As Influenced By Watering Intervals

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Abstract

The study aimed to determine the best planting material for tuber segments at the Clonal Nursery of the College of Forestry, Central Mindanao University, Musuan, Maramag, Bukidnon, from March to June 2020. It was laid out in a completely randomized design (CRD).
The results showed that the tail tuber segments had the most sprouted setts (1.83), as well as the highest percentage (28.33%). However, they sprouted later than the head and middle tuber segments (19 days), which was a big difference. Moreover, watering of tuber setts every four days significantly exhibited the highest number and percentage (30.00%) in sprouting, with the longest shoot (7.20 cm), but delayed sprouting compared to daily and every two-day watering interval. It was concluded that Watering yam segments every two days stimulates sprouting, with an average of 2.50 days after planting. Planting the tail portion of tuber segments yields the highest number and percentage of sprouted setts, but delays sprouting by 16.66 days. Watering tuber segments every four days results in the highest number and percentage of sprouted setts.

Keywords: *Growth performance, Yam (Dioscorea Alata L.) Tuber segments, Watering intervals*

INTRODUCTION

Yam (*Dioscorea alata L.*) belongs to the monocotyledonous family *Dioscoreacea*. Yam, or purple yam, is an important crop due to its many uses. It is a good source of ingredients for processed foods like ice cream, jam, yogurt, hopia, 'piyaya', cakes, pastries, and bread. It contains carbohydrates, proteins, fats, fibers, vitamins, and minerals. According to Scott et al. (2000), yams have the most complete nutrients compared to other food crops. Yam is also very rich in antioxidants like anthocyanin (Larief et al., 2018). Due to its high anthocyanin content, it has been processed as heart tablets and wine, as well as discovered to be a potential novel medicine for hypertension and other immune-related diseases like diabetes (Scott et al., 2000). Moreover, yam production is a source of income for many farmers and provides employment and foreign exchange, which contribute to the economic development of our country.
Bukidnon, with its Type IV climate, where sunshine and rainfall are evenly distributed throughout the year, has high potential for yam production. Among the major constraints of yam production in Bukidnon are the lack of knowledge on proper cultural management practices and the high cost of quality yam planting materials. Conventionally, tubers from previous croppings are reserved and propagated to be used as planting materials.

In fact, most farmers in Lantapan, Bukidnon, reserve about 30–35% of their harvested tubers as planting materials for the next planting season.
The same problem exists in yam-producing areas in the Philippines as well as in other countries. It was reported that the cost of yam planting material contributes as much as 50% of the total production cost (Aighewi et al., 2015). However, tubers could be sold and be an additional source of income. The use of tuber setts from tuber segments of the whole yam tuber has the potential to address the problem of its scarcity and high cost of planting materials. This planting material is practical, requires little space, is easy to prepare, and has a lower cost. The performance of yam tuber setts from tuber segments applied with different watering intervals has not yet been fully studied; hence, this study was conducted.

Objectives

The general objective of this study is to evaluate the growth performance of yam tuber segments as influenced by watering intervals. To achieve this, the specific objectives are the following:
1. Determine the number of days to sprouting of different tuber segments as influenced by watering intervals;
2. Identify the best watering interval for the sprouting and growth of different tuber segments; and,
3. Identify the combination of tuber segments and watering interval that will give the highest sprouted tuber segments and growth of yam plants.

MATERIALS AND METHODS

Time and Place of Study
The study was conducted at the Nursery of the College of Forestry, Central Mindanao University (CMU), Musuan, Bukidnon from May to June 2020.

Variety and Sources of Materials
The purple variety of yam (*D. alata.* L) tubers were brought from the farmers' field at Lantapan, Bukidnon and brought to the clonal nursery of the CMU, College of Forestry (Fig. 1).

Figure 1. Large tuber setts from Lantapan, Bukidnon

Materials and Source
Large yam tubers obtained from healthy plants, of more or less uniform sizes, were purchased from Lantapan, Bukidnon, and used as sources of planting materials for the study. These materials were brought to the Clonal Nursery of the College of Forestry, CMU, Musuan, Bukidnon.

Experimental Design and Treatments

The study was carried out in a 3 x 3 factorial experiment in a completely randomized design (CRD). The three (3) tuber segments, namely, the head, middle, and tail, comprise Factor A, while the three (3) watering intervals constitute Factor B. All treatments were replicated four times with ten sample plants per plot. Details of these treatments are presented in Table 1.

