Growth and Yield Responses of Selected Orange Fleshed Sweet Potato (*Ipomoea batatas* (L) Lam.) Varieties to Seedbed Types in Port Harcourt, South-South Nigeria

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Abstract
This field experiment was conducted between late May and early November 2019 and early March and late September 2020 at the Teaching and Research Farm of the Rivers State Institute for Agricultural Research and Training (RIART), Rivers State University, Port Harcourt, Nigeria, to determine the effect of seedbed types on vegetative growth, forage and tuber yields of orange fleshed sweet potato (OFSP) [Ipomoea batatas (L) Lam.]. The treatments were 3 seedbed types - ridges, flat and mounds with 2 and 4 OFSP varieties in 2019 and 2020, respectively, in a factorial arrangement in a Randomized Complete Block Design with 3 replications each year. In 2019, the field was ploughed twice and harrowed before each type of seedbed was prepared. In 2020 there was no ploughing and harrowing. Two of the seedbed types –the ridge and mound were prepared manually using spades and traditional hoes. Results showed that seedbed type did not significantly ($P \geq 0.05$) affect all the vegetative growth and tuber yield parameters measured in 2019. There was also no significant difference in the vegetative growth and tuber yields of the two OFSP varieties. In 2020, with no ploughing and harrowing, planting on the ridge produced the highest forage and tuber yields that were significantly higher than flat planting but statistically similar to mount planting. The study revealed that to reduce cost of labour, stress and time but enhance optimum forage and tuber yield of OFSP varieties, farmers could avoid initial deep ploughing and harrowing of the field before seedbed making. Planting on the ridge is encouraged for producing higher foliage and tuber yields than flat planting but was just statistically similar to mound planting.

Keywords: *Seedbed, Orange fleshed sweet potato varieties, marketable tubers, seed tubers, high rainfall area*

INTRODUCTION

Sweet potato [*Ipomoea batatas* (L) Lam] belongs to the family Convolvulaceae and order Polemoniales (Oggema *et al.*, 2007). It is the third most important root and tuber crop after potato and cassava in the world (Laban *et al.*, 2015). It is a tuber crop with a short growth cycle of 3-5 months providing small holder farmers with invaluable adjustable planting and harvesting times in both high rainfall regions and drier areas or areas prone to droughts, floods or marginal soils, using low inputs (Amare *et al.*, 2014). The crop is able to adapt to different agro-ecological environments and agronomic and cultural practices under which it is cultivated (Sanginga, 2015). Often grown without fertilizer or irrigation (Parwada *et al*., 2011), it can grow from sea level to altitudes of up to 2,500m and temperatures of 15°C to 33°C, while providing good groundcover against erosion and weed infestation.

Sweet potato plays an important role in improving household and national food security, health and livelihoods of poor families in sub-Saharan Africa ((Sanginga, 2015; Stathers *et al*., 2015; SASHA/CIP, 2010). It is a source of food for human, feed for livestock, a bio-based industrial raw material for production of plastics, sugar syrups, ethanol, butanol, flour and confectionaries (Lebot, 2009; Loebenstein and Thottappilly 2009; Ziska *et al*., 2009; George *et al*., 2011) especially in tropical countries where it is widely cultivated (Bovel-Benjamin, 2007; Abidin *et al*., 2017). Sweet potato is rich in dietary fibre, minerals, vitamins and antioxidants, such as phenolic compounds (Lebot *et al*., 2016) and its anti-carcinogenic and cardiovascular disease preventing properties are now in focus (Chsandrasekara and Kumar, 2016).

The orange fleshed sweet potato (OFSP) which contains beta-carotene is a strategic crop bred to overcome vitamin A deficiency (VAD) (Abidin 2012; Tumwegamire *et al*., 2014) and can supply significant amounts of vitamin A, a number of B vitamins, and vitamins C and K simultaneously all year round and is a good source of energy (Gurmu *et al*., 2014; Sanginga, 2015); thus helping to address the twin-problems of Vitamin A deficiency and under-nutrition in developing economies (Hotz, 2012; Mitra, 2012; Lebot, 2013). Two of the most common OFSP varieties available in Nigeria are UMUSPO 1 commonly referred to as '*King J'*, released in December 2012*; and* UMUSPO 3 locally referred to as '*Mothers Delight'*, containing higher levels of beta-carotene than *King J*, released in June 2013 by Nigeria's National Root Crops Research Institute (NRCRI).

