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PERFORMANCE OF SORGHUM UNDER LOW SOIL FERTILITY AND MOISTURE IN NORTH EASTERN UGANDA

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ABSTRACT

Many studies have been conducted on the yield performance of improved and local sorghum varieties under good management, however, little is known about the yield of these varieties under low soil fertility and moisture. This study therefore presents results of yield performance of improved and local sorghum varieties in North Eastern Uganda conducted between 2014 and 2015. It aimed at comparing yield performance of improved sorghum varieties with that of local cultivars under low soil nutrients and moisture. Data were collected mainly using the semi-structured questionnaires and experiments. The survey results show that 53.3% of the households perceived sorghum yields to have been decreasing while the (46.7%) perceived sorghum yields as either constant or increasing. Analysis of student t-test on sorghum yield shows that there was significant effect ($p \leq 0.05$) between yield of improved and local sorghum varieties. The yield performance of local sorghum varieties (Karieng =1092 kg/ha and Kabir = 1018 kg/ha) were higher that of improved sorghum varieties. Analysis of studentt-test on soil nutrient content and soil moisture before setting up experiment also show that there was only significant effect on sand particle while the rest of other nutrients did not show any effect in the Nabuin, Matany,Iriiri,Gweri and Tubur experimental sites. It can be concluded that the notion of higher yield in the improved sorghum varieties is not generally applicable..

Keywords: yield, improved, local, varieties, cultivars extension

Introduction

Sorghum, (sorghum bicolor L. Moench) is the world fifth major cereal in terms of production and acreage. It is a staple food crop for million of the poorest and most food insecure people in the semi-arid and tropics of Africa, Asia and Central America. The crop is genetically suited to hot and dry agro-ecologies where it is difficult to grow other food grain.

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The challenge of agricultural sustainability especially sorghum production, however, has been more intense in recent years with sharp rise in the cost of food and energy, climate change, water scarcity , degradation of ecosystem services and biodiversity, and financial crisis(Kassam*et al*., 2009). The expected increase in population and associated demand for food, water and other agricultural products will even result into additional pressure (Kassam*et al*., 2009).

In recent decades, the development communities including politicians, policy makers, institutional leaders, scientists and extension workers have been highlighting the need for development of sustainable agricultural systems (Kassam *et al*., 2009). This was attributed to low crop yield as a result of low soil fertility, drought, weed infestation, use of cultivars with low yield potential and socio-economic factors (Bucheyeki *et al*., 2010).In response to this, action on developing improved crop varieties for instance, in term of short maturing, water efficiency among others were taken into consideration through conventional breeding.

Improved sorghum cultivars such as Seso 3B, Sekedo, Epurpur and Serena have been developed by National Semi Arid Research Resource Institute in Uganda. The yield of these improved sorghum varieties are often reported to be higher than that of local cultivars under good management (Ebiyau*et al*., 2005).

Although the yield of these sorghum varieties under good management, including high soil nutrients is well documented, studies on comparing yield performance of improved sorghum varieties with that of local cultivars in low soil fertility and moistureis scanty. To bridge this gap in knowledge, it was necessary to conduct a study on comparing yield performance of improved sorghum varieties with that of local cultivars in North Eastern Uganda. This will contribute to on-going debate that improved sorghum varieties perform better than that of the local cultivars.

1. Materials and Methods

The study was conducted in Iriiri, Matany Sub-counties in Napak District and Gweri, Tubur Sub-counties in Soroti District and on-station at Nabuin, North Eastern Uganda.Data were collected mainly using two methods namely; semi- structured questionnaires,on-station and on-farm experiments. A total of 364 households from four sub-counties (Iriiri,Matany,Gweri and Tubur) were chosen from the household survey based on Krejcie and Morgan method (Krejcie and Morgan, 1970). This was to find out the sorghum varieties and trendsof theiryield in the last five years as well as the limiting and favorable factors for such trends.

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After a survey was conducted, a total of 80 sorghum plots measuring 100m by 45m were then established taking into consideration 10 varieties (Sekedo,Ededea,Seso3B,Epurpur,Gadam,Ekirkir,Enyang,Kabir,Karieng and Serena) replicated twice in the 4 sub-counties using a randomized complete block design. This was to determine the actual sorghum yield ofthe improved and local varieties considering low soil nutrients and moisture as the main factors limiting sorghum yield.

