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Original Paper

Characterization and classification of saline/sodic soils of Coba area of non-irrigated farmlands in Golina Watershed in Raya Valley, Amhara Region, Ethiopia

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***Abstract*— The soil in the Coba area of the Golina watershed at Raya Kobo Valley contains various soluble salts and exchangeable sodium, magnesium, potassium, and calcium. However, excessive concentrations of these elements can affect soil processes and plant growth, with the impact varying based on concentration levels and plant types. To study the salt-affected soils in the area, we excavated one profile from non-irrigated fields and collected ten soil samples at 20 cm intervals in a two-meter profile. The samples were analyzed for chemical properties such as pH, soluble cations and anions, electrical conductivity, exchangeable cations (Ca, Mg, Na, and K), total nitrogen, organic carbon, available phosphorus, exchangeable sodium percentage, sodium absorption ratio, as well as physical characteristics such as soil color, texture, bulk density, and porosity. The analysis revealed that the non-irrigated soil profile had a pH of 7.4 to 8.5, electrical conductivity of 3.1 to 9.7 dsm-1, organic carbon of 0.4 to 1.5%, total nitrogen of 0.09 to 0.27%, available phosphorus of 25 to 46.5 mg kg-1, and a cation exchange capacity of 48.7 to 57.2 cmol (+) kg-1. Considering the top layers of the soil responsible for agricultural purposes, the electrical conductivity, exchangeable sodium percentage, and pH values indicate that the soil can be classified as saline-sodic soil for non-irrigated farmland.**

Keywords*— *Characterization, classification, non-irrigated farm, soil profile, soil properties

I. INTRODUCTION

Soil salinity and sodicity characterization is crucial for assessing soil resources in semi-arid and arid areas where annual evapotranspiration exceeds precipitation. By analyzing the physical, chemical, and biological properties of the soil, appropriate agricultural technologies can be applied, and effective management strategies can be designed. In Ethiopia, the semi-arid and arid lowland sand valleys face significant issues with salinity and alkalinity. Research has shown that 44 million hectares (36% of the country's total land area) are potentially susceptible to salinity problems [1], with 33 million hectares having dominant salinity problems, 8 million hectares having combined salinity and alkalinity problems, and 3 million hectares having dominant alkalinity problems. When soils contain excessive concentrations of soluble salts or exchangeable sodium, they are referred to as salt-affected soils [2]. These soils are generally categorized as saline, sodic, or saline-sodic based on their characteristics [3]. Saline soils have excessive concentrations of water-soluble salts [2, 4], while sodic soils are high in exchangeable sodium [5, 6]. Saline-sodic soils contain both excessive water-soluble salts and exchangeable sodium [7]. The accumulation of excess salts in the root zone of soils in arid and semi-arid climates leads to a partial or complete loss of soil productivity. In the study area, the problems of salt-affected soils have been increasing due to permanent surface runoff and water logging, leading to reduced yields in farmlands. Therefore, this study aims to characterize and classify the soils of the Coba area in the Golina watershed regarding soil salinity and alkalinity. The specific objectives of the study are:

- To characterize and classify the soils of non-irrigated farmlands based on their physico-chemical properties,
- To characterize and classify the soils of the study site according to the criteria set for salt-affected soils.

II. MATERIALS AND METHODS

A. Description of Experimental Location

Coffee inventory was carried out by collecting Robusta coffee around Bondowoso to compare its diversity. Several garden locations around Bondowoso, namely Jember, Banyuwangi and Situbondo. From the visited gardens, superior seeds were taken as plasmanutfah.

B. *Planting Material Production*

Robusta coffee seedlings with several types of clones were planted in a greenhouse using rootstock imported from the Cocoa Coffee Research Center. Stalks from several locations of superior robusta coffee plantations were planted using grafting techniques. Seedlings are planted with a minimum of 5 replications and cultivated for 6 months to produce seeds that are ready for planting.

C. *Agronomic Character Observation*

Agronomic characters were observed by looking at the growth in each experimental unit. This study used several morphological and physiological parameters to characterize these superior clones. Some of the parameters observed were growth rate, number of leaves, leaf shape, leaf morphology, fruit color on the parent plant, annual production potential and leaf chlorophyll content.

D. *Identification of Robusta Coffee Kinship*

Identification of kinship was carried out by looking at the genetic similarity between Robusta coffee with yellow skin compared to several Robusta clones that have been inventoried. The method used is RAPD (Random Amplified Polymorphic DNA) [16]. The primers used in the identification of molecular markers using the RAPD method according to [3] are as follows:

TABLE I. LIST OF PRIMERS TO BE USED FOR RAPD

Primers	Sequences	Tm (°C)
OPI 07	5' CAG CGA CAA G 3'	33.5
OPJ 19	5' GGA GAC CAC T 3'	33.4
OPY 15	5' AGT CGC CCT T 3'	36.9
OPI 20	5' AAA GTG CGG G 3'	36.2
OPX 16	5' CTC TGT TCG G 3'	31.6
OPL 18	5' ACC ACC CAC C 3'	38.7
OPX 20	5' CCC AGC TAG A 3'	31.8
OPY 10	5' CAA ACG TGG G 3'	33.7
OPN 18	5' GGT GAG GTC A 3'	32.9
OPM 04	5' GGC GGT TGT C 3'	38.6

III. Results And Discussion

A. *Characterization of Local Robusta Coffee in Curahpoh Village*

Fig 1. Morphology of the 8th leaf germplasm of yellow robusta coffee in Curahpoh Village

The first activity of this research was a field visit, where the aim of this activity was to find out the main plant for planting coffee with yellow fruit skin. Looking at the morphology in Figure 1, it can be seen that there is genetic variation in the form of differences in leaf characters. Plants 2, 3, 6 and 8 have leaf blades with more visible waves, when compared to coffee 1, 4, 5 and 7. In addition, variations in the size of the length and width of the leaves are also quite large, so further observations are needed to find out the causes of the differences. Physiology and morphology observed from field observations. For further observations it is also necessary to group them based on the results of the initial observations that have been made. Plants with elliptic and ovate leaf shapes need to be grouped and then made more detailed observations to find out whether they need to be separated or not in carrying out the next research stage. This is done to reduce data bias in observations at a later stage.