The ability of sweet potato to adapt to marginal environments has made it popular with resource-poor farmers as yields up to 15 t/ha and more have been obtained with minimum use of fertilizers while with proper fertilization and sufficient moisture as much as 50 t/ha have been achieved (Parwada *et al*., 2011). Sweet potato cultivation and consumption is increasing and new markets are developing around the world for its usage. However as the possibility of a global food crisis in sub-Saharan Africa becomes more real with climate change, their continued viability will require alternative technologies that will increase yield but lower cost of production (George *et al*., 2011; Stathers *et al*., 2015; van Ittersum, 2016).

Planting of sweet potato on mounds and occasionally on flat land have been conventional practices adopted by many small holder farmers in Nigeria, which are labour intensive and expensive (Aina, 2002). The adoption of ridging is almost a borrowed practice. Generally, tillage for seedbed preparation is tedious, expensive, time consuming, may increase soil erosion, and in some cases may not necessarily increase yields, therefore depending on such experiences and locations, farmers use various seedbed types for cultivating sweet potato. Vugt and Franke (2018) declared that tillage methods and soil nutrient limitations may be critical factors responsible for the yield gap among small holder farmers in Africa that prevents them from achieving attainable yield gains from improved sweet potato. Ahmed *et al*., (2012) found that planting sweet potato on ridges and harvesting the vines 105 days after planting (when about 60% of the growth phase of the plant was completed) led to optimum production of herbage for fodder without compromising yield of tubers. Similarly, Chagonda *et al*., 2014 noted that planting on ridges recorded longer mean storage root length and higher yields while those from mounds had shorter root length and lower yields. On the other hand, Mu'azu (2016) reported that planting sweet potato on the mound performed better than planting on the ridges or on the flat with no significant differences between ridges and flats.

Planting on mounds he opined, provided a good environment for the spread of roots as well as proper aeration for growth and development of the tubers. However, Agbede and Adekiye (2009) observed that ploughing to a depth of 20cm followed by harrowing and ridging gave highest yield of sweet potato compared to manual ridging and mounding because it gave the lowest soil bulk density and highest porosity. On the other hand, Dumbuya *et al*., (2016) observed that while plant growth and development was not significantly affected by seedbed type, root yield was significantly affected; with ridges producing the highest root yield compared to mounds. In the same vein Brobbey (2015), showed that tuber yield was higher with ridges than with mounds. Much earlier, Ravindran and Mohankumar (1985) found that tilled soils, especially mound significantly increased sweet potato root yield compared with flat planting. Contrally in an early study, Midmore (1992) found no significant differences in the root yield of sweet potato under row-ridge, two-row bed, on-the-flat and row furrow.

From the foregoing, it appears tuber and foliage yields from sweet potato seem to depend among other factors on genotype/ cultivar/ variety (Kathabwalika *et al*., 2013; Mekonnen *et al*., 2015) type of seedbed - on the flat, mounds, furrows and ridges (Agbede and Adekiye, 2009; Githunguri and Mutuku 2013), the agro-ecological conditions (Kathabwalika *et al*., 2013), soil fertility (Wassu *et al*., 2015), soil type and depth, micro-climate and topography (Agbede and Adekiya 2009; 2011; Agbede, 2006, 2008) and agronomic practices. The objective of this research was to find out the most suitable seedbed type for cultivation of orange fleshed sweet potato varieties in a high rainfall area of Nigeria.

MATERIALS AND METHODS

Experimental sites

This field experiment was conducted between May and November in 2019 and March and August in 2020 at the Teaching and Research Farm of the Rivers Institute for Agricultural Research and Training (RIART), Rivers State University, Port Harcourt, Rivers State in Nigeria. Port Harcourt is situated in the South-south geographical region of Nigeria at latitude 4.51^{o}North and longitude 7.01^{o}East. Rainfall ranges from 2,000–4,500mm per annum with a mean of 2,500mm. The rains begin in late February and continue till early November with peaks in July and September. Relative humidity remains high all year round with mean values of 75% in February, increasing to 86% in the months of July and September. Annual temperatures vary between 26^{o}C to 35^{o}C while solar radiation /sunshine lasts an average of 4hours daily. The soil is a Typic Paleudult described as Ultisols of sandy loam texture with a pH of 4.8 (1:1 soil:water) and contained 1.5% organic carbon, 0.11% total N, 37ppm available P and 0.24, 0.43, and 0.08me/100g exchangeable K, Ca, and Mg respectively.

