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STUDIES ON POTENTIALS OF THE HAUSA POTATO FOR HERBAGE AND TUBER PRODUCTION

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ABSTRACT

Prolonged production of new leaves in the Hausa potato result in competition for dry matter between the source and the sink. Reducing the foliage may reduce this competition in favour of the growing tubers. This study was aimed to study the potential of cultivating the Hausa potato for herbage and tuber production. Five accessions of the Hausa potato were combined with three rates of pruning and laid out in the field using the randomised complete block design in three replicates. Results showed that the accessions differed significantly in emergence rate as well as in stand count at harvest, length and girth of tuber. The accessions differed significantly in number of tubers per plant and mean weight of tubers, but these were not affected by the rate of pruning. Root-top ratio and fresh tuber yield were affected by the rate of pruning. Significant interactions of accession and rate of pruning were observed in emergence rate, stand count, length and girth of tubers, mean weight of tuber, root-top ratio and total tuber yield. The productivity of the Hausa potato, especially root-top ratio and fresh tuber yield, could be adversely affected by high rate of foliage reduction.

Keyword: Hausa potato; pruning; accessions; source; sink
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INTRODUCTION

The Hausa potato [*Solenostemon rotundifolius* (Poir) J.K. Morton] is a minor tuber crop in the family Lamiaceae (PROTA, 2015). It is a small, herbaceous annual crop with prostrate or ascending succulent stems and branches. It attains a height of about 15-30 cm, with somewhat thick leaves which have an aromatic smell like that of mint (Namo and Opaleye, 2018). It has been reported to be one of the best staple tuber crops in terms of its peculiar taste, distinctive fragrance, nutritional and medicinal values (Namo and Opaleye, 2018). The tubers are cooked with a staple carbohydrate. The tubers which are high in calories and essential micronutrients have socio-economic potential to alleviate hunger (Kana *et a*l., 2011).

The Hausa potato is associated with the treatment of various diseases including diabetes, high blood pressure, dysentery, certain eye disorders and other common ailments (Kimiywe, 2006). They can, for example, be dried and put away for use during times of shortage. Although native potato is not a cash crop in the modern sense, part of the harvest is commonly put up for sale in the villages (National Research Council, 2006). Collectively, African women derive considerable income from it. A standard serving provides a large percentage of the daily requirement of calcium and vitamin A (in the form of β-carotene), as well as more than the daily complement of iron. The tubers contain 5-13 per cent protein (calculated on a dry weight basis), or up to twice the amount (5%) found in potatoes (Allemann, 2002). Despite these nutritional and medicinal values, the Hausa potato is not widely cultivated (PROTA, 2006).

One of the major constraints in the production of this crop is the prolonged production of new leaves, which are believed to compete with the tuberous roots for dry matter distribution. This results in generally low fresh tuber yield. Consequently, not many farmers are encouraged to cultivate the crop for household or commercial purposes. Productivity is also suspected to be limited by a lack of balance between the source potential and sink capacity or the rate of translocation of assimilates from the source to the sink (Nanbol, 2019).

Yield as a complex character depends on many quantitative components which are influenced by genetic and environmental factors. Unlike the sweet potato and other tuber crops, the production of new leaves in the Hausa potato takes a longer period after initiation of tubers. These new leaves compete for dry matter which should be translocated to the growing tubers during the bulking period. Therefore, reducing the foliage, which could be used to feed livestock like rabbits, may reduce this competition in favour of the growing tubers. This study was, therefore, aimed to investigate the potentials of the Hausa potato for herbage and tuber production.

MATERIALS AND METHODS

The experiment was carried out at the Potato Sub-station of the National Root Crops Research Institute (NRCRI), Kuru, Plateau State (Latitude $09^0$44'N; Longitude $08^0$47'E; altitude 1,293.3 m above sea level). The annual rainfall is about 1, 415 mm per annum (NRCRI Metrological Station). The study site is characterised by sandy loam soil. Five (5) accessions of the Hausa potato were used in the experiment. Four of the accessions (Langtang 1, Langtang 2, Bokkos 1 and Bokkos 2) were sourced from two Local Government Areas of Langtang and Bokkos in Plateau State, while the other accession (Gembu) was obtained from Sardauna Local Government Area in Taraba State. The experiment was 3×5 factorial, consisting of three levels of pruning (0%, 25% and 50% pruning) and five accessions of the Hausa potato (Bokkos 1, Bokkos 2, Gembu, Langtang 1, Langtang 2). The treatment combinations were laid out in the field using the randomised complete block design in three replicates. The gross plot size was 12 m x 10 m while the net plot size was 3 m x 2.7 m. A discard of 0.5 m was left between the blocks. Vine pruning was done at 87 days after planting, at which time tuber initiation and bulking had begun. Three levels of pruning (0%, 25% and 50%) were applied, using a small knife. To prevent re-growth, vines were cut a few centimetres above the ground level. Data were collected at 4 and 6 weeks after planting on emergence rate, while the rest were carried out at harvest.