Table 1. Treatments and treatment combinations

TREATMENTS		TREATMENT COMBINATION	TREATMENT CODE
Tuber Segments (Factor A)	Watering Intervals (Factor B)		
A_1 - Head	B_1 - Daily	A_1B_1	T_1
	B_2 - every two days	A_1B_2	T_2
	B_3 - every four days	A_1B_3	T_3
A_2 - Middle	B_1 - Daily	A_2B_1	T_4
	B_2 - every two days	A_2B_2	T_5
	B_3 - every four days	A_2B_3	T_6
A_3 - Tail	B_1 - Daily	A_3B_1	T_7
	B_2 - every two days	A_3B_2	T_8
	B_3 - every four days	A_3B_3	T_9

Preparation of Experimental Materials

Yam tubers were divided into three segments: head, middle, and tail (Fig. 2). Each segment was then sliced to about 50–75 g per set. The sliced surfaces of each sett were coated with carbonized rice hulls and cured for a day in open air (Fig. 3). Cured setts were placed in aluminum foil trays lined with 1 cm of carbonized rice hull to facilitate aeration and drainage, then covered with vermicast and subjected to their corresponding treatments (Figs. 4 and 5).
A total of 360 yam setts were used in this study. The experimental set-up was placed in a bench at the nursery, covered with a clear plastic sheet to ensure that the setts receive the intended treatments of watering intervals (Fig. 2).

Figure 2. Yam tubers divided into three segments: (a) head, (b) middle and (c) tail

Figure 3. Individual tuber segments sliced into 50-75g per sett in open air

Figure 4. Cured setts placed in aluminum trays lined with carbonized rice hull and covered with vermicast

Data Gathered

1. Number of Days to Sprouting of Tuber Segments
This was taken by counting the number of days from planting until it sprouts from its tuber segments, which emerged from ten sample plants per replication.
2. Number of Sprouted setts/Segment
Data on the number of sprouted setts per segment was taken 30 days after planting. This parameter was recorded from ten sample tuber setts per segment per replication, and the average was recorded.
3. Percent Sprouted Setts/segment
The number of setts in each segment that sprouted was counted and computed using the formula:

$$\% \text{ Sprouting} = \frac{\text{Number of Sprouted Setts/Segment}}{\text{Total Number of Sets Planted/Segment}} \times 100$$

4. Length of Shoot (cm)
This was taken 30 days after planting by measuring the length of shoots from the base of the sprouted setts to the tip from 10 experimental samples per plot using a tape measure.

5. Number of Shoots/Sett
The average number of setts in a segment was counted from the same ten experimental samples used for the data on the length of shoots.

6. Shoot Diameter
Data on shoot diameter was obtained from the same sample setts that were used to determine shoot length. This parameter was taken by measuring the girth of ten sample setts using a vernier caliper at 30 days after planting.

Statistical Analysis
The data gathered were analyzed statistically using the Analysis of Variance (ANOVA) for a Factorial Experiment in a Completely Randomized Design (CRD). Differences between treatment means were computed using Tukey's Honestly Significant Difference Test (HSD Test).

RESULTS AND DISCUSSIONS
Number of Days to Sprouting

The number of days to sprout tuber segments as influenced by watering intervals is presented in Table 2. It was found that the number of days until sprouting was significantly influenced by the independent effects of tuber segments and watering intervals. However, no significant interaction effects were observed between these two factors.

TREATMENT	NO. OF DAYS TO SPROUTING
Tuber Segments (A)	
Head	8.33
Middle	4.91
Tail	16.66
F-test (A)	ns
Watering Intervals (B)	
Daily	8.91[a]
Once every 2 days	2.50[a]
Once every 4 days	18.50[b]
F-test (B)	*
F-test (AB)	ns
% CV	13.51

Table 2. Number of days to sprouting of yam tuber segments as influenced by watering intervals Means followed by a common letter, are not significantly different at 5% level based on HSD Test.

ns – not significant
* -- significant

Results showed that among the tuber segments, the middle sprouted the earliest with an average of 4.91 days after planting, but this did not vary from the head segment, which sprouted with an average of 8.33 days after planting. These two segments, however, vary significantly from the tail segment, which exhibited a significant delay of 16.66 days after planting.

Watering once every two days significantly stimulated the sprouting of yam, regardless of segment sections, at an average of 2.50 days from planting. Regardless of segments, those watered daily sprouted an average of 8.91 days after planting. Segments that were watered once every four days significantly took the longest time to sprout at an average of 18.50 days; this differed significantly from segments watered daily and once every two days, which sprouted 8.91 and 2.50 days after planting, respectively.

According to Orkwor (1998), differences in time to sprouting or emergence may be attributable to the differential age of tuber tissues. In his experiment, whole tubers were cut into segment setts of head, middle, and tail. It was observed that setts from the head portions sprouted and emerged earliest, followed by those from the tail portion, and lastly setts from the middle portion, which emerged several weeks later.

