EFFECT OF FLY ASH ON THE GROWTH AND YIELD OF SWEET POTATO

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ABSTRACT

Fly ash application at the rate of 5 t/ha enhanced early root bulking, resulting in the development of more tubers per plant of sweet potato. Application of higher levels of fly ash did not increase its tuber yield but promoted the vegetative growth of the crop. Plants from plots manured with 5 t/ha of fly ash significantly produced more marketable tubers and consequently resulted in higher tuber yield compared to those in the control plots. On the other hand, herbage yield was significantly higher in plots treated with 20 t/ha of fly ash. Soil parameters such as pH, manganese and zinc markedly increased with fly ash application while potassium, magnesium and aluminum decreased. No significant effect of fly ash application was observed on the nitrogen, calcium and organic matter content of the soil.

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KEY WORDS: Sweet potato. Fly ash. Plant growth. Tuber yield.

INTRODUCTION

Coal has been used internationally as source of fuel but in the process of utilizing it, fly ash or coal ash as its by-product is often stockpiled in the open field. Because of its abundant supply, there is a great potential in the use of fly ash in agriculture. Several workers observed that it is a suitable liming agent in acidic agricultural soils capable of correcting nutrient deficiency in crops (Fail and Wochok, 1977). Moreover, Capp and Spencer (1970) and Cope (1962) revealed that fly ash contains relative amounts of Si, Al, Fe and Ca; intermediate amounts of Mg, K, Na and Ti; lesser amounts of B, Zn, Mn, Cu and other trace elements. This was confirmed further by Martens (1971) when he obtained desirable results in his experiment on boron deficiency in alfalfa as well as zinc and phosphorus deficiencies in corn.

Hodgson and Bulkley (1975) noted significant effects when coal ash was utilized as a starter fertilizer of forest seedlings of generally acidic and infertile soil of the coastal region of the Southern United States.

Several studies were done to determine the effects of coal ash on the properties of soil. Changes in its physical properties were observed with the application of at least 70 t/ha of coal ash (Fail and Wochok, 1977). However, in this study lesser rates of coal ash were used to avoid salt injury in the planting materials.

This study presented the effects of fly ash on the growth and yield of sweet potato and on some chemical components of the soil.

MATERIALS AND METHODS

Experimental Design and Field Layout. — A slightly sloping area of about 539 sq m was plowed three times and harrowed at weekly intervals. After the last harrowing, the area was laid out in a randomized complete block design with three replications. Plot size was 4 m x 5 m. Fly ash was taken from Bio-Philippines, Inc. at Ormoc City and the treatments used were as follows:

Treatment	*t/ha*
T_0 =	0
T_1 =	5
T_2 =	10
T_3 =	15
T_4 =	20

Soil Sampling and Analysis. — Soil samples at 18 cm depth were collected before fly ash application and after harvest to determine the pH, % organic matter, nitrogen, phosphorus, potassium, magnesium, calcium, aluminum and copper contents of the soil. Soil samples were sent to the Bureau of Soils, Cebu City for analysis of the aforementioned parameters.

Planting. — Healthy tip cuttings of sweet potato (BNAS-51) about 30 to 35 cm long were planted in ridges at a distance of 100 cm between rows and 25 cm between hills with one cutting per hill to have a population density of 29,687 plants/ha.

Cultural Management. — Fly ash was incorporated in the soil using a garden rake two weeks before planting at specific levels per plot. Handweeding was done three weeks after planting followed by hilling up. A drainage canal was constructed at the uppermost portion of the experimental area to avoid entry of excess water from the elevated areas.

Thiodan, Parapest and Benlate were alternately sprayed at the manufacturer's recommended rate when signs and symptoms of insect pest attack and disease infection, respectively, were observed.

RESULTS AND DISCUSSION

Agronomic Characters

Weeks from Planting to Root Bulking.

Early root bulking was obtained with the application of 5 t/ha fly ash. However, higher rates (10 to 20 t/ha) of fly ash application favored the vegetative growth of sweet potato instead of early tuber formation (Table 1). The high amounts of nutrients in higher rates of fly ash not only encouraged more vegetative growth but also prolonged it resulting in the delayed root bulking. Delay in root bulking was also observed in the unmanured plots probably due to low amount of nutrients present in the soil which led to slow growth of the plants, and therefore delayed root bulking. The limited amount of nutrients was attributed to the adverse effect of the low pH (4.3) on the nutrient availability. The pH range suited for sweet potato was reported to be from 5.5 to 6.5 (Orongan, 1979).

