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RESEARCH ARTICLE

EFFECT OF SEED TUBER SIZES ON THE GROWTH AND YIELD OF TACCA LEONTOPETALOIDES (AMORA) AT VARYING NPK FERTILIZER LEVELS IN JOS PLATEAU STATE

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Abstract

Taccaleontopetaloides is gradually assuming the status of a staple food in some middle belt states of Nigeria. Its production and use has been hampered by the fact that it is presently obtained from the wild. The present attempt may form a road map towards domesticating the crop. This experiment was carried out to study the effects of 4 levels of NPK fertilizers (O kg, 100kg, 125kg and 150kg) and 3 seed tuber sizes (< 45, 60 and 100g) on the growth and yield of Taccaleontopeloides L.(amora). The experiment was conducted during the 2018 rainy season at Ritdung integrated farm, Jos South Local Government Area of Plateau State Nigeria(altitude 44 09Ft on latitude 09^0 88^1N and longitude 08^0 85^1E). The 12 treatment studied were factorial combinations of the 3 NPK Fertilizer rates with Control and 3 seed tuber sizes. The potted experiment which were replicated three (3) times were laid out in the format of a Randomized Complete Block Design (RCBD). There were significant differences within the means due to seed tuber sizes for parameters such as Stem girth, Number of Tubers and Mean weight of Tubers while there were no significant differences within the means for parameters such as Leaf Petiole length, Flower Stalk length, Number of Leaves, Number of Leaflets and Number of Flowers. Similarly, there were significant differences within the means due to the various NPK fertilizer levels for parameters such as Flower Stalk Length and Number of Tubers harvested while there were no significant differences within the means for parameters such as Leaf Petiole Length, Flower Stalk Length, Number of Leaves, Number of Leaflets, Stem girth and Mean weight of Tubers. Large seed tuber size (<100g) recorded the highest stem girth, number of tubers and Mean weight of Tubers. $100kgh^{-1}$ of NPK fertilizer rate had the longest Flower Stalk Length and $125kgh^{-1}$ produced the highest number of tubers. This experiment has shown that amora can be successfully grown by farmers using large tubers as seeds and moderate application of NPK fertilizer ($125kgh^{-1}$).

Introduction:-

Taccaleontopetaloides (L.) Kuntze is a wild perennial herb belonging to the family Taccaceae. Tacca is the only genus in the family, relatively recently separated from the family Dioscoreaceae, but closely related (Caddicket al., 2002). The plant is native to the Old World tropics, from western Africa through southern Asia to northern

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Australia. Because of its wide distribution, the plant has numerous common names, but Polynesian arrowroot appears to be the most widely used. In Nigeria, the plant is widespread in the middle belt of Nigeria (Maneket al., 2005) and in the southwestern states, suggesting its Eco geographical distribution within the tropical humid forests of the western parts of Nigeria, up to the Sudan savannah region of the northern parts of Nigeria. It is common as solitary plants in open fields, under the shade of trees or on hilltops. It is found as a plant only in the rainy season, because from September through the dry season the shoot dies off and the tubers become dormant; new shoots sprout and emerge at the onset of rains the following year. It is interesting to note that this plant produces fleshy sweet-tasting fruits, dispersed by birds and mammals that eat the fruit (Drenth,1972).

In Northern Nigeria, the tubers are considered a food, especially during the time other staple foods are scarce (Kay, 1987. The root starch is used to stiffen fabrics. Polynesian arrowroot tubers are food and a delicacy to the people of Shendam, Langtang and the other member of the southern parts of Plateau State. It is a delicacy in many communities where it is found. The starch when dried is used in the preparation of various types of puddings, porridge and ceremonial foods. In India, the flour has been reported to be mixed with wheat flour for making bread, cakes and other sweet meals (Vimala and Nambisan, 2005). It is used as laundry starch.

On many Polynesian islands the bitter raw tubers are used to treat stomach ailments, mainly diarrhea and dysentery (Kay, 1987), as well as guinea worm infection, hepatitis and an antidote for snake bite. Over 134 compounds with different bioactivities have been isolated from Tacca species comprising of steroids, terpeniods, diaryheptanoids and taccalonolides. Taccalonolides are said to have the potential of becoming anti-cancer drugs (Tinley et al.,2003).

