EFFECT OF SOIL DEPTH ON THE DEGREE OF SWEET POTATO WEEVIL INFESTATION

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Portion of BS thesis conducted by the senior author in ViSCA.

ABSTRACT

Soil depth affected the degree of sweet potato weevil infestation. Highest weight of infested tubers was obtained from the control (without soil added) while the lowest weight was obtained at 26 cm soil depth. Weevil population in tubers showed a similar trend. No infestation was recorded at 29 cm depth. Results show that soil depth significantly affected the non-infested tuber yield and the degree of sweet potato weevil infestation. The greater the depth, the fewer the infested tubers. This implies that burying tubers deeper, such as hilling up at the base of sweet potato during tuber formation, can reduce weevil infestation.

Ann. Trop. Res. 2:224-231

INTRODUCTION

Damage caused by insect pests may be considered as one of the major constraints in sweet potato production. Sweet potato weevil, *Cylas formicarius elegantulus* Fabr., the worst insect pest of sweet potato, has a worldwide distribution wherever the crop is grown. It attacks both vines and tubers tainting them with disagreeable odor and bitter taste which render the tubers unfit for human and animal consumption. Under certain conditions, this insect is capable of causing significant crop losses both in the field and in storage. It does not only reduce yield but also lowers the quality of the tubers.

Cultural control measures used in weevil control include rotation of crops, clean cultivation, and destruction of plant residues and alternate hosts. Insecticides are also commonly used to control sweet potato weevil. However, since small farmers cannot usually afford to use costly insecticides, the development of cultural control measures offers a practical solution to the weevil problem. Remoroza (1978) mentioned that deep tuber formation resulted in low weevil infestation. This study presents the effect of soil depth on the degree of sweet potato weevil infestation.

MATERIALS AND METHODS

Mass Rearing of Sweet Potato Weevil. — Weevil-infested tubers were collected from the Philippine Root Crop Research and Training Center experimental fields. The insects were reared on tubers placed inside wire-screen rearing cages (77 cm H x 35 cm L x 35 cm W) in the laboratory. Each batch of adult weevils that emerged were transferred to a similar rearing cage and provided with sufficient amount of uninfested tubers for oviposition to increase their population. These laboratory-reared adults were used for testing in the field by releasing them in potted sweet potato plants.

Planting of Sweet Potato. — The soil used in the experiment was heat-sterilized for 1 hr to kill any insect pests and other organism present in the soil which may attack the plants. Clay pots, 30 cm in diameter, were half-filled with sterile soil. Sweet potato (BNAS-51 variety) cuttings measuring 30 cm long, were collected from the field and were used as planting material. They were examined carefully so that only weevil-free cuttings were used. A single stem cutting was planted in each pot in vertical position. A total of 100 pots were planted with sweet potato.

Each pot was provided with a piece of nylon cloth, at the center of which a single slit was made to allow the base of the cutting to pass through. Before planting, the base of the cutting was inserted through the slit and then planted about 5 cm deep. At planting time, four bamboo sticks were placed inside the pot to prevent the nylon cloth from sagging and at the same time to increase the space beneath the cover for air circulation. To prevent the entry of unwanted pests into the pots or to prevent the introduced weevils from escaping, the slit was sewn to close it.

Each pot was given a basal application of complete fertilizer (14-14-14) at the rate of 60-60-60 kg of N, P_2O_5, and K_2O per ha at planting time. The plants were watered daily to prevent cracking of the soil. The experimental area was kept free from weeds. Foliage feeding insects were controlled mechanically by hand. Two bamboo sticks were used as trellises for the vines to prevent the plants from crawling on the ground.

Treatments. — Four weeks after planting, when the plants were already established, soil was added to the pots so that the levels of the soil surface from the roots were 20, 23, 26 and 29 cm. The control pots (15 cm depth) were not added any soil. The soil was maintained at the different levels indicated by adding more soil after it had settled. The different depths served as treatments and each treatment was replicated four times with five plants per replication. Soil was not added to the control pots after the cuttings were planted.