Final stand count was determined by counting the total number of plants per plot at harvest. After harvesting the top of each harvested plant, the tubers were also harvested and weighed. Root-top ratio was computed as the ratio of the weight of tubers to that of the top. The number of tubers was counted and recorded for 3 randomly sampled plants. Length of tuber was measured using a measuring tape on three randomly sampled tubers from each plot. The tubers used for the measurement of the length of tuber were also used for the measurement of the girth of tuber. All the tubers harvested from each plot were weighed, using a digital weighing balance (CAH-300), and the weight was divided by the number of tubers harvested to obtain the mean weight of tubers. One hundred (100) g of tuber was sampled from each plot, sliced into pieces and oven-dried at 60℃ for 72 hours. Dry matter content was then computed as follows:

$$DM\ (\%) = \frac{b}{a} \times 100$$

Where,

a = Weight of fresh sample

b = Weight of dry sample

All the tubers harvested from each plot were weighed, and the weight was converted to the equivalent in tonnes per hectare before the statistical analysis.

Data collected were subjected to two-way analysis of variance (ANOVA) as described by Snedecor and Cochran (1967) to test for significant difference among the means. The Statistical Analysis System (SAS) software version 9.0 was used for the analysis and the means were separated using the Duncan's new Multiple-Range Test (DMRT).

RESULTS

At four (4) weeks after planting (4 WAP), the emergence rate varied from 54.3 ± 10.3% in the accession Gembu to 90.1 ± 10.3% in the accession Langtang 1 and the difference ($p>0.05$) was significant. Pruning rate did not significantly affect the emergence rate (Table 1). The same trend was observed at 6 WAP. The accession Langtang 1 had the highest emergence rate of 92.6 ± 10.9% while the lowest (61.1 ± 10.9%) was observed in the accession Gembu. Emergence rate did not differ significantly with the rate of pruning. Generally, emergence rate was higher at 6 WAP than at 4 WAP (Table 1).

The highest final stand count of 93.8 ± 9.5 plants per plot was observed in the accession Bokkos 2, although this was statistically similar to all but the accession Gembu (Table 2). The rate of pruning did not significantly affect the final stand count. A significant interaction of accession and pruning rate on stand count was observed. The highest stand count of 100 plants per plot was observed in the accession Langtang 1 at zero pruning while the lowest (64.8) was observed in the accession Gembu at 0 and 25% pruning (Table 3).

Table 1: Main effects of accession and pruning on emergence rate at 4 and 6 weeks after planting

	Weeks after planting	
Treatment	4	6
Accession		
Bokkos 1	80.86b	84.57a
Bokkos 2	96.30a	97.53a
Gembu	54.32c	61.11b
Langtang 1	90.12ab	92.59a
Langtang 2	85.18ab	88.89a
Significance	*	*
LSD $_{0.05}$	15.27	14.90
Pruning		
No pruning	83.33	85.19
25 % pruning	79.99	84.44
50 % pruning	80.74	85.19
Significance	NS	NS
LSD $_{0.05}$	11.83	11.54
A x P	*	*
CV (%)	19.43	18.16

NJB, Volume 35 (1), June, 2022 Namo, O.A.T. *et al.*

Table 2: Main effects of accession and pruning on final stand count, length of tuber and girth of tuber

Treatment	Final stand count	Length of tuber (cm)	Girth of tuber (cm)
Accession			
Bokkos 1	86.41a	4.93a	6.52a
Bokkos 2	93.82a	4.76ab	7.02a
Gembu	66.04b	4.60ab	5.30b
Langtang 1	92.59a	4.09b	6.43a
Langtang 2	91.97a	4.42ab	6.72a
Significance	*	*	*
$LSD_{0.05}$	15.06	**0.84**	**0.95**
Pruning			
No pruning	86.66	4.34	6.46
25 % pruning	83.70	4.50	6.31
50 % pruning	88.14	4.84	6.43
Significance	NS	NS	NS
$LSD_{0.05}$	11.66	**0.65**	**0.73**
A x P	*	*	*
CV (%)	18.09	20.21	15.35

Table 3: Interaction effect of accession and pruning on final stand count, length of tuber and girth of tuber

