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EFFECTS OF SOIL COMPOSITION, CULTIVAR AND RAINFALL ON ESTABLISHMENT OF SWEET POTATO IN KENYAN HIGHLANDS

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ABSTRACT
Sweet potato (*Ipomoea batatas)* is grown for human consumption, animal feeding, and industrial products. Six sweet potato cultivars were on farm planted during the long rains in different agro-ecological zones (AEZ); Kieni (Dry), North Nandi (Moderate) and Bomet East (Wet) within the Kenyan Highlands. A piece of land measuring approximately three-quarters of a hectare was subdivided into 18 plots. Each cultivar was planted in three (3) randomly selected plots, 60 basal vine cuttings per row. One-month post planting, the seedlings in different areas were recorded and data anlysed using general liner model for completely randomized design in Statistical Analysis System, 2003. Copper levels was higher ($p<0.05$) in Kieni than in both North Nandi and Bomet East. Soil pH level was higher ($p<0.05$) in Keni and North Nandi than in Bomet East. Total nitrogen, carbon, potassium, manganese and zinc level was higher ($p<0.05$) in Bomet East than in both Kieni and North Nandi. In Kieni, cultivar 103001and Gweri had a higher $p<0.05$ establishment rate than the rest. In North Nandi, Gweri, Kembu 23 and Wagabolige cultivars had a higher $p<0.05$ establishment rate than the rest. In Bomet East, Gweri and Wagabolige cultivars had a higher $p<0.05$ establishment rate than the rest. Establishment rate for cultivar 103001, Gweri and Naspot 1 was higher $p<0.05$ in Kieni than in North Nandi and Bomet East. Soil composition, cultivar and rainfall affected the establishment rate of sweet potato cultivars in the three study areas.
Keywords: Sweet potato, Nutrients content, rate, Kenya Highlands

INTRODUCTION
Sweet potato (*Ipomoea batatas)* is cultivated in a hundred of developing countries in Africa, Asia, South and Central America and is one of the five most important crops in more than 50 countries (Muli and Agilli, 2010). Sweet potatoes are grown for different purposes, including human consumption, animal feeding, and industrial products (biofuel) (León Velarde et al, 2009). Hundreds of cultivars and land races are used throughout the world (Wanda 1998). The crop is adapted to many agro-ecological zones (AEZ) (Muli and Agilli, 2010). Apart from growing in different environments, the plant grows in varied soil types varying from swamp to sandy loam, fertile, well-drained soils, non-saline, non-alkaline and pH 5-8 (Wanda, 1998; Ondabu et al 2006). Various sweet potato cultivars are classified according to the function; storage roots, forage or dual purposes. The objective of the study was to assess effects of soil composition, rainfall and cultivar on the establishment of various sweet potatoes within the Kenyan Highlands. Data on soil composition and numbers of plants established were recorded.

MATERIAL AND METHODS
The experiment was carried out on-farm during the long rains in three study areas in various AEZ within the highlands of Kenya; Kieni (Dry) (00º33’22.7’’S, 36º86’87.6’’E), North Nandi (Moderate) (00º40’96.2’’N, 35º04’94.8’’E) and Bomet East (Wet) (00º68’49.8’’S, 35º38’53.8’’E) in Nyeri, Nandi and Bomet County respectively. A piece of land measuring approximately three-quarter size of a hectare was subdivided into 18 plots. Each plot measuring 12 x 6 square meters (m) and separated with a 2m border ring as an experimental unit. The plots were later sub-divided into six rows (12m long) and 1m width and were molded into ridges. Six pre-screened sweet potatoes cultivars; Naspot1, 103001, Kemb23, Gweri, Kemb36 and Wagabolige were identified. Each cultivar was planted in three (3) randomly selected plots, 60 basal vine cuttings per row to make a total plant population of 360 vines per plot.

