NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 50 Number 2, December 2019. Pp.153-156
Available online at: http://www.ajol.info/index.php/naj

YIELD RESPONSE OF LIVINGSTONE POTATO *(Plenthrantus esculentus)* TO DIFFERENT LEVELS OF POTASSIUM AND POULTRY MANURE IN SOUTH-EAST NIGERIA

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ABSTRACT
Two years field experiments factorised in a 2×2×4 randomised complete block design were conducted in 2012 and 2013 cropping seasons in South-East Nigeria to investigate the yield response of rizga (Livingstone potato) to different rates of potassium (K) and poultry manure (PM). The soil was acidic, with well drained sandy top soil. Land preparation consists of clearing, disc ploughing, harrowing and ridging. The field was marked out into various plots of 3mx4m (12m²) with planting space of 0.3m x 1m. Planting was done on the crest of the ridges. Treatments consist of 0, 20, 40 and 60kg of K and 0, 5, 10 and15 tonnes of PM per hectare including one variety of Rizga (Longart). The experiment was replicated three times. The result showed that K and PM rates significantly affected the yield components at 8 weeks after planting (WAP). It was also observed that among all the rates, 20kg K when combined with 5t/ha of PM gave the highest mean yield in both years and was therefore recommended for optimum production of Rizga.

Keywords: Yield, Livingstone potatoes, potassium and Poultry manure

Introduction

Rizga is one of the neglected and non utilised crop species in Nigeria that has received some research attention in National Root crop Research Institute Umudike. It is a dicot perennial herb and a member of the *lamiaceae* family. It is indigenous to Africa where it is grown for its nutritious edible tubers, often a substitute for potatoes. The leaves contain a lot of vitamins and can help in digestive problems and abdominal pain (Alleman and Coertze, 1997). It is also an aromatic herb that affects contraction, blood clotting and the treatment of respiratory problems. Considering the nutritional and medicinal values of this crop, improvement in productivity of this crop has not been properly addressed. There is therefore need to explore the productivity and yield of Rizga using inorganic and organic fertilizers.

The effect of organic manure on crop performance and soil attributes varies and is dependent on type of organic materials, crop, soils and the application rates used (Sobulo and Osiname, 1986). Potassium (K) fertilization is an important practice in improving growth and yield of crops. K has been shown to function in root tuberization and other physiological growth in plants. Integrated Nutrient Management (INM) is an approach in soil fertility management that combines organic and mineral method of soil fertilization, probably because manure is not a balanced fertilizer indicating that some plant nutrient needs may be under or over supplied. Any nutrient that is under supplied by manure application cost would in effect reduce yield. Any nutrient that is over supplied by manure application would not have immediate value because it was not needed by the crop. There is need therefore to cite specific agronomic and socio-economic circumstances to redress nutrient in-balances and deterioration more effectively (Akparobi *et al*, 2006). A combination of low chemical input K fertilizer and organic manure (PM) may be a cost-effective economic strategy for rizga production. The objective of this study is therefore to determine the optimum levels of potassium and poultry manure suitable for rizga production.

Materials and Methods

The trial was conducted at the research farm of the National Root Crops Research Institute Umudike, Nigeria during the 2012 and 2013 cropping seasons. The annual rainfall average was 2162.7mm, while the relative humidity, minimum and maximum temperatures ranged from 58-8%, 20-23ºC and 28-33ºC respectively. The soil was acidic, with well drained sandy top soil. Land preparation consists of clearing, disc ploughing, harrowing and ridging. The treatments include a 2x4x4 factorial in RCBD with 3 replications involving combinations of poultry

manure and potassium at different levels and livingstone potato or rizga (longart variety). The field was marked out into various plots of 3mx4m (12m²) with planting space of 0.3m x 1m. Planting was done at the crest of the ridges. Treatments were applied at 4WAP. Weeding was done at 4 and 8 WAP. Collection of data based on yield and yield components were carried out. All data were statistically analysed using GENSTAT as outlined by Gomez and Gomez (1994) and treatment means separated using least significant difference.

Results and Discussion

Growth and Development

Establishment stand count did not record significant ($p>0.05$) difference in both years (Table1). The treatment combinations did not significantly ($p>0.05$) affect the plant height at 4WAP, but there was an increase in height at 8WAP with a combination of 20K+10PM, 60K+10PM and 60K+15PM in both years. Number of branches increased significantly at 60K+15PM in 2012 and 20K+10PM in 2013 at 8WAP. There was no significant difference (Table 2) on the leaf area and the leaf area index which increased progressively as growth proceeds to maturity in both years. Although 44% and 42% increase in leaf area index for 8 WAP were observed in 2012 and 2013 respectively. Treatment combination of 40K+15PM at 8WAP gave the highest number of leaves (98.10%) in 2012, while in 2013, 20K+10PM gave the highest number of leaves (94.32%) over the control.

