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The Effect of Defoliation on the Quality of Sweet Potato Tubers

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ABSTRACT

Sweet potato (*Ipomoea batatas* L.) is the seventh most important food crop. In the tropics it is a staple food in many developing countries and it also serves as animal feed and raw material for many industries. The utilization of sweet potato in many countries has declined which can partly be due to pre and post-harvest losses resulting in excessive waste which has increased prices. The study was conducted to determine the effect of time of pre-harvest defoliation of sweet potato vines on yield performance and quality of sweetpotato and tuberpotato in the Coastal savanna of Ghana. To do this the effect of defoliation and variety on the quality of tubers were studied. Two improved varieties; TIS 86-3017 and TIS 8266 and a local variety, Cape Coast, were subjected to pre-harvest defoliation period of 12, 8 and 4 days before harvesting. A fourth treatment was without defoliation and was designated 0 that is no defoliation. The experiment examined the effect of genotypes and defoliation on tuber quality. The experiment revealed that the improved varieties were no better than the local variety in their yields, resistance to fungal decay and extent of rodent attack. The improved varieties were more susceptible to Cylas weevil infestation in the field than the local variety. The improved varieties suffered more damaged during harvesting and sprouted more in the field than the local variety. Defoliation before harvesting reduced weevil infestation, fungal decay and bruising of tubers during harvesting and handling. However, defoliation increased sprouting of tubers from 2.5% for tubers which were not defoliated to 14.2% in tubers which were defoliated 12 days before harvesting.

Key words: *Ipomea batatas*, varieties, defoliation, cylas weevil, tuber quality

INTRODUCTION

In developing countries, the rapid population growth and pressure on land use is resulting in a massive rural-urban migration and a shortfall in food production. These are creating food shortage and malnutrition. However, the expansion and intensification of agricultural production to meet food demand may severely affect the environment adversely. An alternative solution to the problem of meeting increasing food demand, according to Lieberman (1983) is to reduce post harvest losses by improving storage and conservation or processing.

Sweet potato has a few advantages which can give it an important role in meeting food shortages and malnutrition in developing countries such as Ghana. The crop does well on marginal lands. It is also a famine reserved crop and draught tolerant crop. Sweet potato (*Ipomoea batatas* L.) is the seventh most important food crop after wheat, rice, maize, potato, barley and cassava and in the tropics it is a staple food in many developing countries and also serves as animal feed and raw material industries (Ray and Tomlins, 2009).

There exist a large number of sweet potato cultivars which differ from one another in the root skin colour (white, creams, yellow, brown, orange or purple), flesh colour (white, creams, yellow orange or purplish red), the sizes and shape of roots and leaves, the depth of rooting, the time to maturity, the resistance to disease and in the texture of cooked roots (Woolfe, 1992). Potato tubers with high water content were more susceptible to bruising than those with lower water content but more resistant to black rot as reported by Delorit *et al.* (1984). Otoo *et al.* (2001) observed no significant difference in yield between TIS 8266 and TIS 86 3017 when harvested four months after planting. Stathers *et al.* (2003) observed significant differences in *Cylas* spp. susceptibility among sweet potato germplasm in East Africa.

Defoliation can be referred to as vine killing and it involves removing the top of the plant before harvesting. According to Delorit *et al.* (1984) defoliation can be accomplished mechanically, chemically, by flaming or a combination of the methods. Delorit *et al.* (1984) further stated that defoliation is a necessary practice in potato production to hasten maturity of tubers and it also toughens the skin of tubers which reduces bruising during harvesting. Defoliation also makes harvesting easier. However, according to Kihurani (2004) vine removal before harvesting at two weeks and delayed harvesting enhanced post harvest pathological decay of sweet potato roots, while early harvesting reduced deterioration. Toughening the skin of tubers to withstand bruising and skinning is very necessary because sweet potatoes have high moisture content and a relatively thin delicate skin and are easily damaged.

In spite of the desirable traits listed above that sweet potato possesses, its utilization in many countries has declined. According to Woolfe (1992), this can partly be due to pre- and post-harvest losses resulting in excessive waste which has increased prices thereby making it unattractive to those searching for a low cost nutrition substitute for more expensive and prestigious foods.

The study was conducted to determine the effect of time of pre-harvest defoliation of sweet potato vines on yield performance and quality of sweet potato tuber.

MATERIALS AND METHODS

The performance of two improved varieties and a local variety and the effect of time of defoliation before harvest on the qualities of sweet potato tubers were studied. Two improved varieties; TIS 86-3017 and TIS 8266 and a local Cape Coast Variety were used. They were subjected to pre-harvest defoliation and harvested at the following days after defoliation: 12, 8, 4 and 0 as control.

