Field evaluation of selected yam (*Dioscorea alata*) accessions in acid soils and saline-prone areas

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Abstract
In the context of agricultural problem soils, salinity and acidity dominate the problems related to agricultural landuse. This study was conceptualized to determine the possibility of utilizing some problem soils into yam production. Selected yam accessions were assessed for their performance in acid soils and saline-prone areas. The accessions planted in the saline-prone area, a Balongay clay at Sta. Teresita, Canaman, Camarines Sur, Philippines were Accession 5, Accession 6, Accession 8, Accession 9, Accession 10 and Accession 12 while the Accession 6, Accession 10, Accession 11, Accession 12, Accession 13 and Accession 21 in an acid soil, a Caroyroyan clay loam at Pacol, Naga City, Philippines. This was conducted using Randomized Complete Block Design (RCBD) with three replications. Accession 6 and 10 were both economically viable in saline-prone areas and acid soils as shown by the highest return on investment compared with other treatments.

Key Words
Acid soils, saline-prone areas, problem soil, yam accessions.

Introduction
In Camarines Sur, some farmers had been engaged in growing yam but encountered problem in selling the produce and how they can process and preserve yam and package into other high value yam-products. These are some of the reasons of their resistance to engage in yam production. Hence, very few farmers are cultivating this crop because of lack of information about yam production, processing, product development, preservation and market-linkaging. Yam (*Dioscorea alata*) is considered as a high value crop. They are cultivated in small patches of land, oftentimes less than a hectare, particularly in some regions of the Philippines like the Ilocos, Southern Tagalog, Bicol, Central Visayas and Northern Mindanao. It is an upland crop and usually planted in a well-drained field. Optimum yields are obtained from sandy loam and silt loam soil although acceptable yields are also obtained from clay loam soils, particularly those high in organic matter. Stony and highly compacted soils are not good for yam production.

In the context of agricultural problem soils, salinity and acidity dominate the problems related to agricultural landuse. This study was conceptualized to determine the possibility of utilizing some problem soils (location specific) into yam production so that, lands without constraints for crop production could be utilized for other high value crops and provide information about the yield of yam in these areas. Saline-prone areas and acid soils can be converted into productive agricultural lands considering the necessary information with regard to soil and water management for these problem soils.

The information generated could help farmers with problem soils to increase their income through yam production. This could answer the goals and objectives of the Department of Agriculture which are food security, poverty alleviation, improved productivity and increased income, resource sustainability and global competitiveness.

Methods
Collection and preparation of soil sample
Soil samples at a depth of 20 cm were randomly collected from the experimental area for soil analysis prior to the establishment of the study. One-kilo composite soil samples were mixed, pulverized and placed on trays and large clods were broken into smaller sizes and spread thinly on plastic sheets, passed through 2mm sieve and air dried at room temperature.

Experimental design and treatments
The Randomized Complete Block Design was used. The experimental area covered about 320 sq m, divided into 3 blocks and 6 plots in each block. The treatments for the saline-prone area were as follows : T1 - Accession 5, T2 - Accession 6, T3 - Accession 8, T4 - Accession 9, T5 - Accession 10 and T6 - Accession 12 while for the acid soils the treatments were : T1 – Accession 6, T2 – Accession 10, T3 – Accession 11, T4 – Accession 12, T5 – Accession 13 and T6 – Accession 21. while the T1-Accession 6, T2 - Accession 10, T3 - Accession 11, T4 - Accession 12, T5- Accession 13 and T -6 Accession 21.

