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Response of a Traditional Sweetpotato (*Ipomoea batatas [L.]*) Variety to Fertilization in Leyte, Philippines

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Introduction

Sweetpotato (*Ipomoea batatas* [L.]) is among the major root crops in the tropics playing supplementary role to cassava and maize which has the potential to alleviate problems on malnutrition and food insecurity (FAO, 2010). It provides livelihood and food security among the poorest vulnerable households and food insecure people living and farming in fragile upland environments comprising 65% of the agricultural lands in the Philippines (Roa, 2007). Under favorable conditions, the vines grow quickly serving as a good cover crop helping eliminate weeds and minimize soil erosion (Lebot, 2009). It can also withstand strong winds making it a climate-resilient crop ideal for the typhoon-prone areas in the Philippines such as Bicol, Leyte and Samar islands among others. This was proven when the super typhoon Haiyan hit central Philippines in 2013. Until now, little research has been done on the traditional varieties of sweetpotato in the Philippines particularly in terms of soil fertility management and mineral nutrition. Thus, this study was carried out to evaluate the response of a traditional sweetpotato variety to NPK fertilization. This is the first scientific investigation on this traditional sweetpotato variety.

Material and Methods

The experiment was conducted in Leyte Philippines at 5-10 m ASL elevation, with 2,800 mm annual rainfall and 25-29^{o}C air temperature range. The soil was a sandy loam and well-drained Inceptisol (Cambisol) developed from alluvial sediments of volcanic origin (basalt and andesite rocks). The soil had a pH of 5.8, 3.4 % organic matter (low), 0.21% total N (sufficient), 19 mg kg^{-1} available P (high) and 0.94 cmol$_{c}$ kg^{-1} exchangeable K (high). Separate N, P and K experiments were laid out in RCBD with 3 replications. N had 7 levels 0, 40, 80, 120, 160, 200, 240 kg ha^{-1}, 6 P levels 0, 20, 40, 60, 80, 120 kg P_2O_5 ha^{-1} and 9 K levels 0, 30, 60, 90, 120, 160, 200, 240, 280 kg K_2O ha^{-1}. Plots measured 18 m^{2} (3 m x 6 m) and treatments were based on recommended fertilizer rate 40-40-60 kg ha^{-1} N, P_2O_5, and K_2O. Blanket applications (i.e. all plots) of 40 and 60 kg ha^{-1} P_2O_5 and K_2O, respectively, was done for the N experiment; 40 and 60 kg ha^{-1} N and K_2O for the P experiment; and 40 and 40 kg ha^{-1} N and P_2O_5 for the K experiment. A popular traditional sweetpotato variety (var. *Siete Flores*) was used. Agronomic and yield parameters were gathered although this paper reports only the data on fresh herbage yield, total root yield and harvest index. Plant samples were collected and analyzed for crude protein, total carbohydrates, crude fiber and nutrient analyses. Optimum fertilizer rate was computed following the method of

Neeteson and Wadman (1987). The nutritional quality of sweetpotato leaves and roots were assessed by measuring crude protein, total carbohydrates, and crude fiber contents.

Results and Discussion

Fresh Herbage, Root Yield and Harvest Index

The traditional variety matured only after six months (modern high yielding varieties can be harvested after only three to four months). Rooting behavior appeared to be staggered and slow resulting in highly variable sizes of the roots at harvest which seemed to favor the traditional harvesting practice of small-scale farmers (Cabanilla, 1996; FAO, 2010): they harvest roots only when they need food or cash, thus, harvesting is not done at one time but several times over several months. Table 1 shows that application of different rates of N significantly influenced the fresh herbage and total root yields but not the harvest index. Application of 120 to 160 kg ha^{-1} N produced the highest herbage yield (t ha^{-1}), probably because N has a strong influence on the production of herbage (vines and leaves) than storage roots (Lebot, 2009). Hartemink (2003) also revealed that N application encourages more vine growth than storage root development.