Polynesian arrowroot is still a wild plant in Nigeria. Seed tuber size has a significant effect on the growth and yield of tuber crops. Masarirambi et al. (2012) studied the influence of plant population and seed tuber size on growth and yield components of potato (Solanumtuberosum). They reported significant effects with regards to seed tuber size, because plants from larger seed potato tubers exhibited greater physiological growth and yield compared to smaller seed tubers.

Fertilizers are amendments applied to promote plant growth. Nitrogen, phosphorus and potassium fertilizer are the three nutrients most important for cassava and other tuber crops tuberization(Odedinaet al.,2015). Chemical fertilizers usually have 10-20 times higher concentrations of these three nutrients but manures also contain many secondary and micro nutrients, which may contribute to higher yields (Howeler, 2012). However, nutrient uptake is highly related to plant growth rate, varietal differences, soil fertility status and the prevailing climatic conditions (Howeler, 2002).

The production and the used of this crop has been hampered by the fact that it is not yet domesticated. There is insufficient knowledge on the way it should be grown. To date there is little or scattered documented information on the economic importance, production, cultivation, or agronomic practices of this crop which suffered research neglect for many years. Despite the fact that this indigenous tuberous crop is gaining acceptance among the people of North Central Nigeria, little or no information about the growth of Polynesian arrowroot is known. The present attempt may form a road map towards domesticating the crop and thus enhancing its economic potential. It is common knowledge now that the rains nowadays are unpredictable, unreliable and highly vulnerable to the vagaries of weather such that the demand for food in Nigeria always exceeds its supply. Indigenous crops like Taacaleontopetaloides can withstand the effect of drought and weather stress hence increasing quantity of food production and enhancing Nigeria's food security situation. Taccaleontopetaloides has a good prospect as a delicate tuber crop if cultural practices onexisting crop can be improved before greater efforts towards genetic improvements**.** As part of the process of domesticating Taccaleontopetaloide, this work is aimed at finding out how some agronomic practices can affect the growth and yield of Taccaleontopetaloides, determine the response of Taccaleontopetaloidesto NPK fertilizer, determine the appropriate NPK fertilizer level for Taccaleontopetaloides cultivation and to determine the best seed size for good growth and yield of Taccaleontopetaloides.

Materials and Methods:-

A field experiment to study the effect of different seed sizes on the yield and growth of Amora (Taccaleontopetaloides) at varying fertilizer levels in Jos Plateau state Nigeria was conducted between the month of April and October 2018. The experiment was conducted at Ritdung Integrated Farm located in Rantya Jos South Local Government Area of Plateau State Nigeria. Sandy loam soil was used for the experiment. Taccaleontopetaloides seed tubers were obtained from various sources in Shendam Local Government Area of

Plateau State and kept in a conducive environment and regularly observed for any signs of sprouting (breaking of dormancy). The seed tubers of Taccaleontopetaloidesthat eventually sproutwere sorted out for the different sizes by visual inspection. This was further confirmed by weighing the different seed tuber sizes. The experiment was carried out using Randomized Complete Block Design (RCBD) consisting consisting of 3 seed sizes. Small size(blow 45g), Medium(between 45g and 60g) and Large (above 60g) and 4 fertilizer levels (Control, 100kg/ha, 125kg/ha and 150kg/ha) giving a total of 12 treatment combinations which was replicated 3 times.

Table 1:- Weight range and Mean Weight of Taccaleontopetaloides.

Tuber Size	Weight Range (g)	Means Weight (g)
S_1	<45	40.4
S_2	<60	59.6
S_3	>60	83.6

Key: S1= Small size S2= Medium size S3= Large size

A mixture of top soil, sharp sand and cow-dung in ratio of 2:1:1 was filled into pots for planting of amora sprouted seed tubers. Weeding was carried out every two weeks after planting by hand- picking until harvest.NPK fertilizer was applied at two weeks after planting. The application was by ring band placement based on the respective treatments. Amora plants were harvested at fourteen weeks after planting(WAP). The parameters assessed include length of leaf petiole(cm), length of flower stalk(cm), number of leaves, number of leaflets, number of flowers, stem girth(cm), number of tubers at harvest and mean weight of tuber at harvest Data collected were subjected to analysis of variance(ANOVA) and the means were separated using LSD (Least Significant Difference) at the 5% level of probability (Steel et al., 1997).

