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CONTRIBUTIONS OF SHOOT N, P AND K TO SWEET POTATO (*Convolvulus arvensis* L.)

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ABSTRACT

Trials were conducted during the dry seasons of 2013/2014 at the Irrigation Farm, Institute for Agricultural Research, Samaru to test the response of four varieties of Sweet potato((PR-6, TX PR, LA 07-146 and B-14) to four rates of NPK fertilizer (0, 300, 600 and 900 kg/ha), two forms of seed tuber (whole and cut-tubers). Positive and highly significant correlation (P = 0.01) was observed between tuber yield and shoot N (r = 0.47, 0.74 and 0.57), P (r = 0.51, 0.41 and 0.57) and K (r = 0.33, 0.48 and 0.47) during the dry seasons of 1998/99 and 1999/2000 and the combined of the two seasons, respectively. A strong and positive relationship (P = 0.01) was also found when shoot N, P and K contents were correlated among each other during the two seasons and the two year combined except in 1998/99 dry season when a positive though non significant correlation was observed between shoot N and shoot K (r = 0.15). The direct contributions of shoot N and P to tuber yield were generally much higher than the indirect contributions except for shoot K whose indirect contribution to tuber yield out weighed that of the direct contributions in most cases.

Keywords: potato, shoot, nitrogen, phosphorus, potassium, yield

I INTRODUCTION

Potato is a high nitrogen (N), phosphorus (P) and potassium (K)-demanding crop. Deficiency of any or combinations of these nutrients can result in retarded growth or complete crop failure under severe cases. Application of any or combination of these nutrients on soils particularly of savanna characterized as low in N and P contents and to some extent K will certainly enhance the performance of the crop. This is because an improvement of these nutrients in the soil will surely enhance their composition in the tissue, thereby improving the overall performance of the crop. Tissue analysis could be instrumental for targeting high yield using N, P and K contents, except where the tissue nutrient contents were very high. This is because tuber yield in potato had been reported to be strongly influenced by tissue N, P and K.

II MATERIALS AND METHODS

Two field trials were carried out during the dry seasons of 1998/99 and 1999/2000 at Samaru ($11^0$11'N, 07^0 38'E, 686m above the sea level). Random samples of soils to a depth of 30cm were taken prior to land preparation in each season and analysed for physico-chemical properties. The treatments consisted of combinations of No-NPK, 300, 600 and 900kg/ha of NPK (20-10-10) fertilizers and two form of seed tuber (whole and cut tubers) and four varieties of Sweet potato (Greta PR-6, TX PR, LA 07-146 and B-14). A split plot design was used in which the combination of NPK rates and form of seed tuber were main plots while the crop varieties were assigned to sub-plots; with the treatments replicated three times. The gross sub-plot size was 4.0x3.0m.

The varieties used in these experiments (PR-6, TX PR, LA 07-146 and B-14) were sourced from Sweet potato Research Programme. Tubers of 35-50g weights were separated from larger ones that weigh above 50g. The smaller weight category (35-50g) formed the whole tuber planting material. The other larger tubers were cut into two or more piece depending on size, to create pieces of equivalent weight to the whole tubers (35-50g). Each cut piece contained one or more eyes (or sprouts) depending on the size of the tuber. Tubers less than 35g were considered too small and were culled-out. Cut sets were dusted with mixture of ash and fungicide powder (45% Dithane M-45), to prevent fungal attack as recommended by Beukema and Vander Zaag, (1990). Thereafter, the cut sets were spread in an airy room to allow for healing of the wound for 3 to 4 days. The whole tubers used were also dressed with Dithane M-45 a day to planting.

Shoot samples collected at 9WAP (corresponding to the time 50% of the plant population attained flowering stage) were oven-dried. The oven dried shoots were grounded into powder respectively as per treatment using a grinder. The powder was sieved (using 2mm sieve) and later used to analyze for N, P and K content in the laboratory using one gram each of the sample. One gram of the sieved sample was digested using sulphuric acid and perchloric acid with copper and sodium sulphates acting as catalyst. (Lerner *et al*,2001)The digest was later used to determine the following. For the purpose of determining either shoot parts of the digest was used and distilled into boric acid as per treatment. Thereafter, the distillate was titrated against a standard hydrochloric acid (HCL) and the percent N content determined from the titre using macro-Kjedhal (Bremmer 1965; IITA 1975).

Phosphorus content of either shoot or tuber was determined by the triple acid (H_2SO_4-$HCLO_3$-HNO_3) wet digestion method. The phosphorus within the digest was estimated by the molybdo-phosphoric yellow colour method as described by Dirk and Myrna (1984).

Potassium was determined flame photometrically on an aliquot of the digest solution, which had been alkaline by the addition of a slight excess of dilute ammonia solution. The potassium content was thereafter determined photometrically using atomic absorption spectrophotemetry.

All the data collected were statistically analysed and where the F-values were found to be significant, the treatment means were separated using Duncan's Multiple Range Test, DMRT (Duncan, 1955). The strength of relationship between shoot N, P and K (x) and tuber yield/ha
(y) was studied using correlation coefficient analysis (Little and Hills, 1978).

