DOES THE METHOD OF PLANTING SWEET POTATO VINES EFFECT TUBER YIELD?

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INTRODUCTION

In many subsistence agricultural communities in Papua New Guinea, the Philippines and elsewhere, farmers have definite and often very different ways of planting sweet potato vines.

The method of land preparation for planting sweet potato varies greatly within Papua New Guinea. In his review article (see Papua New Guinea Journal of Agriculture, Forestry and Fisheries (Volume 33, pages 93-94, 1985), R.M. Bourke identified eight main soil cultivation techniques. These are given below.

1. Minimum tillage: soil loosened, commonly with a digging stick, only at the planting point.

2. Soil tilled sufficiently to form mounds 20-30 cm high.

3. Complete soil tillage without mounds or very slight mounding only.

4. Complete soil tillage with mounds about 30 cm high, sometimes arranged in square or rectangular beds.

5. Complete soil tillage with long drained square or rectangular beds.

6. No soil tillage, but beds are formed by digging drains 30 - 50 cm deep.

7. Soil heaped into very large mounds 1.5-5 m in diameter.

8. Mechanical soil tillage in which ridges may be formed by tractor drawn implements.

R.M. Bourke (1985) also reported that five surveys of planting densities used in sweet potato gardens showed densities ranging from 15,000 to 172,000 cuttings per hectare. The methods of planting sweet potato vines into the prepared soil are also very varied, but little published information is available.

In some areas (e.g. Menyamya District), farmers favour placing the vines almost horizontally into the loosened soil. It may also be considered necessary to remove the lower leaves of the cuttings (e.g. in the Kaintiba area). In other areas (e.g. Oksapmin Subdistrict) cuttings may be planted in small mounds in such a way that both ends of the cutting are exposed, one each side of the mound. In the highlands, cuttings may be planted almost vertically into large mounds. In parts of the Southern Philippines, farmers favour tying each cutting into a loose knot before planting.

Conventional mechanical farming usually involves planting cuttings vertically into ridges. However L.H. Chen and his co-workers in 1982 claimed that sweet potato yields could be significantly increased in the United States of America by transplanting sweet potato cuttings horizontally. They built a mechanical transplanter for this work. Unfortunately when they carried out their study they used longer cuttings for horizontal planting than for the vertical planting. Thus the higher yield they obtained may have been due to the use of longer cuttings rather than their horizontal orientation.

This problem with the interpretation of the results of Chen and co-workers' experiments is called 'confounding'. In this case cutting orientation was confounded with cutting length, and we cannot say whether the increased yield was due mainly to horizontal planting or to the use of longer cuttings. It is a common trap which researchers must be careful to avoid if they want to carefully interpret the results of their experiments.

Also working in America, M.R. Hall reported in 1986 that the use of longer cutting (45-50 cm) resulted in an increase in yield compared to the use of short cuttings (20-25 cm). Thus, it is likely that the yield increases obtained by Chen and co-workers were due more to cutting length than to horizontal transplanting.

Apart from the experimental work carried out in the USA, most of the information we have on the method of planting sweet potato cuttings is based on discussions and interviews with farmers, who are often insistent that their method of planting is best. Obviously if a method of planting is working well for a farmer, she will not wish to risk changing

to another method.

In two experiments carried out at the Laloki Plant Quarantine and Horticultural Research station in Central Province, some different methods of planting sweet potato cuttings were investigated.

EXPERIMENTAL DETAILS

The site used was a flat river terrace soil which had been cultivated and made into ridges.

In the two experiments, two sweet potato cultivars ('L22' and 'L44'), and two harvest dates (108 days after planting (DAP) and 133 DAP) were used.

Experiment A. In this first experiment, four methods of planting the sweet potato vines were studied. The planting methods were:

a) 2 nodes placed vertically in the soil;
b) 4 nodes placed vertically in the soil;
c) 6 nodes placed vertically in the soil;
d) 6 nodes placed horizontally in the soil.

One cutting was planted at each planting station.

Experiment B. In the second experiment, three methods of planting were combined with two plant densities (1 or 2 cuttings per planting station) to give six planting method treatments as follows:

a) one cutting per station, 2 nodes placed vertically in the soil;
b) one cutting per station, 4 nodes placed vertically in the soil;
c) one cutting per station, 4 nodes placed horizontally in the soil;
d) two cuttings per station, 2 nodes placed vertically in the soil;
e) two cuttings per station, 4 nodes placed vertically in the soil;
f) two cuttings per station, 4 nodes placed horizontally in the soil.