Experimental Materials and Treatments

In 2019 cropping season, the treatments consisted of 3 seedbed types (ridge, flat and mound) and 2 OFSP varieties (UMSPO 1 – "*King J*" and UMUSPO 3 – "*Mothers' Delight*") laid out in a 3 x 2 factorial arrangement with three replications in a Randomised Complete Block (RCB) design. There were 6 treatment combinations with a total of 18 plots. In 2020 cropping season, the treatments consisted of 3 seedbed types (ridge, flat and mound) and 3 OFSP varieties (OMUSPO 1, OMUSPO 3, TIS.87/0087/) and TIS-8164 (as control) laid out in a 3 x 4 factorial arrangement with three replications in a Randomised Complete Block (RCB) design. There were 12 treatment combinations with a total of 36 plots. Each plot size was 4m x 2m in 2019, but increased to 4m x 3.6m in 2020, with plots separated by a pathway of 1.0m and blocks separated by a distance of 2.0m. Treatments were randomly assigned to the plots.

Preparation of seedbeds and planting material

In 2019, the field was ploughed twice and harrowed before each type of seed bed was prepared. In 2020 there was no ploughing and harrowing. Two of the seedbed types –the ridge and mound were prepared manually using spades and traditional hoes. Each ridge measured a length of 2m and 3.6m, in 2019 and 2020, respectively, using a width of 0.3m and a height of 0.3m. Mounds were prepared at measurements of 0.5m length by 0.3m width and 0.3m height. The flat seedbed did not require further preparation before planting. Planting materials were disease and weevil-free fresh vine tips, measuring 0.20 to 0.25 m and carrying a minimum of four nodes obtained from a vine multiplication nursery in RIART. Excess leaves were trimmed off the cuttings and were tied in bundles and placed in an upright position in a bucket containing some quantity of pure water to avoid wilting during planting in the field (Ahmed *et al*., 2012). Vines were planted at a spacing of 0.3m along the row in a 4-row plot, with two to three nodes inserted into the ground at 45º to the soil surface in holes prepared by using sharp-pointed sticks of about 4 cm diameter. There was a total of 27 and 48 plants per plot in 2019 and 2020, respectively. Weeds were controlled by manual weeding with hoes at 4 and 8 weeks after planting. No fertilisers or pesticides were applied and the experiment was conducted under rain fed conditions. Six and 8 randomly selected plants from the two middle rows of each plot were properly labelled for data collection in 2019 and 2020, respectively. Harvest was done 20 weeks after planting in both years by total handpicking of the roots after determining whole top (forage) yields above ground level.

Data Collection

The following data were collected at harvest: - vine length, number of vine branches, number of leaves per vine, fresh weight of vines. Weight of storage roots was also recorded. The storage roots were graded into 2 categories according to sizes as: marketable tubers (≥80g) and unmarketable therein referred to as seed tubers (<80g) being free from rot, insect or disease damage (Egeonu and Akoroda 2010) by weighing and each category counted.

Statistical Analyses

All data were subjected to analysis of variance using the General Linear Model procedure of the statistical analysis system (SAS, 2010) to determine treatment effects. Where there were significant F-test, means were separated by Fisher's protected Least Significant Difference Test at the 0.05 level of probability.

RESULTS AND DISCUSSIONS

Effects of Seedbed Types on Vegetative Traits of OFSP Varieties

Results of 2019 trial showed that effects of seedbed types: - ridge, flat or mound did not differ significantly (P≥0.05) with respect to total number of leaves, number of secondary branches and length of vines of the two OFSP varieties (Tables 1 and 3) although planting on mounds produced numerically higher number of leaves, and branches whereas planting on ridges resulted in the longest vines. Dumbuya *et al*., (2016) had reported that plant growth and development were not significantly affected by seedbed type. With respect to the OFSP varieties, OMUSPO 1 had more leaves, and branches and longer vines than OMUSPO 3 although the differences were not statistically significant (Tables 1 and 3). There were equally no significant interaction effects between seedbed types and OFSP varieties in any of these traits. The reverse was the case in 2020 cropping season. There were significant effects of seedbed type as well as varietal effect on total number of leaves, number of secondary branches and length of vines of the four varieties (Tables 2 and 3 and Figure 2).