Leaf Area Index.

Tuber production of root crops like sweet potato may be affected by the leaf area index of the plant through its influence on the amount of photosynthates produced in the leaves and translocated to the roots.

As the application of fly ash was increased, leaf area index correspondingly increased because of the increase in number of leaves per plant. This positive correlation may be attributed to the amount of nutrients released as fly ash decomposed with time.

Leaf area index value started to decline when maximum leaf development was reached. Normally, vegetative production reduces at maturity, hence, the reduction of leaf area index. During root bulking, most of the photosynthates are translocated to the roots for tuber formation instead of for vegetative development. For sweet potato, the maximum leaf area index is commonly attained from 10 to 12 weeks after planting (Baliad, 1980; Saladaga, 1981; and Sevenorio, 1981).

Number of Stems/Plant.

Significant increase in the number of stems/plant was observed with the application of fly ash. As the amount of material applied was increased, the number of stems that developed conse-

Table 1. Agronomic characters of sweet potato as affected by varying levels of fly ash.

Treatment (t/ha)	Weeks from planting to root bulking	Leaf area index Months after planting 2	3	4	No. of leaves/plant at harvest	No. of Stems/plant	Vine Length (m)	Herbage Weight (t/ha)
T0 = 0	11.9a	2.37b	2.77b	2.50c	119.2c	3.60c	3.46	9.75b
T1 = 5	8.9b	2.54b	3.42ab	2.58c	125.0c	4.20b	2.96	13.80a
T2 = 10	10.5a	2.62b	3.34b	2.60c	141.4b	5.40ab	2.72	15.00a
T3 = 15	10.70a	2.67b	3.60a	2.82b	149.0b	5.90a	2.30	16.60a
T4 = 20	11.1 a	3.61a	4.75a	3.63a	194.4a	6.30a	3.48	20.10a
CV (%)	6.40	16.99	15.84	12.24	16.96	14.99	23.18	17.73

Means within column followed by a common letter are not significantly different from each other at 5% level, DMRT.

quently increased. The plants in the unmanured plots developed the least number of stems/plant. Additional nutrients from fly ash like phosphorus (Table 2, Final Soil Analysis) upon decomposition and a more favorable pH might have favored the growth and development of the manured plants.

Fresh Weight of Herbage.

No significant difference was attained on the vine length of plants between the treated and the control plants (Table 1). However, application of fly ash significantly increased the production of herbage compared to the control. Treated plots produced more stems and leaves which could probably be caused by the availability of some nutrients when the pH of the soil was altered and the nutrients added to the soil upon fly ash decomposition. Such increase in the development of vegetative parts contributed to the herbage yield of the plants. No significant difference was observed among the treated plots.

Table 2. Initial and final values of organic matter, nitrogen, phosphorus, potassium, calcium, magnesium, aluminum, manganese, zinc and copper content of the soil and unweathered fly ash.

Teatment (t/ha)	pH	Organic matter (%)	Nitrogen (%)	Phosphorus (ppm)	Potassium (ppm)	Calcium (me/100g)	Magnesium (me/100g)	Aluminum (ppm)	Manganese (ppm)	Zinc (ppm)	Copper (ppm)
					(INITIAL SOIL ANALYSIS BEFORE FLY ASH APPLICATION)						
	4.3	3.5	0.175	10.0	259	3.13	3.51	1.20	198.50	10.12	8.0
					(FINAL SOIL ANALYSIS AFTER HARVEST)						
T0 = 0	4.8	2.2	0.11	6.0	161	2.07	2.10	0.50	136.8	9.21	9.25
T1 = 5	5.3	2.2	0.11	14.0	156	2.25	1.80	0.35	123.20	11.28	9.07
T2 = 10	5.4	2.2	0.11	19.0	140	2.0	1.70	0.35	188.21	15.15	9.86
T3 = 15	5.5	2.2	0.11	16.0	140	2.10	1.75	0.45	159.46	10.04	9.14
T4 = 20	5.2	2.2	0.11	12.0	151	2.07	1.71	0.30	155.72	14.0	9.30
					(ANALYSIS OF UNWEATHERED FLY ASH)						
	8.0	2.19	0.09	13800	7600	292	2.71	—	4.71	1.15	1.15

Table 3. Yield and yield components of sweet potato as influenced by different levels of fly ash.