Experimental design: The experimental was a Randomized Complete Block with two factors. The treatments were arranged in a factorial combination of 3 varieties and 4 pre-harvest defoliations. There were 12 plots in a block with three replications.

Each plot measured 10×8 m = 80 m^2. Distance between blocks = 1 m. Distance between plots = 1 m. Total area of experimental plot measured 107×32 m = 3,434 m^2.

Data collection and analysis: The following data were collected:

- Yield
- Degree of cracking in the field
- Sprouting in the field
- Degree of damage during harvesting
- Incidences of pest infestation in the field
- Degree of decay in the field
- Rodent attack in the field

Analyses of variance for the tests were performed using the MSTAT-C statistical package. Mean Separation was done using duncan's multiple range test.

RESULTS

Table 1 gives the tuber yield, dry matter yield and means percentage sprouting. There were no significant differences in yield and dry matter yield at 5% level (p = 0.05). V3 however gave the highest yield of 28.6 t ha^{-1}. Significant differences in sprouting existed among the three varieties in percentage sprouting (p = 0.05). TIS 86 3017 (V2) exhibited the highest mean percentage sprouting in the field. A positive correlation coefficient of 0.34 was established between moisture content and sprouting of tuber.

Defoliation had a highly significant effect on tuber sprouting in the field as shown in Table 2. Defoliation 12 days before harvesting (D12) showed the highest mean percentage sprouting (14.2%). This was followed by D8, D4 and D0, thus 6.0, 2.5 and 1.4%. It was observed that as number of days of defoliation before harvest increased tuber sprouting increased. A moderately strong correlation coefficient of 0.617 was established between defoliation and tuber sprouting. However, there was no significant difference for D8, D4 and D0.

Table 3 indicates there were significant differences (p = 0.05) in the percentage tuber damaged among the three varieties during harvesting and handling. Percentage damage suffered by V2 tubers during harvesting was significantly higher and different from that of V3. Table 4 shows that variety and defoliation interactions had no significant effect on percentage-damaged tubers.

Table 1: Tuber yield, dry matter yield and mean percentage sprouting for sweet potato varieties

Variety	Tuber yield (t ha^{-1})	Dry matter yield (t ha^{-1})	Mean percentage sprouting
TIS 8266 (V3)	28.6	9.6	14.4^{a}
Cape coast (V1)	26.8	8.3	4.6^{ab}
TIS 86 3017 (V2)	23.2	6.9	2.8^{b}
p = 0.05	NS	NS	

Values in a column bearing the same letter are not significantly different by DMRT at p = 0.05

Table 2: Percentage sprouting at different days of defoliation before harvest for all varieties

Time of defoliation before harvest	Variety mean percentage sprouting
D12	14.2^{a}
D8	6.0^{ab}
D4	2.5^{b}
D0	1.4^{b}
CV	7.5

Values in a column bearing the same letter are not significantly different by DMRT at p = 0.01

Table 3: Percentage damaged roots during harvesting

Variety	Damaged tubers (%)
TIS 86 3017 (V2)	9.40^{a}
Local cape coast (V1)	7.50^{ab}
TIS 8266 (V3)	4.75^{b}
CV	14.90

Values in a column bearing the same letter are not significantly different by DMRT at p = 0.05

Table 4: Effect of defoliation before harvest on extent of bruising of tubers during handling from field to store

	Extent of tuber surface bruising				
Variety	D0	D4	D8	D12	Mean
Local cape coast (V1)	8.0	8.0	5.0	5.0	6.5
TIS 86 3017 (V2)	19.0	16.0	13.0	10.0	14.5
TIS 8266 (V3	7.0	6.0	5.0	5.0	5.8
Mean	11.3	10.0	7.7	6.7	

Table 5: Percentage weevil infestation in the field

Variety	Percentage weevil infestation (mean value)
TIS 8266 (V3)	8.80[a]
TIS 86 3017 (V2)	4.30[ab]
Local Cape Coast (V1)	1.20[b]
CV	8.43

Values in a column bearing the same letter are not significantly different by DMRT at p = 0.05

Table 6: Defoliation and weevil infestation in the field

	Weevil infestation (%)				
Variety	D0	D4	D8	D12	Mean
Local cape coast (V1)	4.9	0.0	0.0	0.0	1.2
TIS 86 3017 (V2)	8.1	4.8	2.4	2.1	4.3
TIS 8266 (V3)	14.0	6.7	4.1	10.3	8.8
Mean	9.0	3.8	2.2	4.1	

V2 (TIS 86 3017) suffered the most extensive surface bruising of tubers during handling from field to storage. Mean surface bruising for V2 was 14.5% while V1 and V3 received 6.5 and 5.8% surface bruising, respectively. It can also be observed from Table 4 that extent of surface bruising was highest in D0 tubers and decreased through D4 and D8 to D12 in the three varieties.