Vine length

There was a significant (p<0.05) seedbed type x variety interaction for mean vine length of the four sweet potato varieties assessed (Table 2). The highest mean value of vine length was recorded from planting of variety UMUSPO 1 on the mound while the lowest mean value was recorded when variety UMUSPO 3 was planted on the flat. Planting of Variety UMUSPO I on the mound significantly increased vine length than all other planting combinations except planting of UMUSPO I on the ridge and Variety TIS-8164 on the mount. Among the seedbeds, flat planting produced the longest vines at 12 WAP (Figure 2) followed by ridge while the mound was the least. At 20 WAP, ridging produced the longest vine and was significantly longer than flat planting but statistically similar to mound planting. Varietal effect showed that TIS.87/0087 produced the least vine length that was significantly lower than UMUSPO 1 and TIS-8164 but statistically similar to UMUSPO 3.
This indicates that variety TIS.87/0087 can be used as a good vine source especially where production is aimed at producing sweet potato forage for feeding of ruminants since the vines are rich in their proteins and minerals contents needed in livestock feeds (Rahman et al., 2013; Ahmed et al., 2012; Kebede et al., 2008).

Number of leaves per plant

Number of leaves per plant showed no significant (p>0.05) effects among the three seedbed types. (Table 3) rather significant effect became prominent among the four varieties. The highest mean number of leaves per plant was recorded in variety TIS-8164 while the lowest mean was recorded in variety UMUSPO I compared to the other varieties evaluated. Variety TIS-8164 was significantly higher than UMUSPO I and II but statistically similar to TIS.87/0087. The interaction between seedbed type and varieties was insignificant. The difference perceived among the varieties in number of leaves per plant could be attributed to the difference in their genotypic composition. This result is in agreement with the finding of Wariboko and Ogidi (2014), who observed significant differences in the growth parameters of the varieties tested. In this study varieties TIS-8164 and TIS.87/0087 had the highest number of leaves per plant, an important factor for photosynthesis in the crop. Nwankwo et al., (2012) had stated that growth and adaptability of the crop to the growing conditions of the study area is established in the successful vegetative growth.

Number of branches per plant

Number of branches per plant was not significantly influenced by seedbed types although planting on the ridge produced a higher number than others. Similarly, interactive effect of seedbed x variety was insignificant. Significant (p<0.05) effect became more prominent among the four varieties (Tables 2 and 3). The highest number of branches per plant was recorded in variety TIS-8164, while the lowest mean value was recorded in TIS87/0087 compared to the remaining varieties. The differences observed in number of branches per plant among the evaluated four varieties in 2020 was attributed to their genotypic differences. This result is in conformity with the findings of Rahman et al. (2013). Egbe et al. (2012) and Mukhtar et al. (2010) who conclude that number of branches per plant significantly differ among the respective sweet potato varieties evaluated and attributed the differences to the varietal constitutions of the respective varieties.

Forage yield

Results of 2019 shows that there were also no significant (P≥0.05) effects of seedbed types on forage fresh weight although mounds seedbed produced the highest fresh weights (Table 2). The variety OMUSPO 1 had higher fresh weight of vines and leaves than OMUSPO 3 though they were statistically similar (Tables 1 and 2). There were no significant interaction effects between seedbed types and OFSP varieties with respect to fresh weight of vines and leaves. The various seedbed types did not significantly affect the vegetative traits of sweet potato measured in this study. Dumbuya *et al*., (2016) reported similar findings for sweet potato vegetative growth and development while Mu'azu (2016) found no significant effects of seedbed types for all vegetative traits measured except for number of branches. Since the experiment commenced in the full rains (May ending), perhaps the heavy rains of the zone (2500-4500mm) may have washed down the ridges and mounds (Nedunchezhiyan *et al*., 2012), creating less effects of seedbed rather the generalised effect of tillage (ploughing and harrowing) became prominent.

Results of 2020 shows that fresh forage yield was significantly ($p<0.05$) influenced by seedbed types. Ridge planting produced significantly higher forage yield than flat planting but was statistically similar to mound planting (Figure 3A). Similarly, significant differences occurred among the four varieties studies. Variety TIS-8164 produced the highest yield across the 3 seedbed types, and was significantly higher than all other varieties except variety TIS.87/0087. On the other hand, variety UMUSPO 3 produced the lowest yield which was also not significantly different from variety UMUSPO 3, implying that variety UMUSPO 3 was probably the poorest in forage production among the introduced four improved OFS varieties tested in the agro ecological zone. This result agrees with that of Egbe et al., (2012), that during the growth of sweet potato substantial morphological changes occur which could be different among varieties and these influences the accumulation or distribution of the total dry matter among the major plant organs and directly contributing to the difference in fresh weight.

