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Variation in Fodder and Tuber Yields of Three Sweet Potato Varieties and the 48-h Rumen Dry Matter Degradation in N'dama Steers

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Abstract: Two experiments were conducted to study the influence of planting date on three sweet potato varieties (TIS-87/0087, TIS-8164 and TIS-2532.OP.1.13). Fodder yield peaked ($P < 0.05$) at July planting, while root yield and harvest index peaked at August planting. Leaf-to-stem ratio decreased ($P < 0.05$) from June to August plantings, while 48-h rumen DM degradation was lower for July planting and higher for June planting. Mean root yield and leaf-to-stem ratio were higher ($P < 0.05$) in variety TIS-8164, while TIS-87/0087 recorded lower root yield and TIS-2532.OP.1.13 gave lower leaf-to-stem ratio.

Key words: Date of planting · Fodder yields · Root yields · Leaf-to-stem ratio · Variety · Rumen DM degradation

INTRODUCTION

Planting sweet potato (*Ipomoea batatas* (L.) Lam.) at a time when there is adequate soil moisture achieves good sprouting [1, 2], which suggests that with irrigation the crop could be grown all-year-round [1]. But under smallholder farming systems in most rural areas of sub-Saharan Africa, the use of irrigation facilities is not yet a common practice. In Nigeria, for example, planting between May and September gave the highest marketable tuber yields [3, 4], while in Papua New Guinea, it is from May to August [5]. Tewe *et al.* [6] reported that, in the humid zone of Nigeria, sweet potato weevil (*Cylas spp*.) affects crops planted between October and December of the year. Therefore, the present study was aimed at identifying the most appropriate planting dates for optimum yields and the variations in fodder quality using the 48-h rumen degradation method in N'Dama steers for three dual-purpose high to medium-potential sweet potato varieties under rain-fed agricultural farming systems in the subhumid zone of Nigeria

MATERIALS AND METHODS

Site and Description of Varieties: Two experiments were conducted on the Research Farm of ILRI (International Livestock Research Institute), Ibadan (07°30' N, 03°54' E). The average annual rainfall was 1648 mm over 139 d, relative humidity 75% (56 to 95%), solar radiation 14.04 MJ/m^2.day and temperature 25.9°C (21.7 to 30.2°C). The experiments were sited on a 75 x 200 m plot with sandy-loam soil with crops established on ridges. About 7-d prior to plant establishment, plots were sprayed with Gramoxone® (broad spectrum post-emergence herbicides for grass and broad-leaf weeds) and Premextra® (broad-leaf specific pre-emergence herbicide). One medium yield variety (TIS-2532.OP.1.13) and two high yield varieties (TIS-87/0087 and TIS-8164) of sweet potato obtained from the National Root Crops Research Institute (NRCRI), Umudike, Nigeria were evaluated. The varieties were selected based on results obtained from a previous study by Larbi *et al.* [7].

Experiment 1: Effects of planting date on yields and yield components

Experiment 1 was set up as split-plot design to investigate the influence of planting date on fodder and tuber yields and other yield components of the three varieties. Main-plots were three varieties (TIS-87/0087, TIS-8164 and TIS-2532.OP.1.13) and sub-plots were three planting dates (June, July and August). Disease and weevil-free fresh vine tips, measuring 0.20 to 0.25 m and carrying four to five nodes, were planted with two to three

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nodes underground at 45° to the ridge top in holes prepared by using sharp-pointed sticks of about 4 cm diameter. Planting space was 0.25 m intra-row and 1.00 m inter-row. Hand weeding was done at 14 days after planting (DAP) and thereafter as required when plots were weedy until there was complete ground cover by the plants. At six weeks after planting (WAP), inorganic fertilizer (NPK 15:15:15) was applied as side dressing at the rate of 250 kg/ha.

Harvesting was done at 16 WAP by total handpicking of the roots after determining whole top yields above ground level. Sampling was done using four randomly placed 1 x 1 m sized quadrats, covering an average of three plants per quadrat for each planting date. Data collected at the time of harvesting included fodder yields, root yields, harvest index and leaf-to-stem ratios. Foliage DM contents were determined at 60°C for 72 h and root DM determined at 80°C for 72 h in a Gallenkamp force-drought oven. Dried foliage samples were preserved for rumen DM degradation.