$r = SP_{xy}/\sqrt{SS_x.SS_y}$ Where,

r = Coefficient of correlation
SP_{xy} = Sum of product x and y $\sum (x-x)(y-y)$
SS_x = Sum of squires of x $\sum (x- x)^2$
SS_y = Sum of squires of y $\sum (y- \tilde{y})^2$

The results of the above correlation were used to develop the following simultaneous equations to work out the path coefficients (P1-P5) (Dewey and Lu, 1959).

$$r_{14} = P_1 + r_{12}P_2 + r_{13}P_3 \quad \text{-------(1)}$$

$$r_{24} = r_{12}P_1 + P_2 + \quad \text{-------}$$

$r_{23}P_3$ ---------------------(2)

$r_{34} = r_{13}P_1 + r_{23}P_2 + P_3$ ---------------------------(3)

where P_1 - P_3 are path coefficients, while r_{12} - r_{34} are the coefficients of correlation.

The direct and indirect effects of individual and combined (two factors) contributions of shoot N, P and K composition to tuber yield/ha were determined using path-coefficient analysis. The combined contribution is estimated using the following formula:

$C_{ij} = 2P_iP_j$

Where C = combined effect of i and j, r_{ij} = coefficient between i and j (i and j are the direct and indirect contributions) (Ajala *et al.*, 1996).

The residual factor Rx that is unaccounted for by the direct and combined contributions was estimated using the following formula:

$Rx = 1 - \sqrt{(P_1 r_{14} + P_2 r_{24} + P_3 r_{34})}$

III RESULT

Tuber yield had the strongest relationship with shoot P during 1998/99 (r = 0.51**) and shoot N in 1999/2000 (r = 0.74**) and combined (r = 0.67**). Shoot K (r = 0.33** - 0.48**) generally had the weakest relationship with tuber yield. The inter-relationship that exist within shoot N, P and K were positive and highly significant throughout the sampling periods and combined except during the second season of 1998/99 when the correlation between shoot N and shoot K (r = 0.15) was positively not significant. The correlation between shoot N and P were stronger than that between shoot N and K or shoot P and K during 1998/99 (r = 0.53**) and combined (r = 0.59**). In 1999/2000 dry season the relationship between shoot N and K was the strongest (r = 0.54**). The weakest correlation within shoot N, P and K even though significantly positive was that between shoot P and K in all the years of the trials and combined

IV DISCUSSIONS

Physico-chemical properties of the fields on which the trials were conducted showed that the soil had low N (0.03 %), available P (5.29 – 5.38 ppm) and K (0.17 – 0.18 $cmol/kg^{-1}$).The low N, P and K observed in the soil confirm the report by Klinkenberg and Higgins (1970) and Enwezor *et al.* (1989) who reported that soil of the savannah are generally classified as Alfisol with low pH, organic matter content (<2%), N (0.15%) and available phosphorus (<8ppm). Therefore for enhance crop performance the nutrient status of these soil need to be augmented through fertilizer application.

The strong and positive correlation observed between tuber yield shoot N, P and K contents further emphasized the importance of these nutrients for growth and development of Sweet potato. N is a component of protein which in turn is an integral part of chlorophyll molecule and of nucleic acids that make up the chromosome and thus, very essential and important for growth and development (Harris, 1992). Phosphorus on the other hand is an essential element in plant chemical compound that are responsible for energy transfer necessary for metabolic processes within the plant. It is also a part of the nucleic acid and thus very important for seed formation and root growth as well as increase leaf in the early stages of growth, hastened the senescence of leaves thus depressing leaf are toward the end of the growing period (Harris, 1992). K acts in carbohydrate formation and the transformation and movement f starch from potato leaves to tubers. It play important role in controlling stomatal movement and water status of the plant and increase leaf area later in the season and delayed senescence of leaves (Beukema and van der Zaag, 1990, Harris, 1992; Waddell *et al.*, 1999;Khiari *et al.*, 2001).

The relationship was observed to be stronger between tuber yield and shoot N and P which further proved the general believed that potato like most crops respond more to N and P. Higher shoot N and P means greater vegetativeness and therefore more assimilate production by the green leaves that would translate into higher yield (Harris, 1992; Waddell *et al.*, 1999; Khiari *et al.*, 2001).

The strong and positive relationship among shoot N, P and K observed in this study stressed the importance of these nutrients in the growth and the development of the crop as well as the degree of interdependence that exist between these nutrients. N, P and K play a major important role in the increase in dry matter composition in plant and hence in leaf area. The weaker relationship between shoot P and K could be due to fact that the sampling and analysis of the shoot was done at the growth stage of the crops life.

The direct and indirect contributions of shoot N, P and K to tuber yield revealed that in most cases shoot N and P made greater direct contribution to tuber yield more than they indirectly made. This further stressed the importance of each in growth and development of plants. That is why even the highest indirect contribution was observed to be through either shoot N or P (Beukema and van der Zaag, 1990; Harris, 1992).