Effects of Seedbed Types on Yield Traits of OFSP Varieties

Results of 2019 cropping showed that seedbed type did not significantly ($P\geq0.05$) affect weight of marketable tubers, weight of seed tubers and weight of total number of tubers irrespective of OFSP variety (Tables 1, 3 and Figure 1B). Although, planting on the flat produced the highest marketable tubers, seed tubers and total tubers weight compared to planting on ridges and mounds, they did not differ significantly from one another. There were no significant interaction effects between seedbed type and OFSP variety with respect to yield of marketable tubers, seed tubers and total tubers. This finding agrees with the report of Midmore (1992) who found that seedbed types did not significantly affect tuber yields of sweet potato. This insignificant yield performances observation in the 2019 cropping season could be an indication that effective soil tillage (for good soil aeration, water conservation, infiltration and roots penetration) as was done by double ploughing and harrowing is necessary, irrespective of the seedbed type latter made, for optimum production of sweet potato forage and root tuber in the high rainfall zone.

The reverse was the case in 2020 cropping season where no conventional tillage was done prior to seedbed type preparation. There was no significant seedbed type x variety interaction effect for tuber yield rather significant differences became prominent within seedbed types and varieties, respectively. Planting on the ridge produced the highest tube yield and was significantly higher than planting on the flat which produced the lowest tuber yield in the study. Although yield obtained from planting on the mound was lower than yield from ridge planting, they were statistically similar. Tillage effects become evident in this study in that ridge and mound seedbeds are tillage operations and our study has shown the superiority of ridge seedbed which significantly increased tuberous yield performances over flat seedbed type and also produced higher yield than mound seedbed although they were statistically same. This observation agrees with the report of Brobbey (2015) that tuber yield was higher with ridges than mounds. Similarly, Ahmed *et al.*, (2012) recorded significantly tuber yield of sweet potato when planted on the ridge than planting on the flat.

Significant ($p<0.05$) differences also occurred in respect of tuber yield among the four varieties evaluated (Table 2 and Figure 3B). The highest tuber yield was recorded by variety UMUSPO 1 followed by variety UMUSPO 3 which were statistically similar but significantly higher than other varieties of TIS. 87/0087 and TIS-8164. Tuber yield is an important factor for selection of sweet potato and serves as an indicator of adaptability of the crop to an environment (Nwankwo *et al.*, 2012). The result obtained in this study is in agreement with the findings of Ali *et al.*, (2009) who showed that different varieties exhibit yield potentials based on genetical origin and technology applied. Also, Saraswati *et al.*, (2013) and Tsegaye *et al.*, (2007) working on dry matter content (DMC) of sweet potato tubers attributed significant differences recorded in DMC as a direct response to genetic variation of sweet potatoes.

CONCLUSION

The results of the investigation show that growth, yield and characteristics of sweet potato viz: vine length, number of branches per plant and number of leaves per plant, forage and tuber yields and yield attributes were not significantly influenced by seedbed type in the 2019 cropping season, probably as an effect of the double ploughing and harrowing of land prior to seedbed formation, couple with the heavy rains at planting which washed down the ridges and mounds, despite remoulding, to almost flat surface. These actions may have been responsible for the insignificant effects noticed. The reverse was the case in 2020 where there was no ploughing and harrowing but ridges and mounds were constructed manually and planting was done at the unset of the rains and not in the middle of the rains. There was significant influence of seedbed type on vine length, number of branches per plant and number of leaves per plant, forage and tuber yields. It is as well necessary that seedbed preparation and planting be done with the unset of the rains (about March) for the root system be well established to firmly hold back the soil particles before the full rains of late May.

Base on the results of this study, planting on ridges as early as March of the year is recommended among the tillage systems; among the sweet potato varieties, UMUSPO 1 and 3 would be recommended for root tuber production while TIS-87/0087 and TIS-8164 would produce more forage for livestock feeding.