Cultural management practices
Land preparation. The area was ploughed and harrowed once followed by harrowing after one to two weeks.
Sett preparation. Seed pieces or setts were prepared a few days before planting. The roots were cut into pieces containing at least 2-3 eye-buds and weighing about 250 grams each.
Fertilization. The fertilizer used was 14-14-14 at the rate of 15g/plant and 0-0-60 at the rate of 2g/plant and 1 kg of compost. The amounts applied were based on soil analyses.
Planting. Planting of seed pieces or setts was done late afternoon. The distance of planting was 1 meter between rows and 0.75 meter between hills.
Staking. As soon as sprouts emerged from the soil staking was done with the use of split bamboos. Vines need stakes for better display of leaves. This practice was advisable because studies show that tuber yield was increased. Stakes about 2.0-2.25 meter tall were placed per plant.
Weeding and cultivation. Weeds compete with yam plants in terms of soil nutrients, light and space especially during the early growth stages; hence, hand weeding was employed as needed.
Control of pest and diseases. Furadan was used at the rate of 0.5g/plant to control pest and diseases.
Harvesting. Harvesting was done when the leaves turned yellowish or brownish in color. This was 6 to 11 months after planting. Harvesting of the tubers was done with digging tools. Care was exercised so as not to injure them while digging. Tubers were cleaned, collected and placed in plastic sacks depending upon tuber size.

Data gathered
*Average tuber yield***.** This was determined by weighing the tubers per plant and the average yield was determined for the sample plants and multiplied with the number of plants per hectare. The average tuber yield was expressed in tons per hectare.
*Pests and diseases***.** Observation of the pests and diseases which affected the yam plants was done regularly.
*Statistical analysis***.** The mean was computed instead of using the analysis of variance (ANOVA) for the saline-prone area because some of the accessions did not produce any yield. However, for the acid soils, the ANOVA was used.
*Economic Analysis***.** A simple cost and return analysis was used. This was computed to determine the economic viability of the different treatments in the saline-prone area and acid soil.

Results
Average tuber yield
The highest tuber yield was obtained from Accession 10, with 99.83 tons/ha. This was four times higher than the average tuber yield obtained by Ruiz (2000) using similar accession (Table 1). This accession is considered much favorable to plant in saline-prone areas if compared to the yield obtained by Ruiz in a non-saline area. Similarly, accession 6 showed an average tuber yield of 48.4 tons/ha. This yield was three and a half times higher than the average tuber yield obtained by Ruiz using similar accession. The rest of the accessions yielded lower than that of Ruiz (2000). The most suitable accession in saline-prone area in a decreasing order was Acc. 10 with the highest yield of 99.83 tons/ha, followed by Acc. 6 with a yield of 48.4 tons/ha, then Acc.5 with 13.612 tons/ha and Acc. 9 with 13.2 tons/ha and the lowest was Acc. 8 and Acc. 12 which did not produce any yield due to infestation by insect pests. These accessions were infested with white grubs and ants fed on the tubers at about five months old.

In the acidic soil, the highest tuber yield of 52.58 t/ha was obtained from Accession 10, followed by Accession 6 which got an average tuber yield of 48.25 t/ha. Accession 11, 12, 13 and 21 did not differ significantly in terms of yield which ranged from 10 to 15 tons per hectare (Table 1). Only Accession 6, Accession 10 and Accession 12 out yielded the results obtained from the study of Ruiz (2000). The increase ranged from 345%, 214% to 113%. The rest of the accessions yielded lower.

Table 1. Tuber yield of yam accessions in saline-prone area and acid soils

Treatments	Saline-Prone Area Average Tuber Yield ton/ha	Average Tuber Yield ton/ha (Ruiz 2000)	Treatments	Acid Soils Average tuber Yield ton/ha		Average Tuber Yield ton/ha (Ruiz 2000)
T1 - Acc 5	13.6	19.2	T1 - Acc 6	48.3	b	14.0
T2 - Acc 6	48.4	14.0	T2 - Acc 10	52.6	a	24.6
T3 - Acc 8	0	25.1	T3 - Acc 11	10.2	c	14.9
T4 - Acc 9	13.2	18.7	T4 - Acc 12	13.9	c	12.3
T5 - Acc 10	99.8	24.6	T5 - Acc 13	13.8	c	14.4
T6 - Acc 12	0	12.3	T6 - Acc 21	15.8	c	16.0

Means followed by the same letter are not significantly different

Accessions 6 and 10 showing potential for acid soils and saline-prone areas have more or less the same agronomic characteristics (Table 2). They have both white color flesh and are liked moderately and liked slightly, respectively. Because of the white flesh, these accessions can undergo product development since most people would prefer yam which are violet in color.