Results:-

The effect of seed tuber sizes on the leaf petiole length of Taccaleontopetaloides was not significant at all growth stages during the period of the experiment (Table2). However, the differ in their mean numbers. The mean length of leaf petiole for the large tuber sizes and small seed tuber sizes were higher than those of the medium seed tuber sizes and small seed tuber sizes (Table2). The differences due to varying NPK fertilizer levels on the leaf petiole length was not significant also at all growth stages though differ in their mean numbers (Table 2)

Table 2 shows the effect of seed sizes on the flower stalk length of Taccaleontopetaloides. The trend was similar to leaf petiole length as there was not significant differences at all growth stages due to seed tuber sizes. The effect of NPK levels on the flower stalk length was significant only at 8 WAP with $100kgh^{-1}$ fertilizer level recording the longest flower stalk length (58.6cm) which is statistically the same as that of the $150kgh^{-1}$NPK fertilizer level (50.0cm) while $125kgh^{-1}$ had the shortest flower stalk length (25.2cm) and the difference was significant ($P<0.05$)(Table 2)

The effect of seed tuber sizes and NPK fertilizer levels on the stem girth of Taccaleontopetaloides is presented in table 2. The difference due to seed sizes on the stem girth was significant ($P<0.05$) only at 4 WAP and 14 WAP. At these same stages, large seed size (83.6g) had the thickest stem girth while small sizes (40.4g) had the thinnest stem girth. The difference due to the varying NPK fertilizer levels on the stem girth were not significant. However, the mean stem girth of the varying NPK fertilizer levels varied from each other.

The effect of seed tuber sizes on the number of leaves of Taccaleontopetaloides was not significant throughout their growth period (Table 3). Although they differed in their mean numbers. Small seed tuber sizes (40.4g) recorded the highest number of leaves followed by large seed (83.6g) tuber sizes and medium seed tuber sizes (59.6g) in that order (Table 3). There were no significant differences in the number of leaves due to the different NPK fertilizer levels at all growth stages (Table 3). Although the plants showed different mean number of leaves due to the different NPK fertilizer levels.$100kgh^{-1}$ had the highest mean number of leaves followed by $150kgh^{-1}$, 0 kgh^{-1} and $125kgh^{-1}$ respectively (Table 3)

The effect of seed tuber sizes on the number of leaflets of Taccaleontopetaloideswas not statistically significant at all growth periods (Table 3). However, the mean number of leaflets for the small seed tuber sizes (40.4g) were higher than those of the medium sizes (59.6g) and large seed tuber sizes (83.6) in that order at all growth stages (Table 3). Table 3 shows also the effect of the varying NPK fertilizer levels on the number of leaflets of Taccaleontopetaloides,

this also showed no significant difference as the case of the number of leaves though they differed in their mean numbers.100kgh^{-1} NPK fertilizer levels had the highest mean number of leaflets while 125kgh^{-1} had the least mean number of leaflets (Table 3).

Table 3 shows the effect of seed tuber sizes and varying NPK fertilizer levels on the number of flowers of Taccaleontopetaloides. The trend was similar to number of leaves and number of leaflets as number of flowers of Tacca was not significant at all growth stages due to the different seed tuber sizes and the varying NPK fertilizer levels that were used. Although they all differed in their mean numbers. The mean number of flowers for the large seed tuber sizes (83.6g) had the highest mean number of flowers followed by medium seed tuber sizes (59.6) while small seed tuber sizes (40.4) had the least mean number of flowers (Table 3). The mean number of flowers of 100kgh^{-1} had the highest mean number followed by 150kgh^{-1}, 0kgh^{-1} and 125kgh^{-1} in the order (Table 3).