		Final stand count			Length of tuber			Girth of tuber	
Accession	P (0%)	P(25)	P(50%)	P(0%)	P(25%)	P(50%)	P(0%)	P(25%)	P(50%)
Bokkos 1	77.77b	88.88a	92.59a	4.17a	4.37a	6.27a	6.37a	6.23a	6.97a
Bokkos 2	92.59a	96.29a	92.59a	4.60a	4.27a	5.40a	7.23a	6.77a	7.07a
Gembu	64.81b	64.81b	68.51b	4.17a	5.00a	4.63a	5.50b	5.43b	4.97b
Langtang 1	100.00a	83.33a	94.44a	4.10ab	4.30a	3.87b	6.77ab	6.23ab	6.30ab
Langtang 2	98.15a	85.18a	92.59a	4.67a	4.57a	4.03ab	6.43ab	6.90ab	6.83ab
$LSD_{0.05}$		18.84			0.98			1.18	

The highest length of tuber (4.9 ± 0.5 cm) was observed in the accession Bokkos 1 while the lowest (4.1 ± 0.5 cm) was observed in the accession Langtang 1. The length of tuber was not significantly affected by the rate of pruning (Table 2). The interaction of accession and pruning rate on the length of tuber was significant. The highest length of tuber (6.3 cm) was observed in the accession Bokkos 1 at 50% pruning; the lowest value of 3.9 cm was observed in the accession Langtang 1 at 50% pruning (Table 3). The highest girth of tuber of 7.0 ± 0.6 cm was observed in the accession Bokkos 2 while the lowest value of 5.3 ± 0.6 cm was observed in the accession Gembu. Girth of tuber was not significantly affected by the rate of pruning (Table 2). There was a significant interaction of accession and pruning on the girth of tuber. The highest girth of tuber (7.2 cm) was observed in the accession Bokkos 2 at zero pruning while the lowest value of 4.9 cm was observed in the accession Gembu at 50% pruning (Table 3).

The number of tubers per plant was significantly higher in the accession Langtang 1 (55.1 ± 9.9) than in the accession Langtang 2 (40.1 ± 9.9). The other accessions did not differ significantly (Table 4). The rate of pruning did not affect the number of tubers per plant significantly (Table 4). The accession Langtang 2 had the highest mean weight of tuber of 46.1 ±9.2 g, followed by accessions Bokkos 1 (42.9 ± 9.2 g), Bokkos 2 (38.6 ± 9.2 g) and Langtang 1 (37.6 ± 9.2 g). The lowest mean weight of tuber (27.2 ± 9.2 g) was observed in the accession Gembu (Table 4). Mean weight of tuber was not significantly affected by the rate of pruning. A significant interaction of accession and pruning was observed on the mean weight of tuber. The highest mean weight of tuber of 47.0 g was observed in the accession Langtang 2 at zero pruning; the lowest value of 18.7 g was observed in the accession Gembu at 50% pruning (Table 5).

The highest root-top ratio of 2.73 ± 0.35 was observed in the accession Langtang 1, followed by the accession Bokkos 2 (2.63 ± 0.35); the lowest value of 1.95 ± 0.35 was observed in the accession Langtang 2 (Table 4). The highest value of root-top ratio was observed at zero pruning while the lowest was observed at 50% pruning. A significant interaction effect of accession x pruning on the root-top ratio was observed. The highest root-top ratio of 3.05 was observed in the accession Bokkos 2 at zero pruning. The lowest value of 1.42 was observed in the accession Gembu at 50% pruning (Table 6).

Table 4: Main effects of accession and pruning on mean number of tubers per plant, mean weight of tuber, root-top ratio and total tuber yield

Treatment	Number of tubers per plant	Mean weight of tuber (g)	Root-top ratio	Tuber yield (t ha^{-1})
Accession				
Bokkos 1	47.22ab	42.89a	2.14	1.98a
Bokkos 2	49.89ab	38.56ab	2.63	2.16a
Gembu	45.22ab	27.22b	1.97	1.16b
Langtang 1	55.22a	37.56ab	2.73	2.30a
Langtang 2	40.11b	46.11a	1.95	1.96a
Significance	*	*	NS	*
$LSD_{0.05}$	11.38	15.10	0.90	0.52
Pruning				
No pruning	50.60	43.87	2.75a	2.18a
25 % pruning	47.07	34.80	2.12ab	1.73c
50 % pruning	44.93	36.73	1.99b	1.81b
Significance	NS	NS	*	*
$LSD_{0.05}$	8.82	11.67	0.70	0.07
A x P	NS	*	*	*
CV (%)	24.81	40.65	40.95	28.31

Table 5: Interaction effect of accession and pruning on mean weight of tuber

	Mean weight of tuber (g)		
Accession	P (0%)	P(25%)	P(50%)
Bokkos 1	45.33a	41.33a	42.00a
Bokkos 2	47.00a	36.33a	32.33a
Gembu	44.00a	19.00b	18.67b
Langtang 1	35.33a	33.33a	44.00a
Langtang 2	47.67a	44.00a	46.67a
$LSD_{0.05}$		18.40	