The generally higher % contribution of either shoot N or P further indicates the importance of these nutrients to growth and development Sweet potato. They play an important role in the overall growth of plants, hence higher tuber yield. This could further be seen from the higher combined % contribution to yield from these two nutrients that is more than that from shoot N + K or shoot P + K. The seasonal variations in the result obtained could be attributed to differences in weather conditions, soil inherent fertility status among other factors (Westermann and Kleinkopf 1985; Harris, 1992; Waddell *et al.*, 1999; Khiari *et al.*, 2001).

In conclusion shoot N and P contributed more to tuber yield individually and in the combined form, directly or indirectly under the condition of weather condition of Zaria.

Bibliography

Ajala B.A., Khan A.U. and Ahmed M.K. 1996. Yield analysis of sugarbeet (*Beta vulgaris* L.) grown in Jos, Plateau State, Nigeria, using correlation coefficients. *West African Journal of Biological Sciences.* 5(1): 84-91.

Beukema H.P., Vander Zaag D.E. 1990. Introduction to potato production. Pudoc, Netherlands. 208pp.

Brady, N.C. and R.R. Weil, 2002. *The Nature and Properties of Soils,* 13th edition. Prentice Hall, Upper Saddle River, New Jersey, 07458 USA

Bremmer J.M. 1965. Total Nitrogen. In C.A. Black Ed. Methods of Soil Analysis. Chemical and microbiological properties. American Society of Agronomy, Wisconsin. 2: 1149-1178.

Dewey D.P. and Lu K.K. 1959. A correlation and Path-Coefficient analysis of crested grass seed production. Agronomy Journal. 51: 515-518.

Dewey D.P. and Lu K.K. 1959. A correlation and Path-Coefficient analysis of crested grass seed production. Agronomy Journal. 51: 515-518.

Dirk A.T. and Myrna H. 1984. Soil and plant analysis. Study guide for agricultural Laboratory Directors and Technologist working in Tropical regions. IITA, Ibadan, Nigeria. pp. 155-170.

Duncan D.B. 1955. Multiple ranges and multiple F-test. Biometrics. 11: 1-42.

Enwezor W.O., Udo E.J., Usorah N.J., Ayotade K.A., Adedotu J.A., Chude V.O. and Udegbe C.I. 1989. Fertilizer use and management practice for crops in Nigeria. p. 163.

Ewell, P.T. and J. Mutuura, 2004. Sweet potato in the food systems of eastern and southern Africa. *Int. Soc. Hort. Sci. Acta Hortic.*, 380: 405–12

Harris P. 1992. The Potato Crop. The Scientific basis for improvement 2nd Ed. Chapman & Hall, London. p. 909.

Hobbs, P.R. and R.R. Bellinder, 2004. *Weed Management in LessDeveloped Countries*, pp: 1295–8. Encyclopedia of plant and crop science, Marcel Dekker, Inc

IITA. 1975. Selected methods for soil and plant analysis. Ibadan.

Khiari L., Parent L. and Tremblay N. 2001. The P compositional nutrient diagnosis for potato. Agronomy Journal. 93: 815-819.

Khiari L., Parent L. and Tremblay N. 2001. The P compositional nutrient diagnosis for potato. Agronomy Journal. 93: 815-819.

Klinkenberg K. and Higgins G.M. 1970. An outline of Northern Nigerian Soil. Samaru Bulletin, No. 107, Ahmadu Bello University, Zaria, Nigeria.

Lerner, B.R., 2001. *The Sweet Potato*. Purdue University Cooperative Extension Service, West Lafayette, In U.S.A

Little J.M. and Hills F.J. 1978. Agricultural experimentation design and analysis. John Wiley and Son Inc. New York. p. 350.

Lowe, S.B. and L.A. Wilson, 1975. Yield and yield components of six sweetpotato (Ipomoea batatas) cultivars I. Contribution of yield components to tuber yield. *Exp. Agric.*, 11: 39–48

Motes, J.E. and J.T. Criswell, 2007. *Sweet Potato Production*. Oklahoma Cooperative Extension Fact Sheet F-6022. Division of Agriculture Sciences and Natural Resources, Oklahoma State University

Okonkwo J.C., Ene. L.S.O. and Okoli O.O. 1995. Potato production in Nigeria. National Root Crops Research Institute, Umudike Umuahia, Abia State, Nigeria. p. 109.

Ossom, E.M., M.H. Nxumalo and F.M. Badejo, 2004. *Evaluating Different Traditional Storage Methods on the Shelf Life of Sweet PotatoTubers in Swaziland*, p: 59. Final Report submitted to UNISWA Research Board, September 2004

Waddell J.T., Gupta C., Moncrief J.F., Rosen C.J. and Steele D.D. 1999. Irrigation and N management effect on potato yield, tuber quality and N uptake. Agronomy Journal. 91: 991-997.

Waddell J.T., Gupta C., Moncrief J.F., Rosen C.J. and Steele D.D. 1999. Irrigation and N management effect on potato yield, tuber quality and N uptake. Agronomy Journal. 91: 991-997.

Westermann D.T. and Kleinkopf G.E. 1985. Nitrogen requirements of potatoes. Agronomy Journal. 77: 616-621.