The effect due to seed tuber sizes on the number of tubers at harvest was significant (P<0.05). Large seed tuber sizes and medium seed tuber sizes had the highest number of tubers at harvest and were statistically the same while small seed tuber sizes had the lowest number of tubers at harvest (Table 4). The effect due to the varying NPK fertilizer levels on the number of tubers at harvest was also significant (P<0.05). 125kgh^{-1}fertilizer level recorded the highest number of tubers (1.67) and were statistically different from the other three fertilizer levels while 0kgh^{-1} levelhad the least mean number of tubers (0.44). 150kg^{-1} fertilizer level had 1.11 mean number of tubers and was statistically the same with 100kgh^{-1}which had also 1.11 mean number of tubers(Table 4).

The effect of seed tuber sizes on the mean weigth of Taccaleontopetaloides was significant (P<0.05) at harvest (Table 4). Large seed tuber sizes(83.6g) recorded the heaviest number of tubers while medium seed tuber sizes (59.6g). Small and medium seed tuber sizes were statistically the same in their mean weight of tubers (Table 4).On the other hand, there were no significant differences in the mean weight of the plant tubers due to the varying NPK fertilizer levels used. However,100kgh^{-1} NPK fertilizer levels had the highest mean weight of tubers followed by 150kgh^{-1}, 125 kgh^{-1} while 0kgh^{-1} of NPK fertilizer had the least mean weight of tubers (Table 4).

Table 2:- Effects of Seed Sizes and NPK Fertilizer Level on the Length of Leaf Petiole(cm), Length of Flower Stalk(cm) and Stem Girth Length(cm) of Taccaleontopetaloides at 4, 6, 8, 10, 12, and 14 Weeks after Planting (WAP).

Treatment	4 WAP	6WAP	8WAP	10WAP	12WAP	14WAP
Length of leaf petiole(cm)						
Seed size						
Small (40.4)	15.6	15.8	15.9	16.4	17.3	17.6
Medium (59.6)	16.8	17.1	19.1	19.8	24.9	25.3
Large(83.6)	21.4	21.7	21.9	22.7	23.0	25.2
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Fertilizer(NPK)						
0 kg h^{-1}	20.1	20.2	20.5	21.5	22.2	22.2
100 kg h^{-1}	19.6	20.0	20.9	21.0	20.1	21.4
125 kg h^{-1}	14.2	14.4	15.6	16.1	16.8	17.4
150 kg h^{-1}	17.8	18.3	19.1	19.8	25.9	29.8
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Length of flower stalk(cm)						
Seed Size (g)						
Small(40.4)	26.6	28.9	29.0	29.0	30.5	30.6
Medium(59.6)	35.7	40.3	41.5	44.4	44.6	45.1
Large(83.6)	41.0	46.6	50.6	50.8	51.7	54.2
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Fertilizer (NPK)						
0 kg h^{-1}	27.6	33.1	35.8b	36.2	36.9	37.4
100 kg h^{-1}	48.8	50.8	58.6a	58.8	59.1	60.1

125 kg h^{-1}	21.9	24.8	25.0c	25.2	25.6	25.9
150 kg h^{-1}	39.5	45.6	50.0ab	50.6	51.1	51.9
Significance	NS	NS	*	NS	NS	NS
LSD	-	-	21.1	-	-	-
Stem girth length(cm)						
Seed Size (g)						
Small(40.4)	1.12b	1.53	1.78	1.97	2.15	2.02b
Medium(59.6)	1.71a	2.00	2.18	2.38	2.49	2.55a
Large(83.6)	1.74a	2.03	2.25	2.44	2.53	2.57a
Significance	*	NS	NS	NS	NS	*
LSD	0.48	-	-	-	-	0.50
Fertilizer (NPK)						
0 kg h^{-1}	1.43	1.76	1.90	2.09	2.21	2.26
100 kg h^{-1}	1.77	2.13	2.36	2.53	2.64	2.67
125 kg h^{-1}	1.25	1.59	1.80	1.98	2.11	2.33
150 kg h^{-1}	1.63	1.94	2.20	2.46	2.58	2.62
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-

Means with the same letter(s) within the same column and treatment are not significantly different at 5% levels of probability usingLSD (Least Significant difference)
NS – Not significant

Table 3:- Effect of Seed Sizes and NPK Fertilizer Level on the Number of Leaves, Number of Leaflets and Number of Flowers of Taccaleontopetaloides at 4, 6, 8, 10, 12, and 14 Weeks after Planting (WAP).