In this study, the head portion of the tuber segments ranked second to the middle setts in time to sprout (8.33 days). The earlier sprouting of the head setts can be due to the fact that they are the oldest and contain the shoot primordium that is apically dominant. Contrary to the findings of Orkwor (1998), where the middle setts had delayed sprouting, it was found in this study that the middle setts sprouted the earliest (4.91 days). This behavior may be attributed to the presence of several bud eyes in the middle segment setts. The tail, which is the youngest, may have undergone short dormancy; hence, it took significantly longer for the latest segment to sprout.

Regardless of tuber segments, those watered once every two days sprouted the earliest in 2.5 days after planting. This watering interval may have provided the necessary water requirement for yam tuber segment setts with intermittent drying of the media for two days in order for the roots to dry, which is needed for aeration and root respiration to promote sprouting and growth of setts.

According to Santosa et al. (2004), roots need air just as much as they need water. However, it is necessary to let the plant dry slightly between waterings since shallow or frequent watering creates lazy roots that stay at the upper surface of the media. Frequent watering triggered most of the tuber setts planted in the foil trays to deteriorate in this study. Vermicast, also used as the medium for propagating the tuber segment setts, has a high-water holding capacity, and the setts that were watered daily had too much water, which enhanced their deterioration.

Number of Sprouted Segments

The number of sprouted yam setts as influenced by tuber segments and watering intervals is presented in Table 3. Analysis of variance on these data revealed that this parameter was significantly affected by the independent effects of tuber segments and watering intervals; however, no interaction effects between these two factors were found.

Among the tuber segments, the tail significantly showed the highest average number of sprouted setts at 1.83. This significantly differed from the head and middle segments, with an average number ranging from 0.42 to 0.50 of sprouted setts at 30 days after planting (DAP). Although the tail segment has delayed sprouting, it has the highest number of emergent setts. This may be attributed to its highly meristematic tissues, as the tail segment setts are the youngest tissues.

The youngest and easiest to create tissues are found in the tail region of the tuber segment, as reported by Aighewi et al. (2015). The setts in the tail segment therefore have more sprouted yam setts than those in the head and middle segments.

Regardless of the tuber segments of those watered once every four days, comparison of the watering intervals showed the maximum number of 2.00 sprouted yam segment setts. Statistically equivalent treatments that were irrigated daily with 0.67 sprouting segment setts and those that received water once every two days with 0.08 differed considerably from this treatment (Ogboru, & Samuel, 2015).

Table 3. Number and percent (%) of sprouted setts as influenced by tuber segments and watering intervals at 30 DAP

TREATMENT	NO. OF SPROUTED SETTS	% SPROUTED SETTS
Tuber Segments (A)		
Head	0.42^{b}	14.17^{b}
Middle	0.50^{b}	15.00^{b}
Tail	1.83^{a}	28.33^{a}
F-test (A)	*	*
Watering Intervals (B)		
Daily	0.67^{b}	16.67^{b}
Once every 2 days	0.08^{b}	10.83^{b}
Once every 4 days	2.00^{a}	30.00^{a}
F-test (B)	*	*
F-test (AB)	ns	ns
% CV	13.49	68.29

Means within the same column followed by a common letter are not significantly different at 5% level based on HSD Test.
ns – not significant
* -- significant

In general, germination and sprouting or emergence of seeds, seed pieces and other propagules requires water since the first step in the process focused on imbibition of water and watering intervals should be gradually increased after planting (Blum, 2011; Kasan, et al., 2023).
This step is followed by enzymatic reaction that take place in the presence of water where complex food substances stored in the tubers are converted into simpler forms and translocated into embryonic axis or pre bud initials or bud eyes to initiate cell division and cell elongation resulting sprouting of propagules so, watering should be sustained until they have formed water absorbing roots (Munjal & Anwagi, 2019).
Although watering is needed, intervals of dryness are also required for aeration since oxygen is necessary for the respiration of stored food to stimulate germination, sprouting, and growth. The results of this study indicate that the watering intervals of once every four days significantly hastened and induced the highest sprouting of yam, regardless of tuber segments.

Percent Sprouted Setts

The data on the percentage of sprouted yam segments as influenced by watering intervals is shown in Table 3. As shown, this parameter was significantly influenced by the independent effects of both factors; however, there are no significant interactions.
Results showed that the tail setts significantly gave the highest sprouting percentage of 28.33%, which differed from the middle and head setts that obtained comparable sprouting of 15.0% and 14.17%, respectively. Among the watering interval treatments, it was observed that regardless of tuber segment treatments, yam setts watered once every four days significantly gave the highest average sprouting of 30.00%. This treatment significantly differed from the two watering interval treatments. Although watering daily treatments showed a relatively higher sprouting percentage of 16.67%, this did not differ significantly from those treatments watered once every two days, which had a 10.83% sprouting percentage only.
The results indicate that the use of the tail setts from among the tuber segments will give the highest percentage of germination. It was also found that watering intervals of once every four days, regardless of tuber segments, induced the highest germination of yam setts.

