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Technique of re-hilling sweetpotato mounds to reduce *Cylas* spp. weevil infestation and improve sweetpotato yield in Soroti district, North Eastern Uganda

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Abstract

***Cylas brunneus* and *C. puncticollis* (Coleoptera: Apionidae) are the economic pests of sweetpotato in Uganda and contribute to low crop yield and quality. On-farm work was done in Soroti district, a major sweetpotato growing area, to test integrated crop management (ICM) techniques to improve yield and reduce weevil damage. Two ICM components were evaluated, that is, improved varieties and re-hilling of mounds. The latter treatment was applied to cover cracks, the entry points that weevils use for accessing storage roots. Yield of improved varieties, namely, NASPOT 1 and 1927, compared favorably with that of the control variety, Haraka. In general, re-hilling treatment resulted into significant crop yield increment and low weevil attack on most of the test materials. Results showed that spot re-hilling done when soil cracks appear was sufficient for reducing weevil infestation.**

Key words: Sweetpotato, integrated crop management, re-hilling, *Cylas* weevils

Introduction

Sweetpotato, (*Ipomoea batatas* (L)Lam.) is a staple food in Uganda, and the third most produced crop after bananas and cassava (FAO Statistical Bulletin, 1999). Sweetpotato gained prominence during the 1980s, when cassava production declined due to attack by cassava mosaic disease (Otim Nape *et al.,* 1994), cassava green mite and cassava mealybug (Odongo *et al.,* 1998). Since then, sweetpotato production has remained high and stable. Total production of sweetpotato in Uganda is at 2.5 million metric tons grown on 560,000 ha. of land. Yield of 4.5 t/ha is low by world standard, meaning that the high national production figure is due to expansive growth of the crop (Scott and Ewell, 1992). Low crop yield is attributed to low-yielding varieties that farmers grow , poor agronomic practices and high pest infestation (Ames *et al.,* 1997).

Soroti district, is located in the Northern Moist Farmlands agro-ecology at 1,024m asl, >20°C; >1,200 mm of rainfall with unimodal rainfall (Wortmann and Eledu, 1997). Sweetpotato is a popular crop in the district because of better yields than most other crops under same conditions (Tardif Douglin,1991); and it takes 4-5 months to grow, thus utilizes short rains and relieves soil for other crops; Sweetpotato tuberous roots and foliage are nutritious in raw and processed forms. The authors had observed that sweetpotato vines play important roles in sustenance of livestock during long dry seasons. The crop, is thus compatible with other agricultural enterprises. Because of the importance of sweetpotato in the district, farmers had expressed interest in testing new production technologies.

Five sweetpotato varieties were released by the National Agricultural Research Organization (NARO) in 1995 and another 6 in 1999 (Manning, 2001; Mwanga *et al.*, 2000). These varieties had shown superiority in yield and adaptability to diverse agro-ecological conditions. Unfortunately, the varieties succumb to weevil infestation during dry seasons. This project was an endeavor to introduce and popularize improved varieties accompanied by pest management methods. The integrated crop management (ICM) package would be helpful in improvement of food security and income.

Materials and methods

On-farm promotion of ICM methods was conducted during 1999 and 2000 growing seasons. In the first season, improved sweetpotato varieties, that is, Naspot 1, Naspot 2, Naspot 6, Tanzania, Haraka (local check), no. 23/60, no. 23/40, no. 1866, no. 1927, no. 1381 were planted (Table 1). Mounds in one-half of the plot were re-hilled, while the other half of the plot (control) was not re-hilled. Experimental design was a split-plot, with varieties as the main plot and re-hilling as sub-plot treatment. Each of the farmers' fields was a replication. Plot size was 5m x 5m (25 mounds). Weevil population was monitored during the plant growth until time of harvest.

During the 2000 season, work focused on two varieties, Haraka red and Haraka white, instead of ten as in the previous season. Selection of varieties was based upon interviews conducted during Participatory Rural Appraisals (PRAs), in which Haraka white (HW), and Harake red (HR) were chosen by farmers as the most popular varieties. The varieties have high yield and tend to crack the soil as tubers develop. Planting was made on 17 June 1999 at Agwara, Aukot and Owokai Parishes. Three re-hilling treatments were applied: (1) blanket re-hilling (at 2,3 and 4 months after planting) (2) spot re-hilling or re-hilling only where cracks had developed on mounds and (3) control or no re-hilling. At harvest time, 7 months after planting, yield and infestation records were taken. Also ten vine bases, selected randomly, were cut from each harvested plot and scored on the external part of the vine, on a 1-5 scale, for increasing damage symptoms. Vines were then split in the middle and internal damage symptoms scored. Combined counts of larvae, pupae and adult weevils were taken. Counts of clearwing moth larvae and pupae as well as tubers with symptoms (grooves) of rough sweetpotato weevils were similarly made.