In both experiments, the planting stations were located 25 cm apart on ridges. Four replicates were used. The ridges were 109 cm apart in Experiment A and 132 cm apart in Experiment B. Experiment A was planted near the end of the wet season, and Experiment B was planted in the middle of the dry season. Both experiments were irrigated every 1-2 weeks as necessary, and hand-weeded every two weeks until canopy closure by the vines.

At each harvest, the tubers were dug by hand and graded into marketable and unmarketable sizes. Tubers weighing less than 60 g were classified as unmarketable. For each grade, the number and yield (weight) of tubers was recorded. The weight of tubers damaged by sweet potato weevil *(Cylas formicarius)* was also recorded.

RESULTS

Experiment A. The results obtained from Experiment A are given in Tables 1-4. The highest total yields for cultivar 'L22' were obtained by planting 4 or 6 nodes vertically in the soil. For 'L44', the method of planting had very little effect on yield (Table 1). There was only a small increase in yield between 108 DAP and 133 DAP, the increase being greater for 'L44' than for 'L22'. The percentage of total yield that was marketable size tubers followed the same trends as for total yield (Table 2), with the 4 or 6 nodes vertical planting methods being superior for 'L22' but not for 'L44'. A small increase in marketable yield occurred between 108 DAP and 133 DAP. Cultivar 'L44' had both a higher total yield and a higher percentage of marketable yield than cultivar 'L22'.

For plant survival (Table 3), the 4-nodes-vertical planting method was best for 'L22', whereas, for 'L44' the 2-nodes-vertical method was optimal. Plant survival declined markedly between 108 DAP and 133 DAP; there were 10 percent plant losses for 'L22' and 15 percent losses for 'L44'. The number of tubers per square metre also declined between 108 DAP and 133 DAP for both cultivars and for most of the planting methods (Table 4).

For cultivar 'L22', placing six nodes in the soil either horizontally or vertically tended to result in more tubers per unit area than the 2 or 4-nodes-vertical planting method. However, the opposite effect was seen for 'L44', for which more tubers per square metre were produced using the shallow (2 or 4 nodes) vertical planting methods.

Experiment B. The results obtained from Experiment B are given in Tables 5-8.

The horizontal method of planting resulted in slightly lower total yields than those obtained by the vertical methods of planting (Table 5). However the difference was generally small, and more marked for 'L44' than for 'L22'. Similarly, there was a small increase in yield recorded when two cuttings per planting point were used instead of one. For cultivar 'L44', a yield increase of 0.25 kg per square metre was recorded between 108 DAP and 133 DAP, but there was a negligible increase in yield for 'L22' over the same period. The percentage of the total yield that was marketable sized tubers was not greatly affected by the different treatments (Table 6), except that it was higher for 'L44' (range 89.9-95.5 percent) than for 'L22' (range 71.4-86.5 percent). The number of tubers produced per square metre was not significantly effected by the method of

Table 1. Total yield (kg/sq.m) of sweet potato for two cultivars at two harvest dates, using four methods of planting in Experiment A.

Cultivar	Harvest date	2V(1)	4V(2)	6V(3)	6H(4)	Mean
L22	108 DAP (5)	0.96	1.42	1.29	1.12	1.20
	133 DAP	0.96	1.33	1.79	0.92	1.25
L44	108 DAP	1.80	1.80	1.67	1.82	1.77
	133 DAP	2.16	2.03	1.81	1.88	1.97
MEAN		1.47	1.65	1.64	1.44	1.55

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 6 nodes placed vertically in the soil.
(4) 6 nodes placed horizontally in the soil.
(5) days after planting.

Table 2. Percentage by weight of total yield that was marketable (1) for two sweet potato cultivars at two harvest dates, using four methods of planting in Experiment A.

Cultivar	Harvest date	2V (2)	4V (3)	6V (4)	6H (5)	Mean
L22	108 DAP (6)	80.9	87.4	86.1	74.1	82.1
	133 DAP	84.4	90.6	90.3	80.1	86.4
L44	108 DAP	90.3	92.1	94.3	94.9	92.9
	133 DAP	94.5	96.6	95.6	97.4	96.0
MEAN		87.5	91.7	91.6	86.6	89.4

(1) tubers in good shape in excess of 60g are considered to be marketable.
(2) 2 nodes placed vertically in the soil.
(3) 4 nodes placed vertically in the soil.
(4) 6 nodes placed vertically in the soil.
(5) 6 nodes placed horizontally in the soil.
(6) days after planting.

Table 3. Percentage plant survival for two cultivars of sweet potato at two harvest dates, using four methods of planting in Experiment A.