Table 1. Mean squares from ANOVA of effects of seedbed type on vegetative and tuber yield traits of two OFSP varieties in 2019 cropping season

Sources of Variation	df	Vine length (cm)	No. of leaves/ vine	No. of Branches/ vine	Forage yield (kg)	Total tuber weight (t/ha)	Marketable tuber weight (t/ha)	Seed tuber weight (t/ha)
Block (Rep)	2	8773.0^{NS}	55.2^{NS}	5.1^{NS}	2252.1^{NS}	2.9^{NS}	2.8^{NS}	0.153^{NS}
Seedbed Type (A)	2	3074.7^{NS}	1315.2^{NS}	2.9^{NS}	2176.9^{NS}	0.6^{NS}	0.6^{NS}	0.011^{NS}
OFSP Variety (B)	1	3901.4^{NS}	364.5^{NS}	5.6^{NS}	8234.7^{NS}	1.2^{NS}	1.0^{NS}	0.002^{NS}
A x B (Interaction)	2	643.5^{NS}	241.2^{NS}	0.2^{NS}	696.9^{NS}	0.6^{NS}	0.6^{NS}	0.028^{NS}
Error	10	2370.8	945.5	5.2	2503.7	1.2	1.0	0.022
CV (%)		15.84	14.9	5.25	10.88	14.3	11.13	11.65

* Significant at P = 0.05
ns = Not Significant
CV (%) = coefficient of variability

Table 2. Mean squares from ANOVA of effects of seedbed type on vegetative and tuber yield traits of four OFSP varieties in 2020 cropping seasn.

Sources of Variation	df	Vine length (cm)	No. of leaves/ vine	No. of Branches/ vine	Forage fresh yield (t/ha)	Total tuber yield (t/ha)	Marketable Tuber yield (t/ha)	Marketable Tuber yield (t/ha)
Block (Rep)	2	165.7ns	35.1ns	0.011ns	1.663ns	1.701	0.773ns	0.011ns
Seedbed Type (A)	2	2524.2*	136.1ns	0.210*	8.533*	8.066*	10.803*	0.210*
OFSP Variety (B)	3	1352.0*	1122.9*	0.014ns	16.607*	2.433*	2.743*	0.014ns
A x B (Interaction)	6	182.0*	131.7ns	0.032*	1.029*	0.612ns	0.593ns	0.032*
Error	22	165.7ns	267.2	0.010	1.689	0.438	0.450	0.010
CV (%)		14.3	10.88	9.36	11.13	12.38	13.86	9.98

* Significant at P = 0.05
ns = Not Significant

CV (%) = coefficient of variability

Table 3. Effects of seedbed types on forage and root tuber yield attributes of sweet potato varieties in 2019 and 2020 cropping seasons

Treatments	Vine length (cm)	Number of leaves per vine	Number of branches per vine	Marketable tubers yield (t/ha)	Seed tubers yield (t/ha)	**Treatments**	Mean vine length (cm)	Number of leaves per vine	Number of branches per vine	Marketable tubers yield (t/ha)	Seed tubers yield (t/ha)
2019 cropping season						2020 cropping season					
Seedbed Type (ST)						**Seedbed Type (ST)**					
Ridge (RG)	543.3	159.5	8.9	4.86	0.53	Ridge (RG)	555.7	241.0	12.3	7.24	0.528
Flat (FT)	521.7	177.0	7.9	5.11	0.68	Flat (FT)	472.6	249.9	11.0	4.72	0.683
Mound (MD)	534.3	181.3	9.7	4.65	0.61	Mound (MD)	554.0	244.3	11.5	6.41	0.610
LS D $_{(0.05)}$	Ns	ns	ns	ns	ns	LSD $_{(0.05)}$	23.13	ns	Ns	0.473	0.0244
Varieties (Var)						**Varieties (Var)**					
UMSPO 1 (V1)	610.2	260.3	13.9	7.56	0.87	UMSPO 1 (V1)	305.5	131.4	7.1	3.53	0.393
UMSPO 3 (V2)	589.4	257.5	12.6	7.06	0.96	UMSPO 3 (V2)	296.3	132.3	5.9	2.93	0.429
LSD $_{(0.05)}$	Ns	ns	ns	ns	ns	TIS.87/0087 (V3)	272.8	138.2	5.8	3.41	0.367
						TIS-8164 (V4)	312.1	149.6	7.4	4.04	0.368
						LSD $_{(0.05)}$	26.27	13.23	0.79	0.542	Ns
ST x Var (Interaction)						**ST x Var (Interaction)**					
RG x V1	532.2	151.3	9.7	5.16	0.48	RG x V1	434.0	172.3	9.7	5.52	0.406
RG x V2	536.3	167.7	8.0	4.56	0.57	RG x V2	426.3	167.7	8.0	4.11	0.540
FT x V1	530.7	190.7	8.4	5.56	0.69	RG x V3	396.4	187.3	8.9	5.41	0.333
FT x V2	512.7	163.3	7.4	4.65	0.67	RG x V4	410.6	195.7	10.4	6.62	0.470
MD x V1	557.5	173.0	9.7	4.40	0.56	FT x V1	344.0	184.7	9.1	3.54	0.610
MD x V2	529.6	189.7	9.7	4.90	0.66	FT x V2	329.4	185.3	7.4	3.32	0.813
LSD $_{(0.05)}$	Ns	ns	ns	ns	ns	FT x V3	338.7	181.3	6.4	3.51	0.630
						FT x V4	405.7	198.3	10.2	3.91	0.633
						MD x V1	444.0	168.7	9.5	4.94	0.557
						MD x V2	429.3	176.0	8.4	4.42	0.363
						MD x V3	356.2	184.0	7.7	4.63	0.503
						MD x V4	432.4	204.3	8.8	5.31	0.370