Prior to this, 80 soil samples were collected from the 80 sorghum plots.Soil physical and chemical analysis following standard methods described by Okalebo *et al.* (2002) were done to find out the initial soil nutrient content Soil pH, Organic Matter (OM), Nitrogen (N), Phosphorus(P), Sodium (Na), Magnesium (Mg), Calcium (Ca), Sand, Clay and Silt particles and soil moisture at the Department of Agricultural Sciences, College of Agricultural and Environmental Sciences, Makerere University.

Soil pH was measured in a soil water solution ratio of 1:2.5; Organic matter by potassium dichromate wet acid oxidation method; total N determined by Kjeldhal digestion; Extractable P by Bray P1 method; exchangeable bases from an ammonium acetate extract by flame photometry (K^+, Na^+) and atomic absorption spectrophotometer (Ca^{2+}, Mg^{2+}); and particle size distribution (texture) using the Bouyoucos (hydrometer) method.

2.1 Measurements

Depending on the maturity of these sorghum varieties, the heads ready from plots were harvested by the participation of farmers. The heads were then dried under sunlight for a period of 7 days and then after threshed. Only seeds of the sorghum varieties were then bagged separately and weighed.

2.2Statistical Data Analysis

The farming systems approach to development and appropriate technology was used to calculate the sorghum yield (Norman, 1995).Thus, the sorghum yield were calculated from the following;

Sy (Kg/ha) = ((Py (kg)) x (10,000/ Ps (m^2))…… (1)

Where, Sy: Sorghum yield (Kg/ha), Py; Plot yield (Kg), Ps; Plot size (m^2)

The experiment was analyzed by general linear models with the sorghum yield being the main factor using Microsoft Excel 2010 and Statistical Package for Social Scientists 16.0.

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T-test; two-sample assuming unequal variance was used to test if the yield varies between improved and local sorghum varieties. The p- value was used to detect the significance of the yield of the sorghum varieties.

3. Results and Discussions

The survey results show that there was general decline in the sorghum production in the last five years in Soroti and Napak District. Overall, 53.3% of the households perceived sorghum yields to have been decreasing while the (46.7%) perceived sorghum yields as either constant or increasing (Table 1).

Table 1: The trends of sorghum yield in the last five years (n=97)

Variety	**Increasing**		**Decreasing**		**Constant**	
	f	**%**	**f**	**%**	**f**	**%**
Sekedo	11	12.4	24	12.6	9	11.5
Ededea	29	32.5	48	25.1	16	20.5
Seso 3B	3	3.4	5	2.6	2	2.6
Epurpur	22	24.7	32	16.7	14	17.9
Gadam	9	10.1	5	2.6	6	7.7
Ekirkir	3	3.4	8	4.2	1	1.3
Enyang	6	6.7	25	13.1	8	10.3
Kabir	2	2.2	20	10.5	13	16.7
Karieng	4	4.5	17	8.9	5	6.4
Serena	0	0	7	3.7	4	5.1
Total	89		191		78	
Mean		**24.9%**		**53.3%**		**21.8%**

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This suggest that there has been poor management associated with majorly declining soil fertility (49%) and drought (45.8%) (Table 2). This is in agreement with a study by Bucheyeki *et al*., (2010) that the low average sorghum yields can be attributed to low soil fertility, bird feeding damage, striga, weed infestation, use of low cultivars with low yield potentials, and socio-economic factors.

Table 2: Reasons for the perceived trends (n=96)

Reason	**f**	**%**
Declining soil fertility	47	49.0
Increasing soil fertility	19	19.8
Pest and disease incidence	9	9.4
Drought	44	45.8
Availability of improved variety	13	13.5
Sufficient rains	16	16.7
Insufficient rains	7	7.3
Resistant to striga weeds	1	1
Lack of good improved variety	1	1

Analysis of t-test on sorghum yield show that there was no significant effect ($p \leq 0.05$) between improved and local varieties (Table 3).The yield performance of local sorghum varieties (Karieng =1092 kg/ha and Kabir = 1018 kg/ha) were higher that of improved sorghum varieties (Table 3).This supports a study by (Bucheyeki *et al*., 2010) that local sorghum varieties are well adapted to local stresses and under such conditions can they can produce higher yield than improved sorghum varieties.