Experiment 2: Rumen DM degradation

The dried foliage samples obtained from Experiments 1 were milled through a 2.5 mm screen using laboratory hammer mill and used for incubation in three rumen-fistulated N'Dama steers of average bodyweight 267 kg and about 42 months old. They were housed in individual pens measuring about 2.0 x 2.5 m with half-walls made of wood. Animals were offered maize stover *ad libitum* as basal diet supplemented with 1.5 kg wheat bran daily at 08:00 h, after discarding the leftovers of the previous day. The steers had free access to mineral licks and clean drinking water throughout the period of the experiment. Incubation commenced after 10 d of maintaining animals on this feeding regimen. About 3 g of samples were incubated, in duplicates, in the rumen for 48-h with DM disappearance considered as 48-h rumen DM degradation [8].

Statistical Analyses: Data from Experiments 1 were subjected to analysis of variance (ANOVA) procedures as split-plot using SAS [9] software package. Sweet potato varieties were the three main-plots and planting dates were the sub-plots with four replicates (quadrats sampled). Variety x replicate interaction was used as error term to test for differences between varieties. Data from both years were bulked when the year effect was not significant. The 48-h rumen DM disappearance (dmd) data from Experiment 2 were analysed as 3 x 3 factorial arrangement in a split-plot design with main-plot factor as variety and sub-plot factor as planting date as described by Gomez and Gomez [10]. Variety x replicate interaction also served as error term for testing differences between varieties. And when *F*-tests showed significant differences, mean separation was carried out using least significant difference (LSD) option at 5% probability level.

RESULTS

Effects of Planting Date on Yields and Yield Components: There was significant ($P < 0.05$) variety by planting date (June; July; August) interaction (Table 2). Fodder yields ranged from 1.81 t/ha DM in TIS-8164 to 3.22 t/ha DM in TIS-87/0087 at June planting, from 3.25 t/ha DM in TIS-2532.OP.1.13 to 4.30 t/ha DM in TIS-8164 at July planting,

Table 1:Fodder yields of three sweet potato varieties planted in June, July, August and harvested at 16 weeks after planting (WAP) in 1999 and 2000.

	Fodder yields (t/ha DM)				
Sweet potato variety	June	July	August	Mean	S.E.D. ($P = 0.05$)
TIS-87/0087	3.22	4.12	1.38	2.91	0.812
TIS-8164	1.81	4.30	1.77	2.63	0.649
TIS-2532.OP.1.13	2.71	3.25	2.36	2.78	0.727
Mean	2.58	3.89	1.84		
S.E.D. ($P = 0.05$)	0.440	1.201	0.548		

Table 2: Root yields of three sweet potato varieties planted in June, July, August and harvested at 16 weeks after planting (WAP) in 1999 and 2000.

	Root yields (t/ha DM)				
Sweet potato variety	June	July	August	Mean	S.E.D.($P = 0.05$)
TIS-87/0087	5.84	6.45	7.08	6.46	2.085
TIS-8164	6.31	8.38	8.79	7.83	1.619
TIS-2532.OP.1.13	4.46	8.27	9.69	7.48	1.806
Mean	5.54	7.70	8.52		
S.E.D. ($P = 0.05$)	1.976	2.313	1.222		

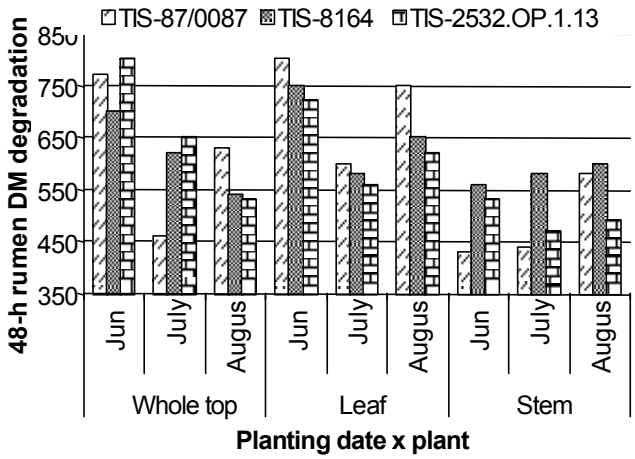

Fig. 1: Variations in 48-h rumen DM degradation (g/kg DM) in the whole top, leaf and stem from three sweet potato varieties planted in June, July and August and harvested at 16 weeks after planting (WAP).

but between 1.38 t/ha DM in TIS-87/0087 and 2.36 t/ha DM in TIS-2532.OP.1.13 at August planting. Mean fodder yield was lower for variety TIS-8164 (2.63 t/ha DM) and higher for variety TIS-87/0087 (2.91 t/ha DM) while for planting date fodder yield, the August planting recorded the least (1.84 t/ha DM) and the July planting recorded the highest (3.89 t/ha DM).