Based on the observation of leaf shape, there are several characteristic differences in the observed samples. There are several samples that show elliptic leaf shapes, but there are some that are ovate. Apart from that, from observing the shape of the plants, there are also many significant differences, namely some plants have a cylindrical shape and some plants have an inverted cone shape. Data on plant height and canopy diameter also vary quite a lot. Between 1.7 m and 2.5 m for plant height and between 1.9 m and 3.2 m for plant canopy diameter. Therefore there is a need for deeper identification and analysis regarding the variations in observations of coffee plants in the field. Is the difference due to differences in the growing environment or differences due to its genetic nature. This is because this coffee plant grows in Perhutani forest areas which have different shade cover and some plants grow in steep contour areas. However, several other characteristics have different ranges that do not vary much.

An inventory of robusta coffee species from various sources has also been carried out, most of which were obtained from the Coffee and Cocoa Research Center. There are also some coffees obtained from private plantation companies in Kab. Jember. The coffee seedlings obtained were planted in the experimental garden of the Faculty of Agriculture for further observation. The next plan is to molecularly test the kinship of Robusta coffee from the Curahpoh plantation compared to the several Robusta varieties that have been collected.

Robusta coffee comes from various sources. There are several varieties including BP358 Sehasence, BP 308, BP 42, BP 44, BP 534, Propelegitim, BP 237, BP 939, Sintaro 2 and SA 237. Plasmanutfah coffee in Curahpoh is then compared with coffee with identified names and specific characteristics. Based on the results of observations, it is known that robusta coffee in Curahpoh village is morphologically identical to BP 44, BP 42, BP 534 and BP358. This hypothesis is supported by the appearance of the leaves which are known to have waves that are quite strong compared to other coffee varieties collected in the trial greenhouse. So it is necessary to test more deeply from physiological observations and then proceed to molecular observations

Fig 2. Robusta coffee that has been identified from coffee and cocoa research centers and from private plantations in Jember Regency

B. Test for Diversity Using RAPD

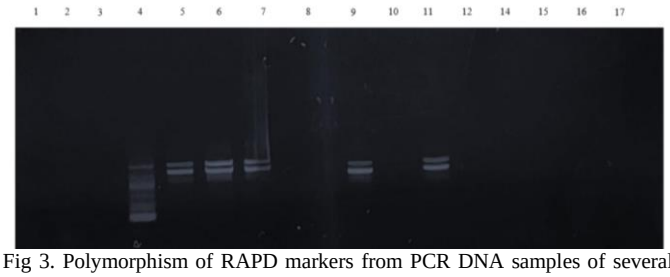

Fig 3. Polymorphism of RAPD markers from PCR DNA samples of several coffee plants with primers OPA02, OPA-03 and OPA-05 (Keterangan M=Marker, 1=BP936, 2=BP534. 3=Simtaro2, 4=BP409, 5=BP42, 6=Sinasense, 7=BP358, 8=BP308, 9=BP939, 10=BP237, 11=Propelegitu)

The diversity of several types of coffee that have been inventoried by the team is proven by molecular analysis. The method used is RAPD with 11 samples. The choice of primers in the RAPD analysis affects the polymorphism of the resulting bands because each primer has its own attachment site, as a result the polymorphic DNA bands produced by each primer differ, both in terms of the number of base pairs and the number of DNA bands [17]. The intensity of the amplified DNA bands in each primer is strongly influenced by the purity and concentration of the DNA template [18], [19]. DNA templates containing compounds such as polysaccharides and phenolic compounds, and concentrations of template DNA that are too small often result in dim or unclear amplified DNA bands [20], [21]. We found this unclear condition in RAPD marker polymorphism from PCR results of DNA samples using the primer OPA-01. The use of primer OPA-01 is less effective. It can be seen that only clone BP939 can be amplified from this primer, even though it is vague that clone BP358 is also able to generate OPA-01 primer. The opposite is seen in the use of other primers that look better. It can be seen that the use of primers OPA-02, OPA-03 and OPA-06 produces a more clearly visible band. Although optimization is needed to generalize it.

The results of molecular identification using RAPD showed a kinship relationship between coffee and Simtaro2, BP42, Sinasense, BP358, BP939 and Propelegitu clones. This is reflected in the results of polymorphism readings using the OPA-02 marker. While using the OPA 03 primer, it can be seen that Simtaro2, BP409, BP42, Sinasense, BP358, BP939, BP237 and Propelegitu clones. The use of the OPA-05 primer made it even more convincing that the BP409, BP42, Sinasense, BP358, BP939, and Propelegitu clones were coffee clones with a high affinity for traits/relationships (Figure 3).

IV. CONCLUSIONS

The conclusions that can be drawn from the identification of the diversity of several Robusta coffee clones based on morphological and molecular observations are as follows: Morphologically the Robusta coffee in Curahpoh village has similarities/identical with BP 44, BP 42, BP 534 and BP358 on the parameters of number of leaves, leaf shape, Leaf morphology and fruit color in plants. Clones BP409, BP42, Sinasense, BP358, BP939, and Propelegitu are coffee clones that are molecularly highly related.

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