Treatment (t/ha)	Number of Tuberous Roots — Weeks from onset of root bulking			Marketable Tubers		Non-marketable Tubers		Tuber Yield (t/ha)	Harvest Index
	0	4	6	Number/ha	Weight (t/ha)	Number/ha	Weight (t/ha)		
T0 = 0	2.4c	4.0c	5.0d	17125c	1.93c	10625	1.18	3.10b	0.25
T1 = 5	4.7a	9.4a	11.4a	21625a	3.08a	20000	1.54	4.61a	0.25
T2 = 10	3.5b	7.0b	8.7b	18750b	2.52ab	13625	1.28	3.80b	0.20
T3 = 15	3.2b	6.2b	7.3c	18870ab	2.39b	14125	1.24	3.53b	0.18
T4 = 20	3.8ab	6.9b	6.9c	19750a	2.68a	14875	1.29	3.84ab	0.16
CV (%)	11.43	9.90	4.20	8.68	38.22	15.87	18.70	12.34	21.30

Means within column followed by a common letter are not significantly different from each other at 5% level, DMRT.

Yield and Yield Components

Number of Tuberous Roots.

Development of tubers was enhanced with the application of fly ash (Table 3). The plants in the unmanured plots developed significantly fewer tuberous roots than those applied with fly ash. The poorer growth exhibited by the untreated plants could be attributed to the prevailing acidic soil condition rendering some nutrients especially P less available for plant development.

Number of Marketable and Non-Marketable Tubers/ha.

Although the number of marketable and non-marketable tubers was increased with the application of fly ash, only the number of marketable tubers was significantly affected by the treatments. This positive response of sweet potato tubers to fly ash application might have been brought about by a more favorable soil condition for growth and development.

The poor tuber production observed in the control plots could have been due to the very acidic condition of the soil rendering phosphorus less available. Phosphorus is one of the essential elements for tuber formation.

Weight of Marketable and Non-Marketable Tubers/ha.

Statistical analysis indicated a significant effect of fly ash application on the weight of marketable tubers (Table 3). Tuber weight was increased to as much as 62.7% with the application of 5 t/ha of fly ash as compared to the control. The same trend was observed with number of tubers. The plants which produced the highest and lowest number of tubers gave the heaviest and lowest tuber weight, respectively.

The weight of non-marketable tubers was not significantly affected by the treatments. Nevertheless, a slight increase in tuber weight (1.54 t/ha) was observed in plots treated with 5 t/ha fly ash in contrast to the control plots with only 1.18 t/ha.

Total Yield.

Application of varying levels of fly ash markedly influenced the total yield of sweet potato (Table 3). Plants applied with 5 t/ha fly ash produced the highest yield of 4.61 t/ha. This conformed with the effect of fly ash manuring on the number and weight of both marketable and non-marketable tubers. This significant difference between the control plants and those treated specifically with 5 t/ha fly ash may be attributed to their difference in root development which may hold true between T_1 and T_2 Moreover, the treated plants were supplemented with nutrients necessary for their growth, development and reproduction which were released upon decomposition of fly ash applied.

Harvest Index.

Harvest index (HI) is the ratio of tuber yield (economic yield) to the biological yield (tuber yield + herbage yield). Economic yield is very important in measuring the productivity of root crops like sweet potato. Higher HI means that the economic yield of the crop is high and the reverse is true when the HI is low.

Application of fly ash did not show significant effect on the harvest index of sweet potato. However, there was a noticeable reduction in HI as the rate of fly ash applied was increased (Table 3). Unmanured plots and those that were applied with 5 t/ha gave similar values. Harvest index started to decrease as the level of fly ash was increased from 10 to 20 t/ha.

This result suggests that if the important consideration in sweet potato is its tuber yield, the amendment of fly ash in the soil is only economical up to a certain level (5 t/ha), beyond which excessive vegetative growth will occur at the expense of tuber production (Tables 1 and 3).

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