Treatment	**4 WAP**	**6WAP**	**8WAP**	**10WAP**	**12WAP**	**14WAP**
Number of Leaves						
Seed Size (g)						
Small (S_1) (40.44)	1.75	2.17	2.25	2.42	2.42	2.42
Medium (S_2) (59.6)	1.75	1.92	2.17	2.17	2.17	2.17
Large(S_3) (83.56)	1.58	1.92	1.92	2.25	2.25	2.25
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Fertilizer (NPK)						
0 kg h^{-1}	1.78	2.00	2.11	2.22	2.22	2.22
100 kg h^{-1}	1.89	2.22	2.44	2.44	2.44	2.44
125 kg h^{-1}	1.33	1.67	1.78	2.11	2.11	2.11
150 kg h^{-1}	1.78	2.11	2.22	2.33	2.33	2.33
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Number of Leaflets						
Seed Size (g)						
Small(40.4)	5.00	6.50	6.75	7.25	7.25	7.25
Medium(59.6)	5.00	5.75	6.50	6.25	6.25	6.25
Large(83.6)	5.00	5.50	5.75	6.25	6.25	6.25
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Fertilizer (NPK)						
0 kg h^{-1}	5.67	5.67	5.78	6.00	6.00	6.00
100 kg h^{-1}	5.33	7.00	7.33	7.33	7.33	7.33
125 kg h^{-1}	4.00	5.00	5.33	5.56	6.00	6.00
150 kg h^{-1}	5.00	6.00	6.22	6.67	7.00	7.00
Significance	NS	NS	NS	NS	NS	NS
LSD	-	-	-	-	-	-
Number of Flowers						

Seed Size(g)						
Small (40.4)			9.25	9.50	9.50	9.58
Medium(59.6)			12.0	12.2	12.2	12.3
Large(83.6)			11.3	11.7	12.3	12.3
Significance			NS	NS	NS	NS
LSD			-	-	-	-
Fertilizer(NPK)						
0kg h-1			9.78	9.78	9.78	9.78
100kg h-1			12.8	13.3	13.3	13.4
125kg h-1			8.11	9.44	9.44	9.56
150kg h-1			12.7	12.8	12.8	12.8
Significance			NS	NS	NS	NS
LSD			-	-	-	-

Means with the same letter(s) within the same column and treatment are not significantly different at 5% levels of probability usingLSD (Least Significant difference)
NS – Not significant

Table 4:- Number of Tubers and Mean Weight of Tubers at Harvest.

1. Treatment	**Numberoftubers**	**Mean Weight of Tubers**
Seed Size (g)		
Small(40.4)	0.75b	20.7ab
Medium(59.6)	1.25a	15.7b
Large(83.6)	1.25a	36.6a
Significance	*	*
LSD	0.29	16.7
Fertilizer (NPK)		
0 kg h^{-1}	0.44c	9.78
100 kg h^{-1}	1.11b	33.5
125 kg h^{-1}	1.67a	20.7
150 kg h^{-1}	1.11b	33.3
Significance	*	NS
LSD	0.41	-

Means with the same letter(s) within the same column and treatment are not significantly different at 5% levels of probability usingLSD (Least Significant difference)
NS – Not significant

Discusion:-

This research work showed that Taccaleontopetaloides L. seed tuber size significantly influenced yield parameters and stem girth of the plant. Growth parameters like length of leaf petioles, flower stalk length, number of leaves, number of leaflets and number of flowers differed in their mean numbers. This could be attributed to the difference in tuber ability to establish and proliferate in root biomass at growth stages (Singh and Bahal, 1997) as exhibited by the various tuber sizes used in this study. In this study, the larger seed tuber sizes displayed an advantage over the medium and small seed tuber size on yield parameters, crop establishment and many growth parameters. The implication of this result is that farmers should sort the seeds before planting and this agreed with the findings of Masarirambiet al. (2012) that large seed tuber size of Irish potato tubers possess relatively larger food reserves with which they produce larger plants that establish faster and in turn produce vigorous seedlings. On the other hand, this research revealed that seed tuber sizes did not significantly(Statistically) influence leaf petiole length, flower stalk length, number of leaves, number of leaflets and number of flowers at any growth stage. This observation may be attributed to the fact that Taccaleontopetaloides is typically decumbent, thus exhibiting no significant difference in regard to leaf petiole length, flower stalk length, number of leaves, number of leaflets and number of flowers as was evident in this studies. However, it is noteworthy that the small seed tuber sizes (<45g) recorded the largest mean number of leaves and mean number of leaflets population which are important growth parameters. This performance by small seed tuber size was translated into the low production of tubers by small seed tubers. This is in line with the findings ofKrochmal and Samuels (1966) that heavy top growth result in low root and tuber yields, this is associated