Table 1: Plot location and time of weevil monitoring on sweetpotato derived from various nursery sources: 1999 season.

Parish	No of farmers	Time of weevil **Monitoring**	Nursery **source**	Varieties
Owokai	6	Dec. 1999	Homestead	Naspot 1, Naspot 2
Owokai	6	Dec. 1999	Homestead	Naspot 1, Naspot 2
Owokai	6	Dec. 1999	Homestead	Naspot 1, Naspot 2
Owokai	6	Dec. 1999	Homestead	Naspot 1, Naspot 2
Aukot	6	Jan. 2000	Swamp	Naspot 6, Tanzania
		Feb.	Tree	Haraka
		March	Volunteer	no. 23/60, no. 23/40 no. 1866, no. 1927 no. 1381

Data analysis: Yield records were converted into per hectare, insect counts converted into square root (1 + counts), and infested tubers expressed as ratio over total tubers prior to statistical analysis. General linear model (GLM) of the SAS statistical package (SAS 1994) was used for analyses.

Results and discussion

Overall mean of numbers, total weight and number of marketable tubers were significantly higher on re-earthed plots when compared with the check ($P \leq 0.05$; Table 2). Low storage root yield was attributed to drought. Yield ranking showed that of improved varieties, NASPOT 1, 1927, NASPOT 2 had good yields, which were comparable to or better than local check, Haraka. Although NASPOT 5 yielded low when compared with other varieties, it has high levels of beta-carotene, so the variety can be promoted for medicinal purpose. Re-hilling the mounds reduced number and weight of infested tubers in 8 out of 10 varieties tested (Table 3). No treatment differences were noted in number of clear wing moths found in plant tissue nor in vine damage.

During the second season, there was no significant difference in means among rehilling treatments (Table 4). Vine weight was low because at time of harvesting most of the vines were drying up due to prolonged drought and effects of grazing by cattle. Variety Haraka red had significantly higher vine weight than HW (Table 5). Infestation was also higher on HR tubers than HW suggesting that high yielding varieties tend to succumb to weevil attack as their tubers get exposed to the surface. For whatever variety the farmer chose, re-hilling resulted in high yield and reduced pest attack.

There was significant relationship between number of infested tubers and clearwing moth damage on vines (Table 6). Positive association suggests that environmental conditions influence the pests in similar manner, that is, dry and hot weather favor population increase of the pests, while cool and wet weather reduces the pest prevalence. Infestation by the pests tends to

Table 2: Number (10^3) and weight (t/ha) of sweetpotato on re-hilled and control mounds at Soroti: 1999 season.

Variety	Treatment	N	Yield/ha		Marketable wt.
			No. tubers	wt. tubers	(/ha)
NASPOT1	Check	12	40.17 + 8.98	8.68 ± 3.15	7.44 ± 2.85
	Re-hill	12	40.50 ± 8.10	8.44 + 2.22	7.39 ± 2.21
Haraka red+	Check	11	33.18 ± 10.48	7.71 ± 3.37	6.85 ± 3.39
	Re-hill	10	38.80 ± 8.85	7.87 ± 2.84	6.83 ± 2.93
1927	Check	12	35.92 ± 14.17	7.61 ± 2.98	6.65±2.78
	Re-hill	12	37.17 ± 12.56	7.54 ± 3.05	6.88±2.86
NASPOT2	Check	11	32.55 ± 12.67	5.58 ± 2.34	4.83+2.12
	Re-hill	11	40.55 ± 12.25	6.93± 1.85	6.06+1.72
Tanzania	Check	12	24.50 ± 8.40	5.37 ± 2.90	4.68 ± 2.95
	Re-hill	12	30.91 ± 10.55	5.62 ± 3.13	4.73± 2.96
1866	Check	9	26.11 ± 8.99	4.09 ± 1.24	3.19 ± 1.01
	Re-hill	9	31.67 ± 9.43	4.71 ± 1.35	3.72 ± 1.54
23/40	Check	10	19.10 ± 10.12	3.89 ± 1.18	3.38 ± 1.66
	Re-hill	12	18.17 ± 5.67	98 ± 1.32	3.21 ± 1.26
23/60	Check	12	14.08 ± 6.79	.21 ± 1.49	2.69 ± 1.57
	Re-hill	11	18.36 ± 10.28	4.43 ± 1.77	3.83 ± 1.67
NASPOT5	Check	13	29.46 ± 10.84	3.03 ± 1.67	2.05 ± 1.52
	Re-hill	12	23.42 ± 10.7	72.83 ± 1.59	1.98 ± 1.48
3181	Check	12	21.42 ± 8.83	7.01 ± 3.54	5.08 ± 1.10
	Re-hill	11	22.25 ± 3.93	6.27 ± 2.41	5.60 ± 2.59
Overall Mean	Check	114	27.76 ±12.55*	5.64±3.18*	4.70±2.82*
Overall Mean	Check	114	27.76 ±12.55*	5.64±3.18*	4.70±2.82*
	Check	114	27.76 ±12.55*	5.64±3.18*	4.70±2.82*
	Check	114	27.76 ±12.55*	5.64±3.18*	4.70±2.82*
	Re-hill	113	29.65 ±12.42	5.86±2.81	5.03±2.75