LSD $_{(0.05)}$	103.36	ns	Ns	ns	0.443

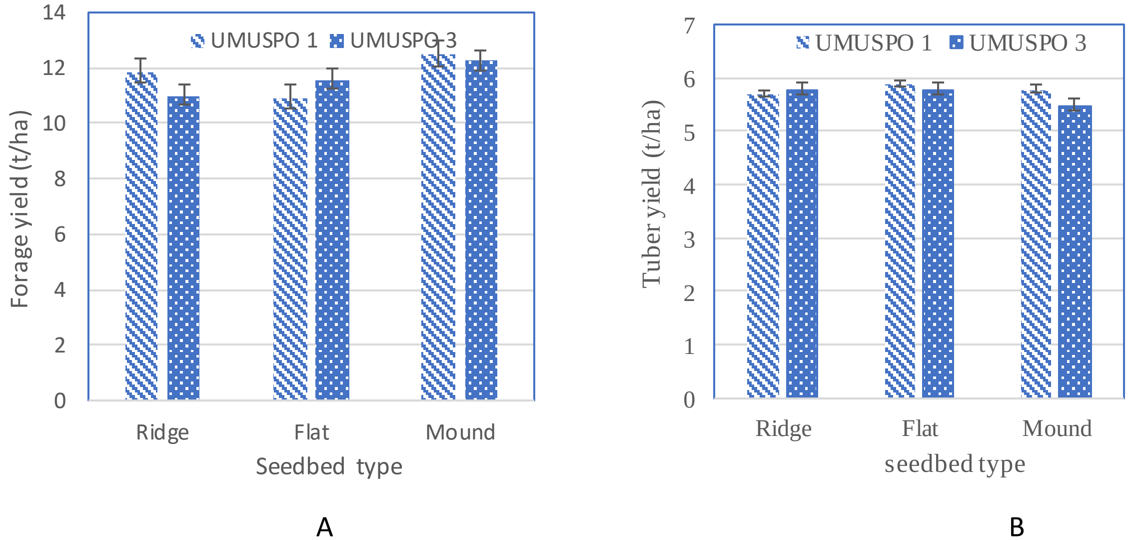


Figure 1. Effects of seedbed types on (A) Forage and (B) Tuber yields of two OFSP varieties at harvest, 20 weeks after planting (WAP) in 2019 cropping season.