Table 1. Fresh herbage yield, total root yield and harvest index of the traditional sweetpotato variety as affected by nitrogen fertilization

Nitrogen Levels (kg ha^{-1})	Fresh Herbage Yield (t ha^{-1})	Total Root Yield (t ha^{-1})	Harvest Index
T1 - 0	34.25*c*	5.39*b*	0.14*ab*
T2 - 40	39.22*b*	9.51*ab*	0.19*a*
T3 - 80	56.20*ab*	14.03*a*	0.21*a*
T4 -120	67.31*a*	14.41*a*	0.18*a*
T5 -160	62.38*ab*	15.31*a*	0.20*a*
T6 -200	52.71*ab*	8.72*ab*	0.15*ab*
T7 -240	45.34*b*	4.79*b*	0.10*b*
cv (%)	25.80	23.17	14.18

Values within each column followed by common letter(s) are not significantly different at 5% level; HSD test of significance

Harvest index varied between 0.11 to 0.85 when harvested during 12 to 24 weeks (Ravi and Saravanan, 2012). In this study, harvest index varied from 0.10 to 0.20, clearly showing low yielding nature of the sweetpotato variety used.

Table 2 shows that application of 20 to 40 kg ha^{-1} P_2O_5 produced the highest fresh herbage and root yields of the traditional sweetpotato. No treatment effect was however observed on the harvest index. Interestingly, the highest P_2O_5 application (100 kg ha^{-1}) was comparable to the treatment without P_2O_5 application because of the decline in root yield at high P application rates suggesting the effect of another limiting nutrient which was identified as N.

Table 2. Fresh herbage yield, total root yield and harvest index of the traditional sweetpotato variety as affected by phosphorus fertilization

Phosphorus Levels kg ha^{-1}	Fresh Herbage Yield (t ha^{-1})	Total Root Yield (t ha^{-1})	Harvest Index
T1 - 0	37.63*b*	6.02*c*	0.14
T2 - 20	57.93*a*	12.25*a*	0.18
T3 - 40	56.24*a*	9.68*b*	0.15

T4 - 60	39.38*ab*	7.19*c*	0.16
T5 - 80	40.77*ab*	7.73*c*	0.17
T6 - 100	43.58*ab*	6.45*c*	0.13
cv (%)	14.38	7.43	16.25

Values within each column followed by common letter(s) are not significantly different at 5% level; HSD test of significance

Table 3 presents the results of the K fertilization experiment. It shows that the application of K_2O significantly increased the fresh herbage yield of sweetpotato relative to the control. Moreover, the application of 90 kg ha^{-1} K_2O or higher increased the root yield of the crop. The higher rates of application were not significantly different from each other in terms of herbage and root yield suggesting luxury consumption for this nutrient. It is widely known that sweetpotato responds to K application (Lebot, 2009). According to several authors, K is most important nutrient in sweetpotato production (Lebot, 2009; Hartemink, 2003).

Table 3. Fresh herbage yield, total root yield and harvest index of the traditional sweetpotato variety as affected by potassium fertilization

Potassium Level	Fresh Yield Herbage (t ha^{-1})	Total Root Yield (t ha^{-1})	Harvest Index
T1 - 0	32.99*c*	8.52*c*	0.21
T2 - 30	48.07*ab*	9.33*bc*	0.16
T3 - 60	47.48*ab*	8.31*c*	0.15
T4 - 90	53.03*ab*	10.67*ab*	0.17
T5 -120	66.41*a*	12.26*ab*	0.16
T6 -160	63.85*a*	10.90*ab*	0.15
T7 -200	58.25*ab*	10.81*ab*	0.16
T8 -240	64.32*a*	14.29*a*	0.18
T9 -280	57.14*ab*	11.99*ab*	0.18
cv (%)	13.54	10.49	15.48

Values within each column followed by common letter(s) are not significantly different at 5% level; HSD test of significance

Using the Mitscherlich-Bray equation (Sonar and Babhulkar, 2002), the study found that 30% of the maximum yield of the crop was supplied by the inherent soil N, 50% by the inherent soil P and 60% by the inherent soil K. This clearly indicate the important contribution of the inherent soil fertility on the yield of the crop.