*Means differ significantly (P<0.05, GLM analysis in SAS; t-test used for means separation)

Table 3: Weevil infestation on sweetpotato varieties on re-hilled and non re-hilled mounds, during 1999 season.

Variety	Trt.	N	Ratio infest/total		Clear wing moth/plant	Vine damage	
			weight	no.		external	internal
NAS1	Check	12	0.61 ± 0.50	0.31±0.27	0.25 ± 0.18	2.65±0.92	2.79±0.94
	Re-hill	12	0.40 ± 0.26	0.26+0.20	0.24 ± 0.15	2.73±1.08	3.03±1.14
Haraka+	Check	11	0.58 ± 0.40	0.28±0.19	0.24 ± 0.19	2.77+0.86	2.84±0.96
	Re-hill	10	0.37 ± 0.22	0.20±0.15	0.20 ± 0.17	2.79±0.95	2.95±0.90
1927	Check	12	0.44 ± 0.28	0.20±0.11	0.19±0.10	2.23±0.85	2.77±0.65
	Re-hill	12	0.21 ± 0.18	0.12± 0.11	0.13±0.12	1.97±1.12	2.35±1.04
NAS2	Check	11	0.62 ± 0.36	0.33 ±0.20	0.19± 0.12	2.75±1.15	2.95±1.06
	Re-hill	11	0.61 ± 0.19	0.35±0.16	0.28± 0.11	2.72±0.67	3.02±0.80
Tanzania	Check	12	0.38±0.42	0.30±0.38	0.12 ± 0.14	2.48±0.98	2.78±1.28
	Re-hill	12	0.29±0.27	0.11±0.15	0.15 ± 0.14	2.31±0.49	2.58±0.77
1866	Check	9	0.26 ± 0.35	0.14 ± 20	0.08± 0.11	2.71±1.15	2.91±1.12
	Re-hill	9	0.51 ± 0.63	0.15±0.12	0.10±0.08	2.77±0.50	3.16±0.73
23/40	Check	10	0.24 ± 0.34	0.14±0.22	0.04±0.06	2.31+1.14	2.71±0.92
	Re-hill	12	0.22 ± 0.19	0.09±0.08	0.06±0.08	2.57±0.75	2.77±0.79
23/60	Check	12	0.30 ± 0.34	0.16 ±0.24	0.08±0.12	2.33±1.04	2.49±1.16
	Re-hill	11	0.15 ± 0.24	0.07 ±0.11	0.06±0.11	2.34±0.79	2.58+1.07
NAS5	Check	13	0.25 ± 0.55	0.11±0.26	0.06±0.11	2.40±0.87	2.66±1.140
	Re-hill	12	0.12 ± 0.17	0.08±0.11	0.04±0.09	2.56±1.22	2.61±1.21
3181	Check	12	0.31 ± 0.29	0.26±0.26	0.17 ± 0.17	2.44±0.58	2.61±0.78
	Re-hill	11	0.34 ± 0.24	0.16 0.17	0.15 ± 0.12	2.50±0.74	2.87±0.97
Mean	Check	114	0.40±0.41*	0.22±0.25*	0.14±0.15	2.50±0.94	2.74±0.99
Mean	Check	114	0.40±0.41*	0.22±0.25*	0.14±0.15	2.50±0.94	2.74±0.99
	Re-hill	113	0.31±0.30	0.16±0.16	0.14±14	2.51±0.88	2.78±0.95

+Check variety; *means differ significantly (P=0.05, t-test; GLM analysis in SAS)

Table 4: Yield in t/ha. and weevil infestation of combined sweetpotato varieties Haraka red and Harake white on re-hilled and control mounds, at Soroti during 2000 season.