There was no significant difference ($P > 0.05$) in root yields among the three varieties within each planting date. The results showed that root yields increased on the average with planting date from June to July to August and varied from 6.46 t/ha DM for TIS-87/0087 to 7.83 t/ha DM for TIS-8164.

The results of leaf-to-stem ratio gave significant ($P < 0.05$) variety by planting date interaction (Table 1). Leaf-to-stem ratio ranged from 2.22 in TIS-2532.OP.1.13 to 3.48 in TIS-87/0087 at June planting, between 1.23 in TIS-87/0087 and 1.89 in TIS-8164 at July planting and from 0.96 in TIS-2532.OP.1.13 to 1.89 in TIS-8164 at August planting. On the average, leaf-to-stem ratio was 1.54 for TIS-2532.OP.1.13 up to 2.17 for TIS-8164 with mean ratios showing that the June planting (2.81) was significantly ($P < 0.05$) higher than the July (1.53) and August (1.42) planting that were similar ($P > 0.05$).

Rumen DM Degradation with Varying Planting Dates: Figure 1 shows the variations in 48-h rumen DM degradation in sweet potato whole top, leaf and stem planted in June, July and August and harvested at 16 WAP. In the whole top, DM degradation decreased with delayed planting dates except in TIS-87/0087 where the least DM degradation occurred at the July planting. In the leaf fraction, the DM degradation pattern for the three varieties showed that it was lower at the July planting and higher at the June planting. In the stem, the results indicated that TIS-87/0087 performed better at the August planting, TIS-8164 was more uniform for all three planting dates while, TIS-2532.OP.1.13 was better at June planting.

DISCUSSION

Effects of Planting Date on Yields and Yield Components: The yields and yield components of three sweet potato varieties planted in June, July and August and harvested at 16 WAP varied among varieties. Fodder yields were generally, lower in August planting and higher in July planting for all three varieties (Table 1). There was variety by planting date interaction with variety TIS-87/0087 performing better in June, TIS-8164 in July and TIS-2532.OP.1.13 in August more than the other two varieties, respectively. This is similar to results from another study by King [11] on sweet potato, when planted at different planting dates.

Root yields increased with varying planting date from June to August (Table 2). For the June and July plantings, TIS-8164 gave higher root yields while TIS-2532.OP.1.13 gave higher root yields for the August planting date. Previous workers have made similar observations from their study where it was shown that different varieties of sweet potato crop differed in their responses to date of planting [12]. In an earlier study on four sweet potato clones, Martin [13] attributed such differences in response to planting dates to differences in their responses to day length, rainfall, temperature and light intensity.

Table 3: Leaf-to-stem ratio of three sweet potato varieties planted in June, July, August and harvested at 16 weeks after planting (WAP) in 1999 and 2000.

	Leaf-to-stem ratio				
Sweet potato variety	June	July	August	Mean	S.E.D. ($P = 0.05$)
TIS-87/0087	3.48	1.23	1.41	2.04	0.314
TIS-8164	2.74	1.89	1.89	2.17	0.452
TIS-2532.OP.1.13	2.22	1.46	0.96	1.54	0.403
Mean	2.81	1.53	1.42		
S.E.D. ($P = 0.05$)	0.560	0.273	0.336		

The leaf-to-stem ratio was higher for the June planting among the three varieties with the mean ratios across planting dates indicating that it was lower in TIS-2532.OP.1.13 and higher in TIS-8164 (Table 3). At June planting, leaf-to-stem ratio was lower in variety TIS-2532.OP.1.13 and higher in variety TIS-87/0087, at July planting it was lower in variety TIS-87/0087 and higher in variety TIS-8164, while at August planting it was lower in variety TIS-2532.OP.1.13 and higher in variety TIS-8164. Mwanga and Zamora [14] posited that the lower proportion of leaf in the fodder as planting date extends from June to August is the result of reduced soil moisture at the time of harvesting.