Nutritional Quality of Sweetpotato

Results indicated that total crude protein yield of roots at harvest increased with increasing rates of N application as was found by Purcell et al. (1987). No significant differences in starch and sugar contents were found as function of N application. P and K fertilization did not cause differences in the crude protein, sugar and starch contents of roots. Sweetpotato is being promoted as a health food. An important constituent of sweetpotato roots which has vital health effects is crude fiber. Analysis of samples collected from the three experiments conducted revealed average value of 20 percent. There were no significant variations in values as influenced by NPK application.

Optimum NPK Fertilization Rates

In this experiment, the optimum fertilizer rates were calculated following the method of Neeteson and Wadman (1987) who pointed out that the optimum rate is reached when the rate of change in yield per change in fertilizer amount is equal to the ratio of the cost of 1 kg fertilizer to the price of 1-ton tuber.

Results revealed that the optimum fertilizer rate for N is 118 kg ha^{-1}. This is close to the rate (120 kg ha^{-1}) which produced the highest root yield but much higher than the blanket recommendation of 40 kg N ha^{-1} recommended for sweetpotato in the Philippines. The optimum fertilizer rate for P_2O_5 was noted to be 38 kg ha^{-1}. This is very close to the rate of P_2O_5 application (40 kg ha^{-1}) which produced the highest sweetpotato root yield. It also agrees very well with the recommended application rate for sweetpotato which is 40 kg ha^{-1}Unlike for N and P_2O_5, the optimum rate for K_2O could not be determined using the equation of Neeteson and Wadman (1987). From the response curve, the root yield increased with increasing rates of K. Contrary to N & P application, there was no decline suggesting luxury consumption of K. Luxury consumption occurs when the nutrient levels are above the optimum; plants take more and more nutrients than needed. Because of this phenomenon which is commonly observed for K, the calculated optimum K_2O rate is 315 kg ha^{-1} which is very high and is not logical. From the response curve, the optimum rate appears to be 90 kg ha^{-1} capable of producing about 10 t ha^{-1} root yield which is 70 percent of the maximum yield.

Conclusions

Application of different rates of N, P_2O_5 and K_2O significantly increased the fresh herbage and total root yield but not the harvest index. The study found that 30% of the maximum yield of the crop was supplied by the inherent soil N, 50% by the inherent soil P and 60% by the inherent soil K. It proved that inherent soil fertility considerably affects the yield of sweetpotato thus, use of blanket fertilizer recommendations as is currently practiced in the Philippines, could result in either under or over fertilization. Optimum rates of NPK application for the soil used were: 118, 38, 90 kg ha^{-1} of N, P_2O_5 and K_2O. NPK fertilization did not significantly influence the nutritional quality of sweetpotato (crude protein, total carbohydrates and crude fiber). Average crude fiber was 20% indicating that this variety can be promoted as a health food.

References

Cabanilla, L. S. 1996. Sweetpotato in the Philippines: Production, processing and future prospects. International Potato Center, Lima, Peru.

FAO. 2010. Food and Agriculture Organization of the United Nations, Rome.

Hartemink, A. E. 2003. Outlook on Agriculture *32*(3):173–182.

Lebot, V. 2009. Tropical root and tuber crops: cassava, sweet potato, yams and aroids. CAB books, CABI, Wallingford, UK.

Neeteson J.J. and W.P. Wadman. 1987. Fertilizer Research 12: 37-52.

Purcell, A. E., W. M. Walter, J. J. Nicholaides, W. W. Collins and H. Chancy. 1982. J. Amer. Soc. Hort. Sci. 107(3):425-427.

Ravi, V. and R. Saravanan. 2012. Fruit, Vegetable and Cereal Science & Biotech 6: 17-29.

Roa, J.R. 2007. Dissertation. Wageningen.

Sonar, K. R and V. P. Babhulkar. 2002. Communications in Soil Science and Plant Analysis, 33:15-18, 3241-3249