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Table 3: Comparison of mean yield of improved and local sorghum varieties under low soil nutrients and soil moisture

Soi	Soi wt	Sol	Sol wt	y	y2
Sekedo	617	Ededea	733	116	13456
Sekedo	617	Gadam	892	275	75625
Sekedo	617	Ekirkir	667	50	2500
Sekedo	617	Enyang	874	2257	66049
Sekedo	617	Kabir	1018	401	160801
Sekedo	617	Karieng	1092	475	25625
Epurpur	801	Ededea	733	-68	4624
Epurpur	801	Gadam	892	91	8281
Epurpur	801	Ekirkir	667	-134	17956
Epurpur	801	Enyang	874	73	5329
Epurpur	801	Kabir	1018	217	47089
Epurpur	801	Karieng	1092	291	84681
Seso3B	466	Ededea	733	267	71289
Seso3B	466	Gadam	892	426	181476
Seso3B	466	Ekirkir	667	201	40401
Seso3B	466	Enyang	874	408	166464
Seso3B	466	Kabir	1018	552	304704
Seso3B	466	Karieng	1092	626	391876
Serena	720	Ededea	733	13	169
Serena	720	Gadam	892	172	29584
Serena	720	Ekirkir	667	-53	2809
Serena	720	Enyang	874	154	23716
Serena	720	Kabir	1018	298	88804
Serena	720	Karieng	1092	372	138384

Mean weights were statistically significant , ($p \leq 0.05$,student t-test), p=0.00000936

soi wt: mean yield of improved sorghum varieties
sol:local sorghum varieties
sol wt: mean yield of local sorghum varieties
y:difference between mean yield of improved sorghum varieties and yield of local sorghum varieties

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y: difference between mean yield of improved sorghum varieties and that of local sorghum varieties

Analysis of student t-test on soil nutrient content and soil moisture before setting up experiment also show that there was only significant effect on sand particle while the rest of other nutrients did not show any effect in the five study sites of Nabuin, Matany,Iriiri,Gweri and Tubur (Table 4).The soil results also show that N in three sites were lower than that in Iriiri (Table 4). This therefore resulted to low sorghum yield (Table 3) compared to its full potential, usually at 3000kg/ha under good management, including high soil nutrient content (Ebiyau *et al*., 2005).

Table 4: T-test analysis of soil nutrient content and soil moisture before setting up experiments

Site	Soil levels	pH	OM (%)	N (%)	P (PPM)	K	Na	Ca	Mg	Sand (%)	Clay (%)	Silt (%)	Soil moisture
						cmoles/kg							
Gweri	Top	6.20	2.20	0.21	8.05	0.59	0.11	5.93	2.35	58.70	19.80	21.50	0.79
	Bottom	6.50	2.90	0.24	15.12	0.61	0.10	6.54	2.53	59.50	22.60	17.90	0.70
Iriiri	Top	6.50	2.60	0.18	124.86	0.73	0.13	6.29	2.63	60.56	21.67	17.78	2.78
	Bottom	6.20	2.60	0.19	71.77	0.69	0.11	6.17	2.63	67.11	17.22	15.67	4.52
Matany	Top	6.40	2.40	0.22	35.96	0.71	0.09	6.81	2.33	59.22	23.78	17.00	1.88
	Bottom	6.40	2.50	0.19	18.95	0.67	0.08	6.76	2.93	60.50	17.80	21.70	2.06
Nabuin	Top	6.30	2.60	0.21	31.22	0.65	0.10	5.95	2.51	60.55	19.65	19.80	0.96
	Bottom	6.20	2.40	0.22	30.85	0.65	0.10	6.43	3.06	62.21	19.42	18.47	1.18
Tubur	Top	6.00	2.50	0.18	11.60	0.70	0.13	6.30	2.87	59.78	23.44	16.78	3.56
	Bottom	6.30	2.5	0.22	11.16	0.64	0.09	5.87	2.63	64.56	19.56	15.89	2.00
	p-value	**0.80**	**0.36**	**0.38**	**0.30**	**0.19**	**0.14**	**0.30**	**0.24**	**0.05**	**0.21**	**0.67**	**0.86**

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4. Conclusions

The results show that local sorghum varieties produced higher yield than improved sorghum varieties when subjected to low soil fertility. Therefore, it can be concluded that the notion of higher yield in the improved sorghum varieties is not generally applicable.

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