The results of the study of the effect of variety on weevil infestation of tubers in the field are shown in Table 5. Differences among the varieties in weevil infestation were significant ($p = 0.05$). TIS 8266 (V3) suffered the highest weevil infestation of 8.8%. The local Cape Coast variety (V1) suffered only 1.2% weevil infestation which was the least. TIS 86 3017 (V2) suffered 4.3% weevil infestation. TIS 86 3017 (V2) was not significantly different from the local Cape Coast (V1) in their weevil infestation levels.

Table 6 shows the results of the study on the effect of variety and defoliation interaction on weevil infestation of tubers in the field. Defoliation reduced weevil infestation in all the varieties. Tubers from plants which were not defoliated before harvest, were more heavily infested by weevils (9.0%) than tubers from defoliated plants. The mean percentage weevil infestation for D4, D8 and D12 were 3.8, 2.2 and 4.1%, respectively for all the three varieties. Table 7 shows the results of the study of the effect of defoliation on tuber fungal-decay in the field. Significant differences ($p = 0.05$) in fungal decay were observed among tubers subjected to different days of defoliation before harvest. Tubers which were not subjected to defoliation before harvest (D0) showed significantly higher fungi decay (2.3%) than those subjected to defoliation before harvest. D4, D8 and D12 tubers suffered 0.2, 0 and 0% fungal decay, respectively. No significant differences ($p = 0.05$) were

Table 7: Effect of defoliation on fungal decay of tubers at harvest

Time of defoliation before harvest (Days)	Mean percentage decay of tubers
D0	2.3[a]
D4	0.2[b]
D8	0.0[b]
D12	0.0[b]
CV	5.34

Values in a column bearing the same letter are not significantly different by DMRT at $p = 0.05$

Table 8: Rodent attack of tubers in the field

Blocks	Rodent attack (%)
1	3.8[a]
2	2.9[b]
3	0.6[b]
CV	5.3

Values in a column bearing the same letter are not significantly different by DMRT at $p = 0.05$

observed among the three varieties in fungal decay in the field. Local Cape Coast variety suffered the least fungal decay in the field. Table 8 shows that there were significant differences among the Blocks in rodent attack at 5% level. Percentage rodent attacks were 3.8% for Block 1, 2.9% for Block 2 and 0.6% for Block 3. Block 1 was closer to the bush than any other block.

DISCUSSION

None of the three varieties was significantly superior in yield than the others which is in support of similar findings by Otoo *et al*. (2001) who observed no significant difference in yield between TIS 8266 and TIS 86 3017 when harvested four months after planting. The observed difference among varieties in surface bruising suggests that the varieties differ in their thickness and toughness of the skin.

The observation of significant differences among the varieties in percentage sprouting can be essential in selecting varieties which have longer post-harvest storage life. Data (1985) also observed significant differences among sweet potato varieties in percentage sprouting in the field. The varieties were observed to be significantly different from each other in their susceptibility to weevil infestation in the field which is supported by observation by Crop Post-Harvest Programme (1998) which stated that cultivars differ significantly in levels of weevil infestation in the field.

The varieties did not differ from each other in their mean percentage fungal decay in the field. Significant differences however existed with respect to defoliation treatments to percentage fungal decay. This observation could be due to possible toughening of skin of tubers against fungal attack as a result of defoliation.

Defoliation reduced surface bruising during handling which is in support of an observation by Delorit *et al*. (1984) who reported that vine killing before harvest toughens the skin of potato against surface bruising and skinning during handling and storage.

Defoliation significantly influenced sprouting of tubers in the field. The observed reduction in weevil infestation of tubers defoliated before harvest could have resulted from high temperature generated inside the ridges upon the exposure of the ridges to direct sunlight when the vines were cut and rolled to the sides of the ridges.

CONCLUSION

The local variety was more resistant to weevil infestation in the field than the improved varieties. The improved varieties exhibited a higher percentage of sprouting in the field. Defoliation before harvest reduced level of weevil infestation and moisture content of tubers in the field. On the contrary, defoliation increased sprouting of tubers and did not significantly reduce damage to tubers during harvesting.

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