Soil clips for the three different study locations were obtained from the soil survey map of Kenya. Soil fertility was

determined by collecting 18 soil samples (top 30 cm) in a zig-zag method from each experimental plot and bulked according to each cultivar. A sub-sample was then obtained which and was analyzed for soil composition using standard chemical methods of AOAC (1998), before planting was done. In addition, each area monthly rainfall was recorded from the nearby weather station.

One month after planting, the established vines in each plot were recorded. Data were analyzed using General Liner Model (GLM) for Completely Randomized Design (CRD) in Statistical Analysis System (SAS) software version 9.1, 2003 using the following model;

$Y_{ijk}=\mu+\alpha_i+\varepsilon_{ijk}$ whereby,

Y_{ijk}= Total response establishment

μ=Overall mean on a given variable

$\alpha_{i=}$ Effect due to areas and cultivars

$\varepsilon_{ijk=}$ Random error effects

For significant any differences, means were separated using least significant difference (lsd) procedures (Steel and Torrie, 1980) at p=0.05.

RESULTS

Soil clips for the three areas are shown in Figure 1a, b and c.

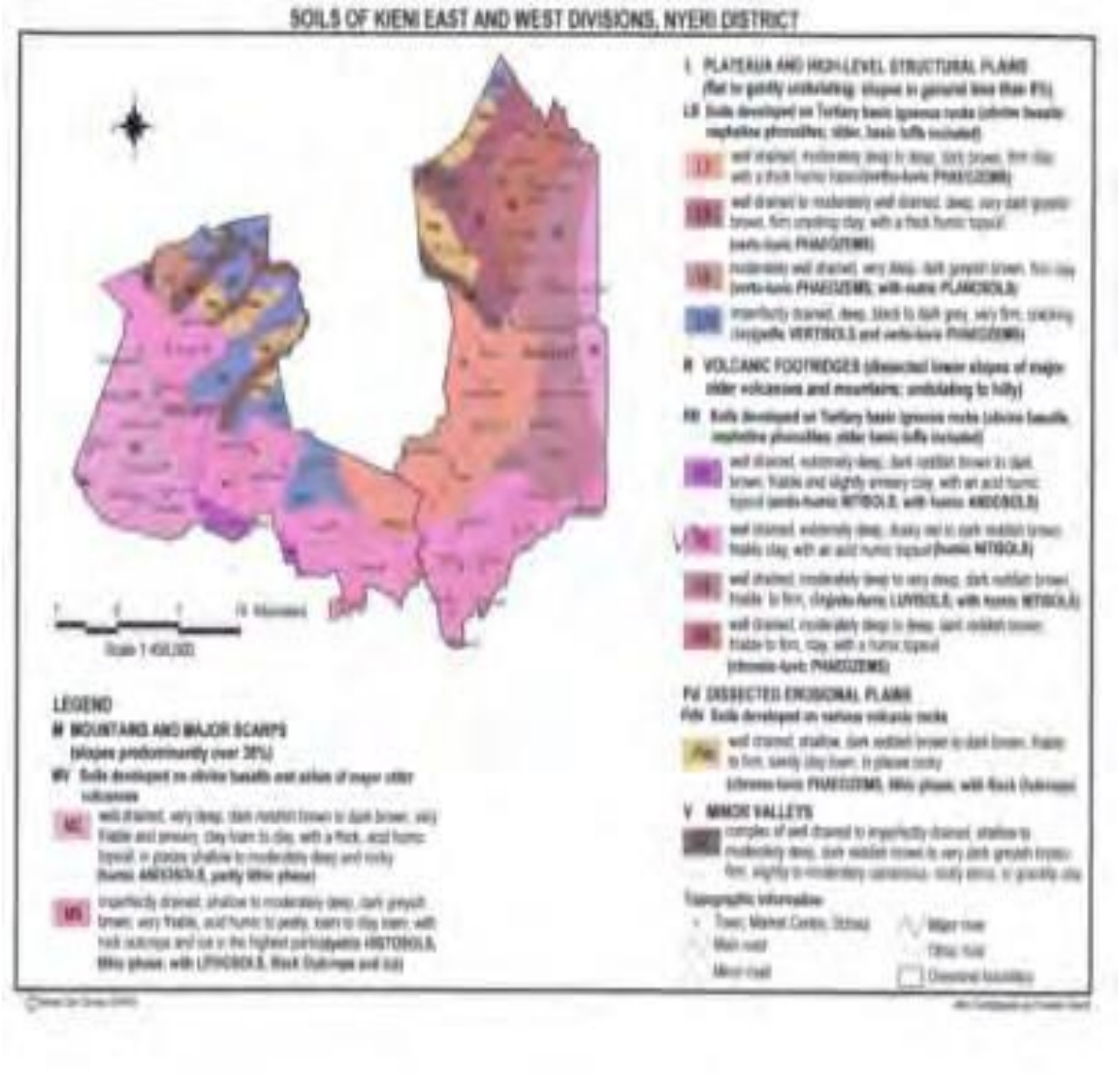

Fig. 1a Soil types in Kieni, Nyeri County ; Source Kenya Agricultural and Livestock Research Organisation (KALRO),National Agricultural Research Labolarories (NARL)

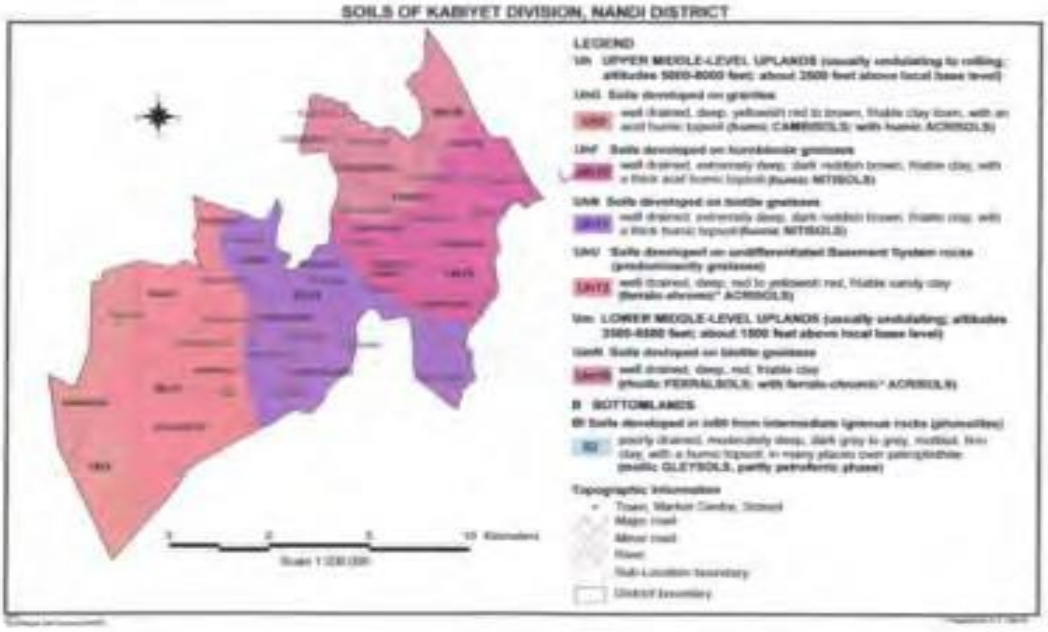

Fig. 1b Soil types in North Nandi, Nandi County; Source Kenya Agricultural and Livestock Research Organisation (KALRO),National Agricultural Research Labolarories (NARL)