Artificial Infestation with Weevils. — To each pot containing one-month-old sweet potato plant, 20 adult weevils were introduced at the same time through artificial infestation.

Small vials were used as containers for adult weevils. Twenty adult sweet potato weevils (1:1 male to female ratio) from the rearing cages were placed in each vial and brought to the experimental area where the pots were situated. Antennal structure was used as the basis for differentiating male and female sweet potato weevils. The weevils were confined in the pots by using round pieces of fine-meshed nylon cloth cut to fit the rim of the pots (Fig. 1) and held in place using elastic bands. The rubber bands were removed to loosen the nylon and the adult weevils were introduced at the base of each plant. Then, the nylon cloth cover was fastened back on the pot to prevent the weevils from escaping. The weevils were allowed to remain in the pots for four weeks after which the number of living weevils in the pots was counted. Since many weevils died due to continuous heavy rains, re-infestation with 7 adult weevils per pot was done six weeks after the first infestation.

Fig. 1. Top view of a 30-cm diameter clay pot planted with sweet potato showing the nylon cloth which was provided to prevent the escape/entry of sweet potato weevils.

RESULTS AND DISCUSSION

Number of Weevils Collected from the Soil.

Table 1 shows the mean number of adult weevils counted from the soil surface one month after the first artificial infestation and weevils collected at harvest. Elmer (1960) reported that the average longevity of the adult weevils was 82-88 days and their total life cycle was 24-32 days. Thus, it is possible that the weevils collected from the pots may have been a mixture of the artificially introduced weevils and the newly-emerged ones. In spite of these two sources, the number of weevils collected from the soil per pot was very low. There were about 4 weevils per pot after the first infestation, while only one weevil was recovered per pot at harvest. This low number can be attributed to the death of some weevils due to continuous heavy rains which occurred for several weeks after infestation. Water collected in the pots during each rain and drowned some weevils. Records at the ViSCA Agro-Meteorological Station showed that the average monthly rainfall for the months covering the conduct of the study was 208.8 mm.

Tuber Yield.

Table 2 shows the mean number and weight of infested and non-infested tubers per pot. Results indicate that as the depth of the soil increased, the number and weight of infested tubers tended to decrease.

On the other hand, the number and weight of non-infested tubers increased with decreasing soil depth. As the tubers formed farther from the soil surface, it became harder for the weevils to reach them due to the thicker soil barrier.

The highest weight of infested tubers (204.01 g) was obtained from the control (no soil added) while the lowest weight (21.18 g) was obtained at 26 cm soil depth. There was no weevil infestation in tubers at 29 cm soil depth. This may be attributed to the failure of the

Table 1. Number of adult weevils counted per pot from the soil surface one month after first infestation and those collected at harvest.

Soil Depth (cm)	One Month After Infestation	At Harvest	Total
15 (control)	4.00	1.25	5.25
20	4.10	0.25	4.35
23	4.25	1.05	5.30
26	3.65	0.75	4.40
29	3.60	0.75	4.45
Grand Total	19.60	4.05	23.65

Table 2. Number and weight of infested and non-infested tubers per pot of sweet potato grown at different soil depths.

Soil Depth (cm)	Infested Tubers		No. of Weevil/kg Infested Tubers	Non-Infested Tubers		Total	
	No.	Wt. (g)		No.	Wt. (g)	No.	Wt. (g)
15 (control)	2.45	204.01	45.00	1.66	123.17	4.11	327.18
20	2.00	190.28	37.00	3.00	272.85	5.00	463.13
23	1.20	93.69	51.00	2.25	228.95	3.45	322.64
26	0.50	21.18	78.00	3.35	285.52	3.85	306.70
29	0	0	0	4.45	347.10	4.45	347.10

LSD for weight of infested tubers:
0.05 = 35.523
0.01 = 49.125
C.V. % = 23.15

weevils to reach deeply-buried tubers, thus making infestation impossible.