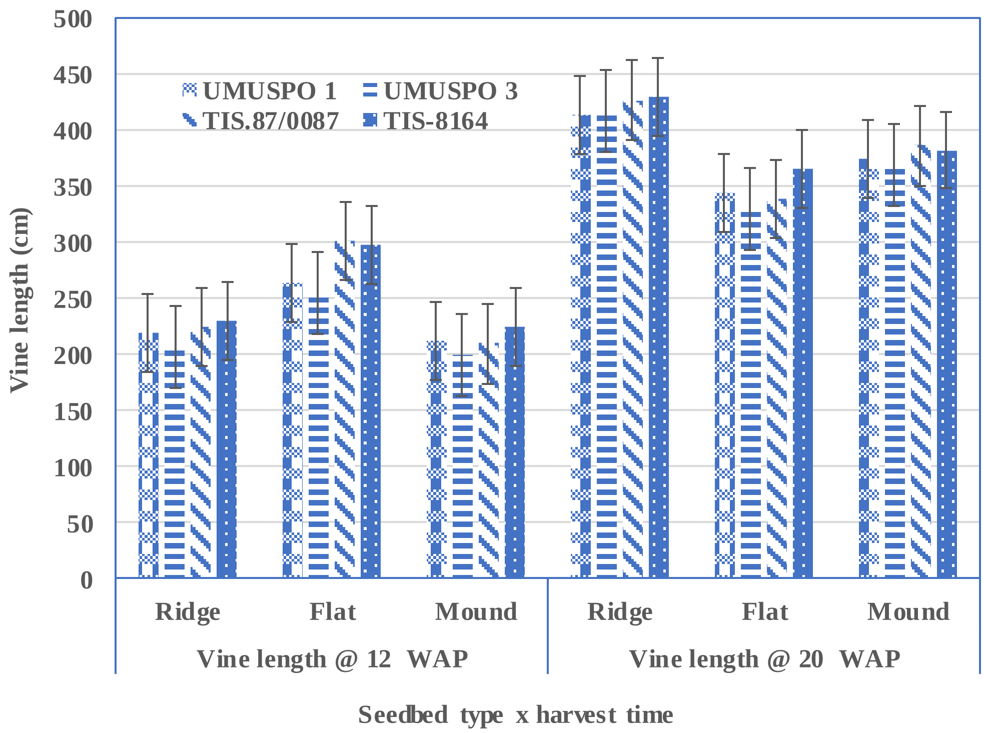
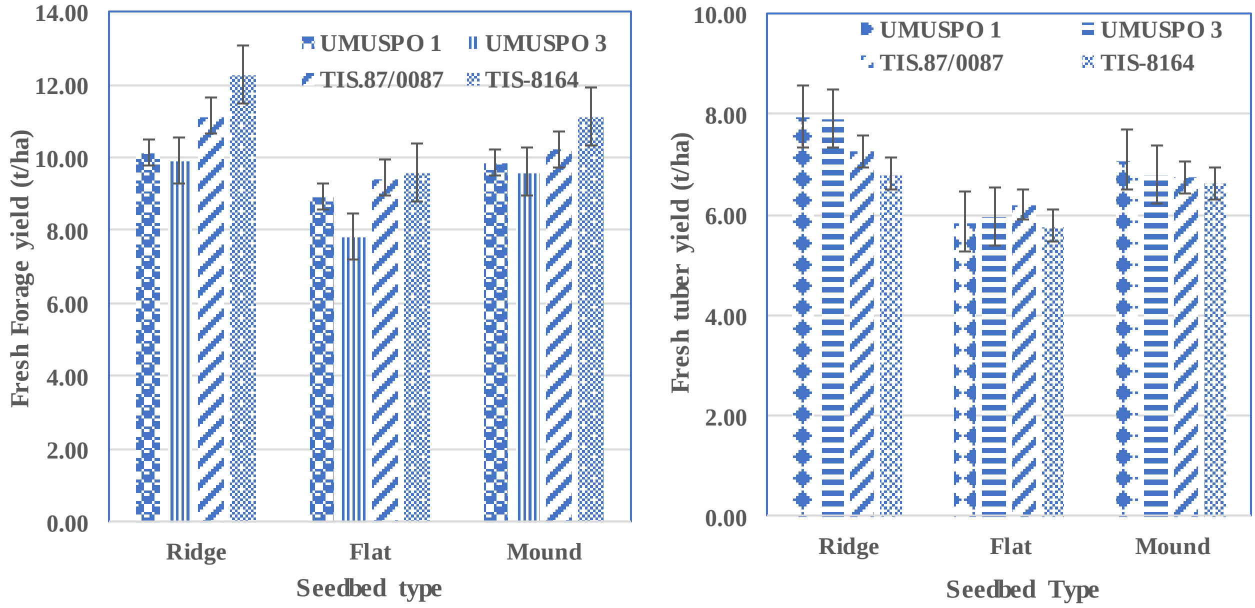


Figure 2. Effects of seedbed types on vine length of four sweet potato varieties measured at 12 and 20 weeks after planting (WAP) in 2020 cropping season.



A B

Figure 3. Effects of seedbed types on (A) Forage and (B) Tuber yields of four OFSP varieties at harvest, 20 weeks after planting (WAP) in 2020 cropping season

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