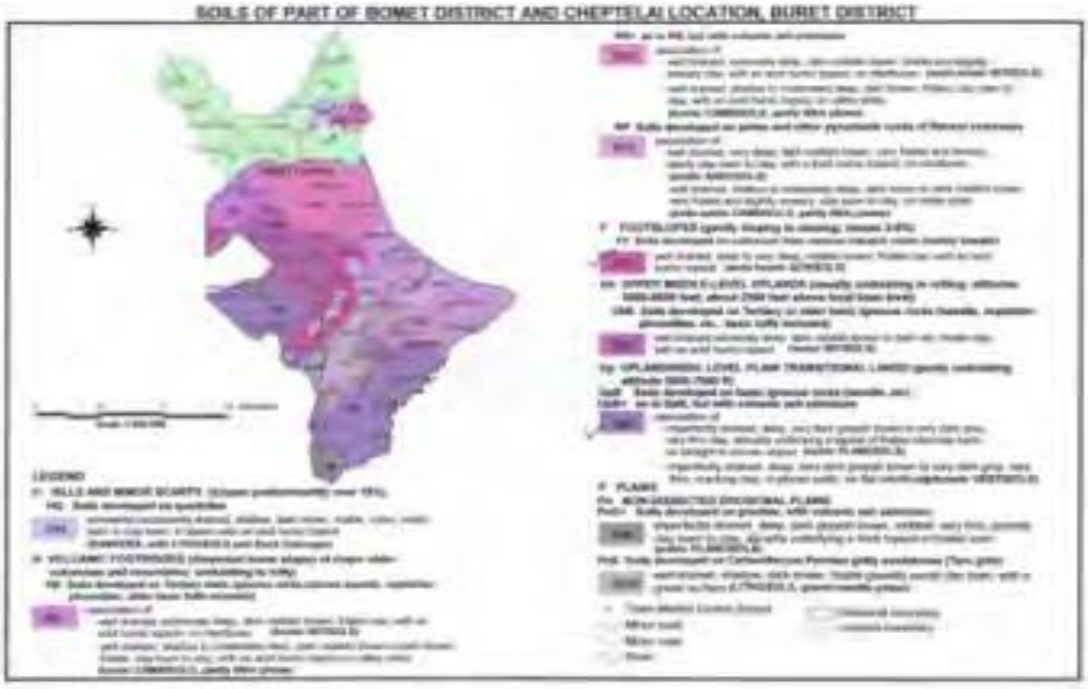

Fig. 1c. Soil types in Bomet East, Bomet County; Source Kenya Agricultural and Livestock Research Organisation (KALRO),National Agricultural Research Labolarories (NARL)

Results on soil variables in the study areas are summarized in Table 1.
There was difference ($p<0.05$) in some soil variables due to area variation (Table 1). Copper levels was higher ($p<0.05$) in Kieni than in both North Nandi and Bomet East (Table 1). Soil pH level was higher ($p<0.05$) in Keni and North Nandi than in Bomet East (Table 1).Total Nitrogen, carbon, potassium, manganese and zinc level was higher ($p<0.05$) in Bomet East than in both Kieni and North Nandi (Table 1). Results for the monthly rainfall in the study areas are summarized in Table 2, below.

Table 1. Soil composition for different areas

	Areas			
Variables	Kieni	N. Nandi	Bomet E.	Lsd
Soil pH	4.89^{a}	5.00^{a*}	4.30^{b*}	0.20
Total Nitrogen %	0.16^{b*}	0.14^{b*}	0.24^{a*}	0.02
Org. Carbon %	1.01^{b*}	0.99^{b*}	1.48^{a*}	0.18
Exch. Acidity me%	0.40^{a*}	0.40^{a*}	0.40^{a*}	0.18
Potassium me%	0.54^{b*}	0.87^{ab*}	1.19^{a*}	0.55
Calcium me%	4.46^{a*}	5.40^{a*}	4.80^{a*}	1.79
Magnesium me%	1.54^{a*}	2.47^{a*}	2.70^{a*}	2.30
Manganese me%	0.45^{b*}	0.45^{b*}	1.88^{a*}	0.17
Phosphorus ppm	16.7^{a*}	38.7^{a*}	26.0^{a*}	39.3
Copper ppm	2.87^{a*}	2.12^{b*}	1.67^{b*}	0.52
Iron ppm	70.70^{a*}	49.87^{a*}	70.70^{a*}	61.64
Zinc ppm	4.50^{b*}	0.39^{c*}	14.3^{a*}	2.81