Cultivar	Harvest date	2V (1)	4V (2)	6V (3)	6H (4)	Mean
L22	108 DAP (5)	98.8	98.8	97.5	97.5	98.2
	133 DAP	85.0	98.8	93.8	76.3	88.5
L44	108 DAP	92.5	95.0	80.0	95.0	90.6
	133 DAP	82.5	75.0	66.3	73.8	74.4
MEAN		89.7	91.9	84.4	85.7	87.9

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 6 nodes placed vertically in the soil.
(4) 6 nodes placed horizontally in the soil.
(5) days after planting

planting (Table 7), but considerably more tubers were produced where two cuttings per planting station were used (range 8.5-12.6) compared to one (range 7.03-9.58). Also 'L22' produced more tubers per square metre (mean 10.9) than did 'L44' (mean 9.2).

The proportion of total yield that was not damaged by sweet potato weevil is shown in Table 8. Where two cuttings per planting point were used, the greatest damage by sweet potato weevil at 133 DAP occurred for the 4-nodes horizontal or vertical planting methods (range 71.5-78.2 percent undamaged). For these two planting treatments, weevil damage was more severe when two cuttings per station were planted compared to one cutting per station (range 82.7-91.8 percent undamaged). Very little weevil damage was seen at 108 DAP. However, between 108 DAP and 133 DAP, weevil damage increased by 13 percent for 'L22', and by 17 percent for 'L44'. Both cultivars appeared to be similarly susceptible to weevil attack.

DISCUSSION

For both experiments, the horizontal method of planting resulted in lower yields compared to the corresponding vertical method but the difference was generally small (of the order of 10 percent). The results obtained in these experiments support the results obtained by Hall (1986) in the USA, and do not support the conclusion of Chen and co-workers (1982) that the horizontal planting method is superior to the vertical planting method.

Where only one cutting per planting point was used (Experiment A, and half the treatments of Experiment B), there was generally a reduction in the number of tubers harvestable per square metre between 108 days after planting (3.5 months) and 133 days after planting (4.5 months) (see Tables 4 and 8). This is probably due to plants dying during this period, as shown by the decline in percentage plant survival between 108 DAP and 133 DAP in Experiment A. Thus it appears that while the crop is maturing, some plants are dying, probably due to competition between the vines of plants next to each other. The tubers of any plants that die may rot in the ground. If those tubers sprouted and grew, the new shoots would probably not be able to compete with the vines that are already covering the soil.

Where two cuttings per planting point were used in Experiment B, the number of tubers per square metre generally increased between 108 DAP and 133 DAP (see Table 7). This is in contrast to the situation for one cutting per planting point. (The fact that more tubers per square metre were produced when two cuttings per planting point were used helps to explain why slightly higher total yields were obtained when two cuttings per station were used per planting point at 133DAP). In this experiment, the use of two cuttings per planting point resulted in only a small reduction in the percentage of total yield that was marketable (means: 87.8 percent for two cuttings/station, and 88.7 percent for one cutting/station).

However where larger numbers of cuttings per planting point, or higher plant densities, are used the percentage of large (marketable) tubers may be severely reduced, and the total yield would then be made up of a large number of relatively small tubers. This effect is especially important to consider in lowland areas during dry seasons when successive harvesting cannot be practiced due to the presence of the sweet potato weevil pest.

As can be seen from Table 8, the weevil damage was very minor at 108 DAP (average crop loss was 2.8 percent), but increased greatly between 108 DAP and 133 DAP (average crop loss at 133 DAP was 18.0 percent). Results from other experiments at Laloki have shown that almost all the crop can be damaged by weevils if harvesting is delayed until 150-160 days after planting (5-5.5 months).

CONCLUSIONS

1. On the flat alluvial soils at Laloki in the dry season, sweet potato yields are not markedly effected by the orientation of cuttings (vertical or horizontal) at planting or by the number of nodes placed in the soil. The results do not support the suggestion that horizontal planting of sweet potato vines is a superior method. Indeed the data suggest that planting four nodes vertically may be a reliable and easy method of planting which produces slightly higher yields than horizontal planting.

2. At the spacings used (25 cm x 109 cm or 132 cm), the number of tubers produced per square metre can be increased by using two cuttings per planting point instead of one. This may slightly increase total yield but the average tuber size is reduced.

3. For the two cultivars tested at Laloki ('L22' and 'L44'), yield increases between 108 DAP and 133 DAP were relatively small (less than 20 percent), especially for 'L22' (less than 5 percent). However weevil damage increased 13-17 percent during this period. Thus for sweet potato grown for sale or for human consumption, there appears to be very little advantage in delaying the harvest until 133 DAP. The earlier harvest (at 108 DAP) is therefore preferred.

Table 4. Number of tubers per square metre for two sweet potato cultivars at two harvest dates, using four methods of planting in Experiment A.