Treatment	N	Vine wt.	Total tub.	Total tub. wt.	Mark. no.	Mark. wt.	No. infest.	Wt. infest.	Clean wt+.
Spot-hilled	20	2.54	37.83	5.15	15.96	3.79	0.17	0.19	0.11
		(1.02)	(18.64)	(3.30)	(10.09)	(3.12)	(0.23)	(0.24)	(0.13)
Blanket hilled	22	2.89	38.64	5.64	15.68	3.84	0.20	0.30	0.20
		(1.21)	(18.62)	(2.76)	(8.82)	(2.44)	(0.30)	(0.14)	(0.30)
Control		13	3.07	35.13	5.44	13.88	3.72	0.19	0.24 0.19
		13	3.07	35.13	5.44	13.88	3.72	0.19	0.24 0.19
		(1.51)	(16.50)	(3.29)	(9.86)	(2.92)	(0.24)	(0.16)	(0.24)

weaken the plant making it susceptible to other pests. Vine weight also related positively with total and marketable weight of tuberous roots and clearwing moth populations (Table 7), signifying that vigorous and aggressive plants tended to produce higher yield than less aggressive ones. Heavy feeding on planting materials by livestock (cattle, pigs and goats) often translated into yield loss.

Pest management methods that target sweetpotato weevils are important production packages for sweetpotato (Laboke *et al.* 1997; Odong *et al.* 1997; Smit *et al.* 1997 and Downham *et al.* 2001). Given the advantage gained by mound re-hilling treatment in the first study and the no significant difference among treatments in the second, we recommend that re-hilling of sweetpotato mounds be applied only once, when cracks develop on mounds. This treatment would be

Table 5: Yield in t/ha of and weevil infestation on sweetpotato varieties Haraka red and Haraka white on farmers fields in Soroti district, 2000 season.

Variety	N	Vine wt.	Tub.no. (10^3/ha)	Tuber wt.	Mark. no.	Mark. wt.	No. infest.	Wt. infest.	Clean wt.
Haraka R	34	3.04*	42.67	5.77	16.67	3.97	0.18*	0.22	0.14*
		(1.31)	(18.59)	(3.15)	(10.58)	(2.91)	(0.23)	(0.23)	(0.15)
Haraka W	28	2.58	30.67	4.98	13.38	3.55	0.20	0.20	0.13
	28	2.58	30.67	4.98	13.38	3.55	0.20	0.20	0.13
	(1.16)	(14.34)	(2.97)	(7.71)	(2.65)	(0.29)	(0.29)	(0.19)	

Means in columns with *differ significantly (t-test, GLM analysis, SAS); no significant interaction between variety and re-hill treatment.

Table 6: Regression estimation for weevil and yield parameters for variety Tanzania during 1999 season.

Dependent Variable	Independent variable	Intercept	Slope	R^2	CV	P-value
Infested wt	Total wt.	0.304 (0.004)	0.002 (0.001)	2.6	52.2	0.62
Infested wt.	Market wt.	0.320 (0.158)	0.002 (0.005)	1.5	70.2	0.69
Infested wt.	Grooved tubs	0.239 (0.156)	0.005 (0.005)	0.7	58.3	0.32
Vines with clearwing attack	Total infested	2.417 (1.457)	18.606 (4.201)	58.9	54.6	0.00
No. clearwing tubs.	Market no.	2.909 (4.211)	0.073 (0.070)	0.8	84.7	0.31
No. clearwing vines	Total tuber no.	-4.719 (9.582)	0.122 (0.098)	4.0	83.4	0.24

Analysis based on data cutting across sites and vine sources; standard deviation in parentheses; df=1,12

Table 7: Regression estimation between yield parameters for variety Haraka red during 1999 season; analysis based on data from different sites and vine sources; standard deviation in parentheses; df=1,38

Dependent Variable	Independent variable	Intercept	Slope	R^2	CV	P-value
Total wt.	Vine wt.	8.471 (2.497)	1.209 (0.126)	70.7	27.7	0.00
Market wt.	Vine wt.	6.667 (2.478)	1.175 (0.125)	69.9	29.9	0.00
No. clearwing counts	Vine wt.	0.044 (0.032)	0.003 (0.001)	13.6	66.1	0.02

adequate to control weevils and boost crop yield. Farmers can apply the method on their current local popular variety, which may show susceptibility to weevils, or introduced varieties. Because re-hilling is labor-intensive, work can be done once in order to save labor for other farm activities. The ICM technologies, if adopted by farmers, would contribute to increase in household food security and generation of wealth. Based upon results obtained from this work, a training manual was developed with farmers' input, tested and administered to the farming communities in the district. Manual will be tested, modified and promoted in other parts of the country.

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