On the other hand, the number of weevils per kg of infested tubers tended to increase with soil depth. This was because weevils in shallow soil depth have less difficulty in moving from one tuber to another, thus distributing infestation. On the other hand, weevils which can reach deeply buried tubers must have found it difficult to move from one tuber to another because of the soil which acted as barrier and thus infested only a few tubers.

Statistical analysis showed that the differences in weights of infested tubers between treatments were highly significant at 1% level. Comparison between the weights of infested tubers from plants grown in the 4 depths and that of the control using Least Significant Difference (LSD) test also showed highly significant differences with T_1 (20 cm soil depth). Differences among T_2 (23 cm), T_3 (26 cm), and T_4 (29 cm) were also significant.

Weevil Population in Stem.

As shown in Table 3, the average weevil population collected from sweet potato stems ranged from 0.95 (29 cm soil depth) to 3.5 (control), showing high weevil population in the stem of control plants and very low population in T_4 plants (29 cm soil depth). This low weevil population in stems of T_4 plants may be attributed to the very limited breeding site available for weevil development and multiplication. The area of the stem exposed to weevils was very much limited because the soil surface was so near the pot's rim and the nylon cloth cover. This was shown by the presence of severely damaged

Table 3. Number of larvae, pupae and adult weevils found per stem of sweet potato grown at different soil depths.[1]

Developmental Stage	Soil Depth (cm) 15 (control)	20	23	26	29
Larva	1.40	0.60	0.45	0.80	0.50
Pupa	0.25	0.45	0.15	0.05	0.40
Adult	1.85	1.10	1.20	0.50	0.05
Total	3.50	2.15	1.80	1.35	0.95

[1]Data based on a total of 20 plants per treatment; emergence holes in excess of the total number of adults collected from the pots were counted as emerged adults.

stems. Since weevils could not occupy the same tunnel at the same time, the lesser the area exposed for weevil infestation, the lesser was the number of weevils found in the stem. On the other hand, the high weevil population in the stems of control plants may be explained by the presence of greater stem base area between the nylon cloth cover and the soil surface which was exposed to the weevils, thus providing a convenient breeding site. Furthermore, weevils could tunnel only up to a maximum of 2 cm up and down the area of the stem exposed to weevils as shown by tunnels formed when the stems were split at harvest.

There were more adults than larvae and pupae. In this study, emergence holes were counted as adults although the adults have already left the stem and were found in the soil at harvest.

Weevil Population in Tubers.

Data on weevil population in sweet potato tubers are presented in Table 4. Highest number of weevils was obtained in the control (no soil added) with an average of 9.23 weevils per pot. This was attributed to the formation of tubers near the soil surface which favored weevil infestation, and led to considerable number of infested tubers. On the other hand, weevil population found in tubers at 20, 23 and 26 cm soil depth were 7.10, 4.85 and 1.65, respectively. Weevil population tended to decrease as the depth of the soil increased. However, no infestation was observed at 29 cm soil depth. Fig. 2 compares the degree of weevil infestation between the control (15 cm depth, no soil added), T_1 (20 cm soil depth) and T_4 (29 cm soil depth). These results suggest that the weevils can pass through the soil only up to a certain depth to infest the tubers, and that soil is an important barrier to weevil infestation. Statistical analysis shows that the effect of soil depth on the degree of sweet potato weevil infestation is highly signifi-