Rumen DM Degradation with Varying Planting Dates: Variations in 48-h rumen DM degradation in the whole top, leaf and stem of the three sweet potato varieties with varying planting dates as depicted in Figure 1 suggest that differences were dependent on the genetic make-up of the plant. In the whole top, 48-h rumen DM degradation was lower in July and higher in June planting for variety TIS-87/0087, while it decreased from June to August plantings in varieties TIS-8164 and TIS-2532.OP.1.13. The differences in recorded 48-h rumen DM degradation are also attributable to differences in leaf-to-stem ratios among the varieties at different planting dates that ultimately result to differences in fibre contents of the whole top [15].

In the leaf, the 48-h rumen DM degradation trend in all three varieties showed that it was lower for the July planting and higher for the June planting. In the stem, variety TIS-87/0087 was better degraded for the August planting, TIS-8164 was similar across the three planting dates and exceeding 550 g/kg DM, while TIS-2532.OP.1.13 was better at the June planting.

CONCLUSION

The studies have shown that yields and quality of sweet potato varieties differed with different planting dates within a given environment. Thus, farmers could embark on appropriate crop variety management practices to ensure optimum fodder and root yields/quality under smallholder crop-livestock production systems. Based on observed results from the study, the recommended planting period is in July and harvesting should be done at 16 WAP. Such a planned cultivation process would guarantee sustainable yields of tuber for human consumption, while simultaneously producing good quality fodder for utilization by livestock.

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REFERENCES

1. King, G., 1982. Sweet potato production guide for the dry Papuan lowlands. Harvest., 8: 59-62.
2. Ramirez, G.P., 1992. Cultivation, harvesting and storage of sweet potato products. In: Roots, Tubers, Plantains and Bananas in Animal Feeding, Animal Production and Health Paper, FAO, Rome. 95: 203-215.
3. Nwinyi, S.C.O., 1987. Sweet potato: a potential and staple food crop of Nigeria. Outlook on Agric., 16: 178-181.
4. Mandal, R.C., 1993. *Tropical Root and Tuber Crops*, Agro. Botanical Publishers, India.
5. Bourke, R.M., 1982. Growing sweet potato for sale in the highlands. Harvest. 8: 47-58.
6. Tewe, O.O., F.E. Ojeniyi and O.A. Abu, 2003. *Sweetpotato Production, Utilization and Marketing in Nigeria*, Social Sciences Department, International Potato Center (CIP), Lima, Peru.,
7. Larbi, A., I. Etela, H.N. Nwokocha, U.I. Oji, N.J. Anyanwu, L.D. Gbaraneh, S.C. Anioke, R.O. Balogun and I.R. Muhammad, 2007. Fodder and tuber yields and fodder quality of sweet potato cultivars at different maturity stages in the West African humid forest and savanna zones. Animal Feed Science and Technol., 135: 126-138. doi:10.1016/j.anifeedsci.2006.05.021.

8. Ørskov, E.R. and I. Mcdonald, 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agricultural Sciences, Cambridge. 92: 499-503.
9. SAS, 1989. *User's Guide, SAS (Statistical Analysis Systems), Version 6, 4th edition, Volume 1,* Cary, N.C.,
10. Gomez, K.A. and A.A. Gomez, 1984. *Statistical Procedures for Agricultural Research*, 2nd edition, John Wiley and Sons, New York.
11. King, G.A., 1985. The effects of time of planting on yield of six varieties of sweet potato (*Ipomoea batatas* (L.) Lam.) in the southern coastal lowlands of Papua New Guinea. Tropical Agriculture, Trinidad. 62: 225-228.
12. Sajjapongse, A., M.H. Wu and Y.C. Roan, 1988. Effect of planting date on growth and yield of sweet potatoes. Hort. Sci., 23: 698-699.
13. Martin, F.W., 1987. Planting dates and yields of four sweet potato clones in Peurto Rico. *Journ*al of Agriculture of the University of Peurto Rico., 71: 379-384.
14. Mwanga, R.O.M. and O.B. Zamora, 1989. Agronomic responses of sweet potato (*Ipomoea batatas* (L.) Lam) to varying levels of shade. Philippine J. Crop Sci., 14: 83-90.
15. Ørskov, E.R., 1991. Manipulation of fibre digestion in the rumen. Proceedings of the Nutrition Society, 50: 187-196.