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Research Application Summary

Effect of seed size and fungicidal protection of potato seed from different sources on growth and tuber yield in Uganda

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Abstract

Poor seed quality is a major bottleneck to sustainable production of potato (*Solanum tuberosum* L.) in Uganda. This is primarily due to over reliance on informal seed sources, most of which are characterised by poor seed types and quality. The objective of this study was to determine the effect of fungicide protection of seed from informal sources on potato growth and tuber yield in Uganda. The study was conducted at three locations in south-western Uganda (Kabale, Rukiga and Mbarara) for two seasons September-December 2018 (2018B) and March-June 2019 (2019A). Treatments included: three seed sources (certified KaZARDI-control, own saved and local market), two seed sizes (large and small) and two levels of seed fungicide treatment (treated with the fungicide Victory 72 WP and untreated). Parameters evaluated included: number of main stems, plant height, late blight incidence and total tuber yield. Results revealed that the certified KaZARDI source generally had the highest values for most of the measured parameters. This was followed by own saved source while the local market source provided the lowest quality values. Large sized seed exhibited superior performance to the small seed for most of the parameters. Also, fungicide-dressed seed showed better performance for most of the assessed parameters, than the undressed counterparts. These results suggest that fungicide dressing will improve the performance of potato seed supplied by informal sources, particularly the own saved large and small seeds.

Key words: Own saved seed, *Solanum tuberosum,* Uganda

Résumé

La mauvaise qualité des semences est un goulot d'étranglement important à la production durable de pomme de terre (Solanum tuberosum L.) en Ouganda, principalement dû à la dépendance sur les sources de semences informelles, dont la plupart sont caractérisées par de mauvais types et de qualité de semences. L'objectif de cette étude était de déterminer l'effet de la protection antifongiques des semences provenant de sources informelles sur la croissance de la pomme de terre et le rendement des tubercules en Ouganda. L'étude a été menée à trois endroits dans le

sud-ouest de l'Ouganda (Kabale, Rukiga et Mbarara) pour deux saisons, septembre-décembre 2018 (2018b) et mars-juin 2019 (2019a). Les traitements inclurent trois facteurs : les sources de semences (la semence certifiée Kazardi comme Control, semence sélectionnée par les cultivateurs, et semence disponible sur le marché local ; deux tailles de graines (larges et petites) ; et deux niveaux de traitements fongiques des semences (traité avec le fongicide Victory 72 WP et non traitée). Les paramètres évalués furent le nombre de tiges principales, la hauteur des plantes, l'incidence de la rouille tardive et le rendement total des tubercules. Les résultats ont révélé que la semence certifiée kazardi a généralement enregistré les valeurs les plus élevées pour la plupart des paramètres mesurés, suivi de la semence des cultivateurs. La semence large a enregistré des performances supérieures à celle de la petite graine pour la plupart des paramètres. En outre, les semences enrobées de fongicides ont montré de meilleures performances pour la plupart des paramètres évalués que leurs homologues non-enrobées. Ces résultats démontrent que l'enrobage des semences avec des fongicides améliorera les performances des graines de pommes de terre fournies par des sources informelles, en particulier celles de grande taille sélectionnée par les cultivateurs.

Mots clés: Graines sauvegardées, *solanum tuberosum*, Ouganda

Introduction

Potato (*Solanum tuberosum* L.) is a crop of worldwide significance. In Uganda, potato is a staple food in many households and a quick source of income, especially to small-scale farmers in the highland regions where it is mostly grown. Despite the socio-economic significance of the crop, potato production in Uganda has progressively declined from a record yield of 6.9 t ha^{-1} in 2007, to 4.1 t ha^{-1} in 2017 (FAOSTAT, 2019). These low yields are against the potential yield of 25 t ha^{-1} reported on research stations in Uganda (Namugga *et al*., 2017). The low yields have been attributed to a number of confounding factors, of which predominant use of uncertified seed from informal sources is the main limiting factor. In Uganda, quality potato seed production and supply is the mandate of Kachwekano Zonal Agricultural Research and Development Institute (KaZARDI), whose capacity to fully sustain its clientele demand is limited. Thus, high-quality potato seed produced remains inadequate and, therefore, less accessible and unduly expensive. This coupled with inadequate knowledge about quality seed, restrict resource-poor farmers to unregulated informal seed sources, such as farm-saved (self-supply), and from local markets and neighbours (Namugga *et al*., 2017). Informal seed is typically characterised by continuous recycling, with cumulative build-up of diseases within the tubers consequently, resulting in reduced yields (Gildemacher *et al*., 2009). Although use of informal seed is known to limit potato productivity, there is still paucity of information on the subject in Uganda. The objective of this study, therefore, was to determine the effect of fungicide protection of seed from informal sources on potato growth and tuber yield in Uganda.

Materials and Methods

A field experiment was conducted in three districts (Kabale, Rukiga and Mbarara) of south-western Uganda, during two consecutive seasons September-December 2018 (2018B) and March-June 2019 (2019A). The potato seed used was of the Rwangume variety obtained from Kabale district. Treatments included: three seed sources (certified KaZARDI-control, own saved and local market), two seed sizes (large: 35-55 mm and small: <35 mm) and two levels of seed

fungicide treatments (untreated and treated with fungicide Victory 72 WP). The study design was a randomised complete block design in a split-split-plot arrangement, replicated three times.