with high nitrogen. Increased nitrogen levels result in carbohydrates combining to form proteinaceous materials (tops) rather than polymerizing to form starch (tubers and roots). Medium and large seed tuber sizes relatively recorded the largest number of tubers at harvest. This suggests that the observation that larger seed tubers emerge and establish faster due to higher nutrient reserves in the tubers. It is also possible that the high nutrient reserves of the large and medium seed tubers coupled with the increased nutrition consequent from fertilizer application, increased the thickness and girth of the stems at the expense of leaves required to increase number of leaves and number of leaflets for higher photosynthetic activity. Stem girth was longest among stems produced by large seed tubers and medium seed tubers. This may be attributed to the low number of leaves and leaflets produced (low food reserves at the top) which was then translated into the highest number of tubers produced by medium and large seed tuber sizes.

NPK fertilizer application rates significantly influenced flower stalk length and yield of Taccaleontopetaloides, implying that fertilization is required forTaccaleontopetaloides cultivation and for many tuber crops. Yield parameters evaluated showed significant differences. The reason for this observation could be linked to the fact that, Nitrogen, Phosphorus and Potassium (NPK) fertilizer are the three most important nutrients for cassava and tuber crops in general (Odedina, et. la., 2015). With the sufficient NPK supply to Taccaleontopetaloides in the current study, there was adequate protein synthesis from carbohydrates which increase Taccaleontopetaloides growth. NPK supply affects carbohydrate utilization, enhance protein synthesis which increase relative growth rate, metabolism, cell division, cell elongation stimulating apical growth and formation of leaves (Verma, et al., 1996).

However, 125kgh-1 impacted large number of tubers in this study. This implies that Taccaleontopetaloides requires not low and not larger amount of NPK fertilizer but requires a moderate amount of NPK fertilizer for tuber formation. This is in relation with several experiments carried out by Agbaje and Akinlosotu, (2004), Polthanee and Wrongpichet, (2017), Krochmal and Samuel (1966), that the highest yield of cassava was obtained with the high concentration of Nitrogen and phosphorus. In an experiment carried out byTekalign and Hammes, 2005, Malavolta et al., 1955, it was discovered that phosphorus was necessary for good tuber production. It was also discovered that high concentration of phosphorus gave a 93% increase in yield. it is essential for the phosphorylation process in the enzymatic synthesis of starchy reserves in cassava tubers. In an experiment carried by Krochmal and Samuel, 1967, on cassava, they reported that tuber yields were brought about by combinations and interactions of Nitrogen with Phosphorus (NP), Potassium with Phosphorus (KP) and Nitrogen, Phosphorus with Potassium (NPK). In this study, 100 kgh1 level of NPK fertilizer displayed an advantage over 0 kgh-1, 125 kgh-1 and 150 kgh-1 on flower stalk length growth parameter. This could be attributed to the findings of Ahmed, et. al., 2017, which says that Potassium enhances the synthesis and translocation of carbohydrates; whereas, Phosphorus encourages cell walls and length of plants. Also, that fertilizers application results in more photosynthesis and food accumulation, which in the experiment result in better growth and converted vegetative growth in early stages due to balanced nutrition and also had sufficient food material to produce flower earlier. This study revealed that the different NPK fertilizer levels that were used did not significantly influence leaf petiole lengths, number of leaves, number of flowers, number of leaflets and weight of tubers at any growth stage. This observation may be attributed to the fact that Taccaleontopetaloides is typically decumbent, thus exhibiting no significant difference in regard to these parameters listed above.

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