E=East, N=North. *indicates $p < 0.1$

Table 2. Rainfall (mm) in various study areas during the months of the growing season

	Months						
Areas	Apr	May	Jun	Jul	Aug	Sep	Oct
Kieni	99.0	137.0	47.0	36.5	60.5	11.5	52.7
N. Nandi	64.1	311.2	77.6	202.0	161.1	96.2	101.4
E. Bomet	150·0	232.5	165·0	97.5	135.0	97.5	195.0

Except in the month of April, Kieni area generally had low rainfall levels compared to both North Nandi and Bomet East (Table 2). Results for establishment rate for the various sweet potato cultivars are summarized in the Table 3.

Table 3. Establishment rate (%) of the sweet potato cultivars in different areas

	Cultivars						
Area	103001	Gweri	Kemb23	Kemb36	Naspot1	Wagabolige	lsd
Kieni	83.0^{aA*}	88.0^{aA*}	66.7^{abA*}	63.7^{bA*}	80.7^{abA*}	72.7^{abA*}	23.40
N.Nandi	64.3^{abB*}	76.3^{aB*}	76.7^{aA*}	72.0^{abA*}	56.3^{bB*}	73.0^{aA*}	16.04
Bomet E.	64.0^{cB*}	74.0^{aB*}	71.0^{abA*}	71.7^{abA*}	59.7^{cB*}	72.3^{aA*}	7.98
Lsd	3.42	9.33	19.6	24.42	13.56	25.1	

E=East, N=North. *indicates $p < 0.1$

There was difference $p<0.05$ in some sweet potato establishment rate due area and cultivar (Table 3). In Kieni, cultivar 103001and Gweri had a higher $p<0.05$ establishment rate than the rest (Table 3). In North Nandi, Gweri, Kembu 23 and Wagabolige cultivars had a higher $p<0.05$ establishment rate than the rest (Table 3). In Bomet East, Gweri and Wagabolige cultivars had a higher $p<0.05$ establishment rate than the rest (Table 3). Establishment rate for cultivar 103001, Gweri and Naspot 1 was higher $p<0.05$ in Kieni than in North Nandi and Bomet East (Table 3).

DISCUSSION

In the different areas cultivar establishment ability is an important aspect as is a major factor in the determination of production potential of the plants. There was however, variation in percentage of cultivar establishment was observed in the three areas could be attributed to variation in soil composition, cultivar and rainfall. High variability in the cultivar establishment was mainly attributed to soil heterogeneity among other factors (Tewe et al, 2003). For instance, the high establishment rates of cultivar 103001 and Gweri in Kieni could have been attributed to high

levels of copper in the area which could have been utilized by the two cultivars. Plants require copper as an essential micronutrient for normal growth and development an in its absent plants develop specific deficiency symptoms, most of which affect young leaves (Yruela, 2005). Copper requirements for most plant tissues normal range is between 3-10 ppm which is close to soil levels in Kieni. In addition, high copper, Low pH and potassium level in Kieni soils could have contributed to high establishment levels for sweet potato in the area than in others. Flourishing of Gweri cultivar in the three study areas (Kieni, North Nandi and Bomet East) could have been attributed to its high fibrous ro`ot system which was vigorous in utilizing the available fertility and soil moisture (Karachi, 1990). All the areas received enough rainfall for establishments for various sweet potatoes establishment. Successful establishment could be attributed to reliable and unlimited moisture conditions (Karachi 1990). Further, an adequate moisture supply is probably essential for promoting rapid and uniform root development and good stand establishment in sweet potatoes (Belehu and Hamus, 2004).

CONCLUSION

Soil composition, cultivar and rainfall were important factors which affected the establishment rate of the various sweet potato cultivars in the Kieni, North Nandi and Bomet East.

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