Cultivar	Harvest date	2V (1)	4V (2)	6V (3)	6H (4)	Mean
L22	108 DAP (5)	7.76	8.80	8.12	10.54	8.81
	133 DAP	6.48	7.16	9.28	7.24	7.54
L44	108 DAP	5.94	6.48	5.22	5.26	5.73
	133 DAP	6.33	5.51	5.42	4.52	5.45
MEAN		6.63	6.99	7.01	6.89	6.88

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 6 nodes placed vertically in the soil.
(4) 6 nodes placed horizontally in the soil.
(5) days after planting.

Table 5. Total yield (kg/sq. m) for two sweet potato cultivars at two harvest dates, using one or two cuttings per planting station and three methods of planting in Experiment B.

Cultivar	Harvest date	One cutting/station			Two cutting/station			Mean
		2V(1)	4V(2)	4H(3)	2V(1)	4V(2)	4H(3)	
L22	108 DAP (4)	0.85	0.80	0.82	0.71	0.88	0.91	0.83
	133 DAP	0.64	0.83	0.51	0.83	1.00	1.06	0.81
L44	108 DAP	1.60	1.30	1.34	1.44	1.41	1.29	1.40
	133 DAP	1.55	1.63	1.41	1.91	1.72	1.43	1.61
MEAN		1.16	1.14	1.02	1.22	1.25	1.17	1.16

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 4 nodes placed horizontally in the soil.
(4) days after planting.

Table 6. Percentage by weight of total yield that was marketable(1) for two sweet potato cultivars at two harvest dates, using one or two cuttings per station and three methods of planting in Experiment B.

Cultivar	Harvest date	One cutting/station			Two cuttings/station			Mean
		2V(2)	4V(3)	4H(4)	2V(2)	4V(3)	4H(4)	
L22	108 DAP(5)	86.5	86.4	85.7	86.4	80.2	84.4	85.0
	133 DAP	81.8	85.2	71.4	83.8	80.3	86.0	81.4
L44	108 DAP	95.3	93.8	94.8	92.7	94.2	93.2	94.0
	133 DAP	95.5	95.0	93.4	91.1	89.9	91.0	92.7
MEAN		89.8	90.1	86.3	88.5	86.2	88.7	88.2

(1) Tubers having good shape and in excess of 60 g are considered to be marketable.
(2) 2 nodes placed vertically in the soil.
(3) 4 nodes placed vertically in the soil.
(4) 4 nodes placed horizontally in the soil
(5) days after planting.

4. Plant survival was very high up to 108 DAP, but between 108 DAP and 133 DAP there was a sharp increase in plant mortality. This helps to explain the observed reduction in the number of tubers per square metre during the same period. It also helps to explain the reduction in yield at later harvests seen in some other sweet potato experiments in PNG.

FURTHER READING

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Table 7. Number of tubers per square metre for two sweet potato cultivars at two harvest dates, using one or two cuttings per station and three methods of planting in Experiment B.

Cultivar	Harvest date	One cutting/station			Two cuttings/station			Mean
		2V(1)	4V(2)	4H(3)	2V(1)	4V(2)	4H(3)	
L22	108 DAP(4)	9.5	7.7	9.6	10.4	12.2	10.9	10.0
	133 DAP	8.3	8.7	8.6	11.1	11.7	12.6	10.2
L44	108 DAP	8.0	8.4	7.6	9.4	8.7	8.5	8.4
	133 DAP	7.8	7.0	7.2	11.4	10.8	9.6	9.0
MEAN		8.4	8.0	8.3	10.6	10.7	10.4	9.4

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 4 nodes placed horizontally in the soil.
(4) days after planting.

Table 8. Percentage of total yield that was not damaged by sweet potato weevil, for two sweet potato cultivars at two harvest dates, using one or two cuttings per station, and three methods of planting, in Experiment B.

Cultivar	Harvest date	One cutting/station			Two cutting/station			Mean
		2V(1)	4V(2)	4H(3)	2V(1)	4V(2)	4H(3)	
L22	108 DAP(4)	89.2	96.2	98.2	94.6	88.1	99.6	94.3
	133 DAP	80.9	91.8	83.9	94.3	78.2	71.5	83.4
L44	108 DAP	99.1	98.6	99.0	100.0	99.9	97.8	99.0
	133 DAP	87.9	82.7	88.2	90.6	72.7	76.6	83.1
MEAN		89.3	92.3	92.3	94.9	84.7	86.4	89.9

(1) 2 nodes placed vertically in the soil.
(2) 4 nodes placed vertically in the soil.
(3) 4 nodes placed horizontally in the soil.
(4) days after planting.