Shoot Length (cm)

Table 4 shows how watering intervals affect the typical shoot length of yam tuber segments. Analysis of variance on the typical yam shoot length showed that tuber segment treatments had no appreciable impact on this parameter. However, the shoot length of the yam was significantly influenced by the watering intervals. But there were no significant interactions observed among these two factors.

Results revealed that the three tuber segments—the head, middle, and tail—were statistically comparable in terms of length of shoots, with 8.11 cm, 0.53 cm, and 2.28 cm, respectively, 30 days after planting.

Among the watering interval treatments, yam setts regardless of tuber segments showed that watering daily has significantly stimulated the development of the longest shoots with an average of 6.50 cm, compared to yam setts watered every two days at 0.01 cm, which is comparable to yam setts watered every four days (4.41 cm).

These results indicate that regardless of the yam tuber segments planted, setts that are watered daily are comparable to yam setts that are watered once every four days in terms of shoot length.

Santosa (2004) claims that in several tuber crops, irrigation promotes plant growth and development. The study's findings showed that watering at intervals of 1, 3, 5, 7, and 15 days had an impact on the quantity and size of leaves, as well as the size of corms and root development. Watering at intervals of 1, 3, or 5 days did not cause any irregularities in plant growth; nevertheless, frequent watering causes the foot yam corms to go into dormancy, which lowers production.

Table 4. Average shoot length (cm) of yam segments as influenced by watering intervals at 30 DAP

TREATMENT	SHOOT LENGTH (cm)
Tuber Segments (A)	
Head	8.11
Middle	0.53
Tail	2.28
F-test (A)	*
Watering Intervals (B)	
Daily	6.50 [a]
Once every 2 days	0.01[b]
Once every 4 days	4.41[a]
F-test (B)	*
F-test (AB)	ns
% CV	33.73

Means followed by a common letter are not significantly different at 5% level based on HSD Test.
ns – not significant
* -- significant

In addition to giving the tuber setts water, a four-day watering interval allows the roots to dry out and allow for aeration, which allows food that has been stored to respire and speeds up the setts' growth and development. The entire amount of water given to the growing surface (soil or medium) in addition to the water provided by rainfall to the crops for optimal growth is known as the water demand (Weil & Brady, 2017). It was also stressed that letting the plants dry out a little bit between waterings will encourage the roots to spread more into the soil in search of moisture, which will improve the plants' establishment in their growth containers. Due to the high water-holding capacity of the vermicast media, repeated watering (either daily or every two days) overwetted the medium, resulting in rotting setts.

SUMMARY AND CONCLUSION

The study aimed to determine the best planting material for tuber segments conducted at the Clonal Nursery of the College of Forestry, Central Mindanao University, Musuan, Bukidnon, from May to June 2020.

This study, entitled "Growth Performance of Yam (*Dioscorea alata L.*) Tuber Segments as Influenced by Watering Intervals," was laid out in Growth Performance of Yam Tuber Segments as Influenced by Watering Intervals" and carried out in a 3 x 3 factorial experiment in a Completely Randomized Design (CRD). Three (3) tuber segments served as Factor A and three (3) watering intervals as Factor B. All treatments were replicated four (4) times, with ten (10) samples per replication.

Results revealed that tail tuber setts significantly had the highest number (1.83) and percentage (28.33%) of sprouted setts, which differed from the head and middle tuber setts. However, the tail tuber sett had significantly delayed sprouting (16.66 days), compared to the middle and head setts, which significantly sprouted early at 4.91 and 8.33 days, respectively.
Tuber segments watered once every four (4) days significantly exhibited the most number (2.00) and percentage (30.00%) of pre-sprouted setts and developed the longest shoot (19.04 cm), which differed significantly among watering intervals. Those watered daily and once every two days showed comparable results, but those watered once every 4 days had significantly delayed sprouting. On the basis of the findings of this study, the following conclusions and recommendations are made:
1. Watering once every two days significantly stimulates the sprouting of yam, regardless of segment sections, with an average of 2.50 days after planting.
2. Planting of tail portion of tuber segments gave the highest number and percentage of sprouted yam setts, but had delayed sprouting of about 16.66 days compared to the other tuber segments with 4.91 and 8.33 days to sprout.
3. Watering of tuber segments once every four days gave the most number and highest percentage of sprouting and shoot length of yam setts.

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Conflict Of Interest

The author declares no conflict of interest.

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