Yield and Production

In 2012 and 2013, the highest mean tuber numbers were obtained with the treatment combination of 40kgK+5tPM (45.26). The mean yield gave values of less than 1t/ha hectare in the control and the treatment combinations of 20K+0PM, 60K+0PM, 0K+5PM, 40K+10PM and 0K+10PM while other treatments gave high values of more than 1t/ha. Combinations of 40+0PM and 0K+15PM were able to attain a higher tonne per hectare despite the absence of the complimentary fertilizer supplement, giving 12.6% and 46.4% over the control respectively. However, combination of 20KgK and 5tonnes of PM with up to a tonne per hectare was 78% greater than the control, whereas, the highest mean yield in tonnes/ha was achieved with combinations of 60kgK and 5tonnes per hectare of poultry manure which was 88% greater than the control.

Growth parameters which were observed to increase as growth increased were as a result of increase in physiological metabolism of the plant, This might be due to addition of fertilizer sources as nutrient to plants, indicating that higher application of K and PM contributed immensely to the growth of this crop. The increase in number of leaves, number of branches, leaf area and plant height led to an increase in leaf area index (LAI) as K and PM increased. This is in agreement with the findings of Adeboye *et al* (1985), who noted that increase in K and PM could result to an increase in LAI which is a determinant of high root yield. Rajput, *et al (*2012) studied growth parameters in relation to yield, and also emphasised that functional leaves and leaf area index are the main growth factors which may directly affect crop yield. The higher yield obtained in 40K+0PM and 0K+15PM could have resulted due to a higher K which had a significant role in physiological process in plant growth. Treatment combination of 0K+15PM that gave a higher yield might be due to a higher level of PM that lead to the build-up of organic matter which has a function in modification and improvement of soil structure. The low yield obtained in the control indicated that the combination of the two (PM and K) could result to a better tuber yield. Ironically, the mean tuber yield of both years obtained in the absence of PM revealed that only K can function in root tuberization with the agronomic and inherent efficiency of the soil status (Kwari, 2004)

Conclusion

The combination of potassium and poultry manure increased effectively the yield of livingstone potato with the combination of 20kgK and 5t/ha of poultry manure. This combination gave 78% higher yield than the control which is not significantly different with the highest yield of 88% above the control obtained in 60k+5PM. This combination improved yield in livingstone potato production. In relation to the economic perception and consideration, 20kgK and 5t/ha of poultry manure is therefore recommended for optimum production of livingstone potato in South East, Nigeria.

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Table 1: Rate of Potassium (K) and Poultry Manure (PM) on the Establishment, Stand Count and Yield Component of Rizga

	Establishment std count				Plant height (cm)				No of branches			
	2012		2013		2012		2013		2012		2013	
Treatments	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**
0	10.8	21.40	9.22	16.01	30.19	48.81	23.11	48.81	13.10	16.30	7.02	12.00
20+0pm	9.40	24.81	8.06	15.20	32.18	52.31	28.32	52.30	17.50	21.50	16.50	24.08
40+0pm	6.40	25.23	12.11	20.11	35.25	50.41	26.41	50.41	18.30	24.81	12.11	23.08
60k+0pm	12.00	27.08	8.04	16.22	36.23	53.23	38.38	53.23	12.33	19.20	4.23	9.00
0k+5pm	8.01	24.33	24.21	28.00	42.05	54.11	35.22	54.11	14.14	18.40	9.41	16.02
0k+10pm	12.45	21.28	15.16	27.11	48.81	52.01	36.01	52.11	12.00	18.11	10.21	19.40
0k+15pm	8.23	25.50	12.10	22.00	48.00	51.34	42.30	51.34	13.41	17.81	12.06	27.01
20k+5pm	12.14	23.14	17.01	25.11	43.28	53.12	40.00	53.17	16.11	21.10	7.19	19.08
20k+10pm	10.11	27.10	19.23	28.00	45.16	61.27	44.02	51.27	13.13	17.90	12.01	28.01
20k+15pm	10.28	28.10	13.01	23.22	42.15	4.005	45.02	54.00	19.60	14.80	10.00	23.12
40k+5pm	13.05	27.00	17.34	28.11	38.21	51.02	32.11	51.02	25.00	29.30	12.17	20.31
40k+10pm	14.31	27.80	15.00	28.10	39.14	55.00	38.01	55.01	12.90	16.10	9.22	23.51
40k+15pm	12.04	21.31	12.03	24.11	43.02	58.01	32.41	58.01	10.30	24.00	12.03	27.11
60k+5pm	8.01	26.03	17.01	25.33	48.33	55.31	43.01	55.31	12.40	17.10	12.23	26.08
60k+10pm	12.14	24.33	12.08	22.11	49.22	61.30	43.20	61.30	18.40	23.80	11.11	23.71
60k+15pm	10.10	28.04	14.30	25.00	44.41	70.10	45.21	70.10	20.30	30.50	10.01	27.11
LSD	NS	NS	NS	NS	NS	3.12	NS	5.01	NS	2.25	NS	1.40