Table 6: Interaction effect of accession and pruning on root-top ratio

	Root-top ratio		
Accession	P (0%)	P (25%)	P (50%)
Bokkos 1	2.32b	1.72c	2.38b
Bokkos 2	3.05a	2.53b	2.32b
Gembu	2.69a	1.82c	1.42c
Langtang 1	2.97a	2.89a	2.33b
Langtang 2	2.70a	1.66c	1.48c
$LSD_{0.05}$		0.62	

Total tuber yield was highest in the accession Langtang 1 (2.3± 0.4 t ha^{-1}) and lowest in the accession Gembu (1.2 $\pm$ 0.4 t ha^{-1}). The highest tuber yield of 2.2 $\pm$ 0.4 t ha^{-1} was observed at zero pruning, while the lowest ($1.73 \pm 0.4\ t\ ha^{-1}$) was observed at 25% pruning (Table 4). A significant interaction of accession and pruning on tuber yield was observed. The highest tuber yield of 2.5 t ha^{-1} was observed in the accession Bokkos 2 at zero pruning; the lowest value of 0.97 t ha^{-1} was observed in the accession Gembu at 50% pruning (Table 7).

Table 7: Interaction effect of accession and pruning on total tuber yield

	Tuber yield (t ha^{-1})		
Accession	P (0%)	P (25%)	P (50%)
Bokkos 1	2.07a	1.63b	2.23a
Bokkos 2	2.53a	2.10a	1.83b
Gembu	1.43b	1.07b	0.97b
Langtang 1	2.13a	2.30a	2.47a
Langtang 2	2.73a	1.57b	1.57b
$LSD_{0.05}$		0.72	

DISCUSSION

Being a pre-treatment parameter, emergence rate was not significantly affected by pruning. However, seed size and genotype affected emergence rate. For example, accessions Langtang 1 and Langtang 2 with large tuber size (Table 4) showed a higher emergence rate than the other accessions with smaller tuber sizes. Rykbost *et al.* (1995) noted that genotypes with large tubers had higher food reserve that could be used for the germination and growth of young seedlings.

The accession Gembu had a significantly lower stand count at harvest than the other accessions. Stand count at harvest was not significantly affected by pruning. The accession Gembu was introduced to the Jos-Plateau from Taraba State, which is different from the Jos-Plateau environment.

The length and girth of tuber were not significantly affected by rate of pruning but both were affected by the genotype. Length and girth of tubers could also be influenced by the environment as shown in the significant interaction effect. Ogedengbe *et al.* (2015) reported that variations in length and girth of tuber were due to the size of the tuber planted and the genotypic differences. Netsai *et al.* (2019) noted that length and girth of tuber were cultivar-dependent.

The mean number of tubers per plant and mean weight of tuber were not significantly affected by the rate of pruning but differed with accession. The results indicate that the higher the number of tubers, the lower the tuber weight. For example, the accession Gembu with a high number of tubers per plant (Table 4) had the lowest mean weight of tuber (Table 4). Similarly, the mean weight of tuber and total tuber yield appeared to be related; for example, the accession Gembu, with the lowest mean weight of tuber (Table 4) also had the lowest total tuber yield (Table 4).

The root-top ratio did not differ significantly with the accession. However, it was affected by the rate of pruning, being highest at zero and lowest at 50% pruning. The productivity of tuberous root crops has been reported to be limited by vigorous vegetative growth due to the competition for assimilates between the source and the sink (Kai and Tiexia, 2018). Pruning is aimed at reducing the competition between the source and the sink in favour of the sink. Pruning has been reported to be effective for the growth and yield of sweet potato (Munetsi, 2015). Mulungu *et al*. (2006) cautioned that the practice could negatively alter the crop's productivity in terms of both the storage roots and the tops. This study has shown that pruning up to 50% could negatively affect the root-top ratio.

The total tuber yield was significantly lower in the accession Gembu than in the other accessions, and decreased as the rate of pruning increased. The result suggests that excessive pruning in the Hausa potato could lead to reduction in fresh tuber yield. The result also indicates that fresh tuber yield is both genotypically and environmentally influenced, as evidenced in the significant interaction of accession and pruning. Results of this study have corroborated the findings of Olorunnisomo (2007) that vine pruning could result in yield reduction due to reduced supply of photosynthates to the growing tubers.

CONCLUSION

The productivity of the Hausa potato, especially root-top ratio and fresh tuber yield, could be negatively affected by high rate of foliage reduction. Therefore, caution should be applied if foliage will be reduced to feed livestock, so that fresh tuber yield is not adversely affected.

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