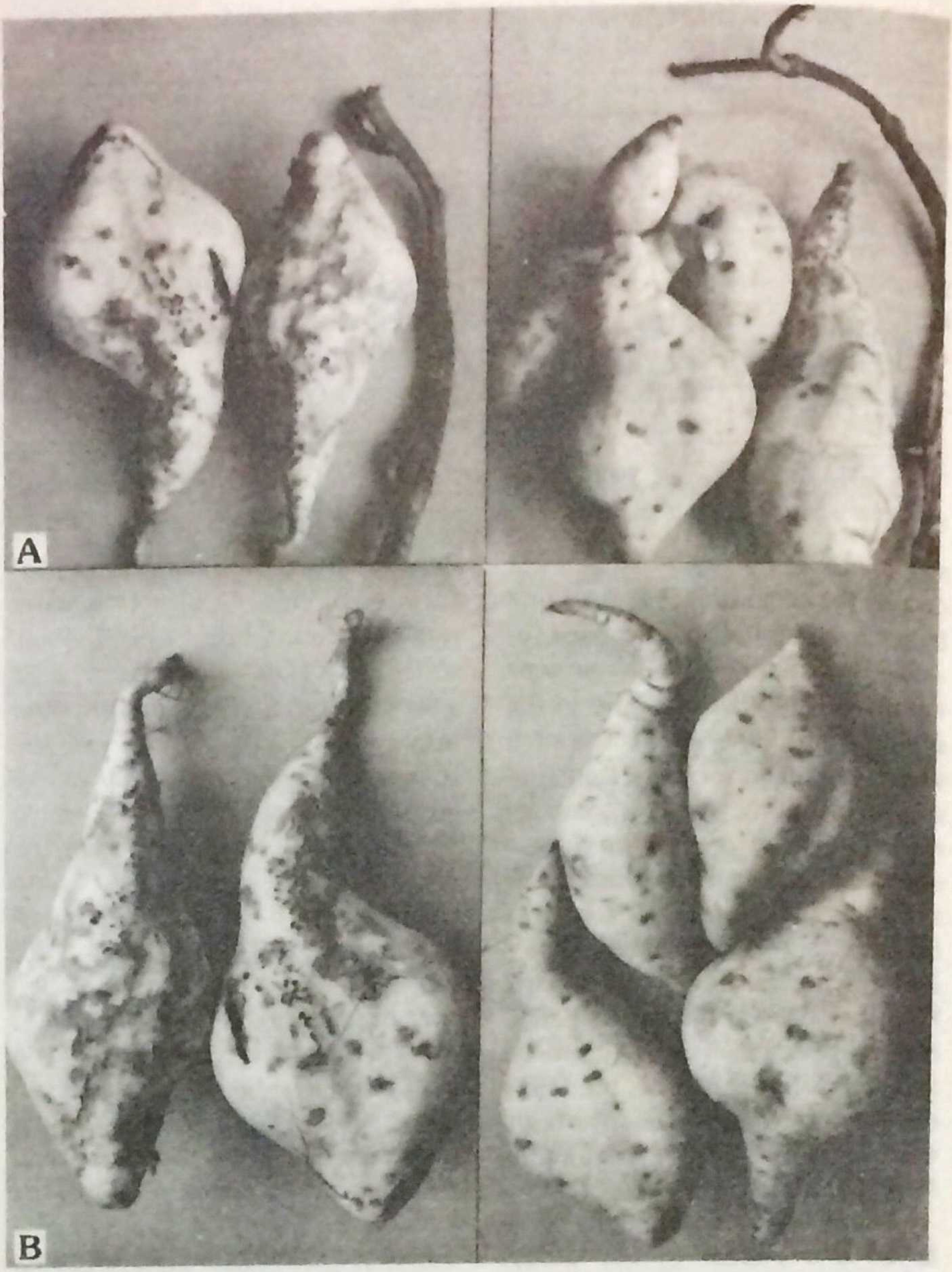

Fig. 2. Comparison of degree of damage by the weevil between A, control showing severe infestation and T_1 (20 cm soil depth) showing light infestation; B, control showing severe infestation and T_4 (29 cm soil depth) showing no infestation.

cant at 1% level.

A comparison between the number of weevils found in tubers at 4 soil depths and in the control revealed that the 4 treatments were significantly different from the control at 1% level using the LSD test.

Table 4. Number of larvae, pupae and adult weevils found in tubers per pot of sweet potato grown at different soil depths.[1]

Developmental Stage	Soil Depth (cm				
	15 (control)	20	23	26	29
Larva	4.78	4.20	2.90	0.80	0
Pupa	1.85	1.15	0.80	0.25	0
Adult	2.60	1.75	1.15	0.60	0
Total	9.23	7.10	4.85	1.65	0

[1] Data based on a total of 20 plants per treatment; emergence holes in excess of the total number of adults collected from the soil were counted as emerged adults.

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