Table 2: Effects of potassium and poultry manure (pm) levels on the yield components of livingstone potato

	Leaf Area (cm2)				Leaf area index				No of leaves			
	2012		2013		2012		2013		2012		2013	
Treatment	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**	**4wap**	**8wap**
0 control	12.30	21.30	8.00	8.05	4.10	7.10	2.70	6.01	38.23	58.01	25.11	48.21
20k+0pm	14.40	23.21	9.15	22.30	4.80	7.23	3.05	7.43	37.10	69.20	29.13	57.10
40k+0pm	14.15	24.56	9.20	18.11	4.70	8.19	3.06	6.03	33.10	50.31	31.02	57.20
60k+0pm	11.13	21.33	8.05	18.31	3.71	7.11	2.68	6.10	37.18	55.09	29.01	58.10
0k+5pm	13.16	23.1	11.30	19.10	4.05	7.87	3.76	6.36	35.16	63.19	31.02	63.02
0k+10pm	10.13	25.31	8.33	21.00	3.38	8.43	2.77	7.00	42.10	88.01	28.01	67.11
0k+15pm	11.13	23.29	10.30	23.14	3.71	7.76	3.43	7.71	53.11	72.33	29.11	59.00
20k+5pm	12.21	27.31	9.25	18.50	4.07	9.10	3.08	6.16	69.30	80.11	30.12	62.31
20k+10pm	14.00	28.14	11.33	24.61	4.67	9.38	3.77	8.20	90.10	103.30	70.15	94.32
20k+15pm	12.15	28.13	8.41	22.33	4.05	9.37	2.80	7.44	88.53	109.11	55.06	88.11
40k+5pm	13.00	27.31	12.80	24.01	4.33	9.10	4.36	8.00	79.22	115.10	39.10	67.11
40k+10pm	13.33	27.01	13.00	24.11	4.44	9.00	4.33	8.03	78.33	99.10	48.00	88.31
40k+15pm	14.03	29.13	12.11	25.06	4.80	9.71	4.03	8.35	98.10	125.00	50.00	90.11
60k+5pm	12.12	24.01	13.14	24.31	4.04	8.00	4.38	8.10	63.51	90.55	55.11	88.30
60k+10pm	13.00	29.10	12.12	25.33	4.33	9.70	4.04	8.44	72.01	103.30	52.11	72.11
60k+15pm	14.01	30.33	13.30	26.1	4.67	10.11	4.43	8.62	78.39	110.11	60.02	83.09
LSD	NS	NS	NS	NS	NS	NS	NS	NS	2.10	2.04	1.13	2.14

Table 3: Effects of potassium and poultry manure in the Yield of Rizga in 2012 and 2013 cropping season

	Total tuber no/plt			Total tuber yield		
Treatment	**2012**	**2013**	**Mean**	**2012**	**2013**	**Mean**
Control 0	24.07	30.85	27.45	0.80	1.06	0.93
20k+0pm	22.46	30.47	26.47	0.63	1.01	0.82
40k+0pm	31.61	30.30	30.96	0.79	1.60	1.99
60k+0pm	31.44	34.37	32.91	0.58	1.36	0.97
0k+5pm	18.51	19.45	18.98	0.90	0.43	0.66
0k+10pm	25.42	22.46	26.15	0.33	0.77	0.55
0k+15pm	25.82	26.48	26.15	1.61	1.72	1.66
20k+5pm	23.50	32.85	28.02	1.14	0.95	1.05
0k+10pm	21.33	58.64	39.99	1.10	2.42	1.61
20k+15pm	21.03	44.32	32.75	1.80	1.67	1.38
40k+5pm	46.03	44.49	45.26	1.30	1.16	1.48
40k+10pm	23.60	28.70	26.15	1.33	0.13	0.88
40k+15pm	23.33	50.99	37.16	1.03	1.64	1.49
60k+5pm	18.27	36.59	27.38	1.33	0.74	1.88
60k+10pm	23.60	49.45	36.53	1.13	1.73	1.43
60k+15pm	21.43	57.70	38.07	1.06	1.71	1.39
LSD	2.58	1.22		0.15	0.90	