Table 2. Agronomic characteristics of the yam accessions.

Characteristics	6	10	11	12	13	21
1. Growth habit	Medium	Large	Small-medium	Small-medium	Medium	Small-medium
2. Length of petiole	medium	Long	Short	Short	medium	medium
3. Color of petiole	White	White	Purple-green	Purple	Purple-sepia	Purple-green
4. Length of internodes	Medium	Long	Short	Short	Short	Short
5. Emerging leaf color	Light Septa	Light Septa	Dark Septa	Dark Septa	Dark Septa	Dark Septa
6. Leaf shape	Entire Cordate	Entire Cordate	Sagitate	Sagitate	Sagitate	Entire-cordate
7. Vine	Winged	Winged	Winged	Winged	Winged	Winged
8. Method of climbing	Right	Right	Right	Right	Right	Right
9. Flowering habit	None	Heavy-flowering	None	None	None	None
10. Arial tuber formation	None	Heavy	Slight	None	Slight	Slight
11. Tuber shape	Long tapering	Oblong	Round - branching	Round - Branching	Round - branching	Round - branching
12. Root skin	smooth	Rough	smooth	smooth	smooth	smooth
13. Root color						
-skin	violet	white	violet	violet	violet	violet
-flesh	white	whitish-yellow	violet	light-violet	White-violet	White-violet
14. Maturity	8-10 months	8-10 months	6 -8 months	6 - 8 months	6 - 8 months	6 -8 months
15. Pest resistance						
Insect	Resistant	Resistant	Mod Resistant	Mod Resistant	Mod Resistant	Mod Resistant
Diseases	Resistant	Resistant	Mod Resistant	Mod Resistant	Mod Susceptible	Mod Resistant
16. Storage life	4-6 months	4-6 months	3-6 months	3-6 months	3-6 months	3-6 months
17. Yield (t/ha)	14. 0	24.58	14.93	17.34	14.44	16.03
18. Aroma	Mild	Mild	Natural	Natural	Mild	Natural
19. Flavor	Slightly sweet	Flat	Slightly sweet	Slightly sweet	Slightly sweet	Slightly sweet
20. Texture	Dry tough	Dry tough	tender	tender	tender	tender
21. General acceptability	Like Moderately	Like Slightly	Like Moderately	Like Moderately	Like Moderately	Like Moderately

Pest

The only pest observed in the experimental area specifically in the saline-prone area which affected the yield of some of the accessions was white grubs. Grub infestation was noted from 3 to 6 months after planting. Yellowing of the leaves and wilting were the observed above ground symptoms. Examination at the base of the plant showed white grubs feeding on the tubers. Moreover, the climatic condition during the months where infestation was observed was favorable for the insect because of low rainfall. Grubs feed on the roots of plants, and also cause mechanical damage as they tunnel through the soil. In addition to damaging roots and stems of potatoes, white grubs feed on tubers, leaving large shallow circular holes in them. The infested plants often do not show symptoms on aboveground parts. As a result, considerable damage was done before the grub problem is discovered. In heavy infestations, the soils become soft and fluffy due to grub movement.

Cost and Return Analysis
In the saline-prone area, the simple cost and return analysis showed that only Accession 6 and 10 was economically viable. Accession 10 had 900% while Accession 6 had 387% returns on investment. Similarly, in the acid soil, the Accession 6 and 10 had 372% and 414% return on investment, respectively.

Conclusion
In saline-prone areas and in acid soils, planting of yam accessions 6 and 10 would be beneficial to farmers. There is really a great potential for commercial exploration of yam considering the fact that it can thrive well even in soils with constraints in crop production. It can always be considered as a component of every farming system. However, since both accessions have white flesh color and most people prefer yam which are violet in color they could just undergo product improvement and development. To encourage farmers to go into yam production, it is recommended that the yam industry be promoted, package the yam-based products by way of capacity building such as trainings, seminars, demonstration and organizing them into cooperatives. Full government support for this value crop is enjoined to push the full development of the yam industry. This is one way of managing the soils for the future generations. The use of problems soils for crops than can adapt to the existing soil conditions.

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