Plot size was 3.5 m 3.65 m, each plot consisting of five rows. Plants parameters evaluated included: number of main stems, plant height, total tuber yield and late blight incidence. Data collected were subjected to analysis of variance (ANOVA) for a split-split-plot design, using GenStat 14th edition software. Significant treatment means were separated using Fisher's Least Significant Difference (LSD) at 5% level of significance.

Results

Seed sources significantly influenced plant height ($P < 0.05$) and total tuber yield ($P < 0.001$) (Table 1). Furthermore, seed size significantly ($P < 0.001$) affected plant height, number of main stems, as well as total tuber yield ($P < 0.01$). Additionally, potato seed dressing with fungicide significantly ($P < 0.05$) influenced total tuber yield only. Seed source x seed size interaction significantly ($P < 0.05$) influenced only tuber yield among the evaluated parameters. Seed sources x seed treatment as well as seed source x seed size x seed treatment interactions were non-significant for the evaluated parameters (Table 1).

Table 1. Analysis of variance table for the effect of potato seed sources, seed size and seed treatment on growth, late blight incidence and total tuber yield across south-western Uganda

Source of Variation	Variance ratio				
	DF	Plant height (cm)	Number of main stems	LB incidence (%)	Total tuber yield (t ha^{-1})
Seed source	2	14.55*	0.51	13.30*	115.10***
Seed size	1	57.17***	53.32***	30.08**	25.53**
Seed source X seed size	2	0.45	2.51	2.09	8.31*
Seed treatment	1	0.10	0.01	0.65	6.69*
Seed source X seed treatment	2	1.72	0.57	0.38	2.04
Seed source X seed size X seed treatment	2	0.19	0.40	2.38	2.45

*Indicates significance at 0.05, **Indicates significance at 0.01, ***Indicates significance at 0.001, Values without asterisks are not significant.

Certified seed from the KaZARDI source resulted in the tallest plants and highest total tuber yield (Table 2). This was followed by seed from the own saved source while seed from the local market sources had the lowest values for these parameters. The local market source resulted in the highest number of main stems while the lowest number resulted from own saved source (Table 2). Large size seed tubers gave rise to taller plants, more main stems and total tuber yields, compared to small size seed tubers (Table 3). Potato seed fungicide treatment provided more main stems, plant height, total tuber yield and reduced late blight incidence compared to untreated seed (Table 4).

Table 2. Effect of potato seed sources on growth and total tuber yield across south-western Uganda

Seed source	Number of main stems	Plant height (cm)	Total tuber yield (t ha^{-1})
KaZARDI (certified)	2.47	60.89	8.60
Own saved	2.40	56.97	7.00
Local Market	2.50	53.00	6.95
Grand mean	2.46	56.95	7.52
L.S.D (0.05)	0.29	4.06	0.34

Table 3. Effect of size of potato tubers and seed sources on growth and total tuber yield across south-western Uganda

Seed sources	Number of main stems		Plant height (cm)		Total tuber yield (t ha^{-1})	
	Seed size		Seed size		Seed size	
	Large	Small	Large	Small	Large	Small
KaZARDI (certified)	2.88	2.07	63.33	58.45	9.26	7.93
Own saved	2.60	2.19	58.82	55.13	6.96	7.04
Local Market	2.74	2.26	54.95	51.06	7.45	6.44
Grand mean	2.74	2.17	59.03	54.88	7.89	7.14
L.S.D. (0.05)	0.32		3.99		0.49	

Table 4. Effect of fungicide treatment of potato seed tubers, seed sources and sizes on growth and total tuber yield across south-western Uganda

Seed source	Number of main stems				Plant height (cm)				Late blight incidence (%)				Total tuber yield (t/ha)			
	Large		Small		Large		Small		Large		Small		Large		Small	
	TR	UTR	TR	UTR	TR	UTR	TR	UTR	TR	UTR	TR	UTR	TR	UTR	TR	UTR
KaZARDI	3.02	2.73	1.94	2.19	63.56	63.10	59.23	57.68	92.98	90.28	91.09	89.61	10.11	8.41	7.91	7.96
Local market	2.75	2.73	2.15	2.37	54.12	55.77	49.39	52.72	86.15	88.48	85.48	82.33	7.50	7.40	6.34	6.54
Own saved	2.72	2.48	2.17	2.22	59.72	57.91	56.79	53.48	87.26	84.50	81.09	83.83	7.25	6.66	7.53	6.55
Grand mean	2.83	2.64	2.08	2.26	59.13	58.93	55.14	54.63	88.79	87.75	85.89	85.26	8.29	7.49	7.26	7.02
L.S.D. (0.05)	0.40	5.36	4.97	0.86												

TR =Treated, UTR = untreated

Discussion

Seed sources. The superior growth parameters and total tuber yield from certified seed from the KaZARDI source (Table 2) was anticipated because of the healthy head start of the sprouts expected of disease protected planting materials. This conforms to Awad's (2009) observation that seeds of high quality maximise use of the available resources, resulting in rapid shoot growth. Local market sourced seeds resulted in the highest number of main stems, probably due to the more sprouts recorded from tubers obtained from this seed source (Burke, 2011). In light of these observations, seed source remains a critical determinant of field performance of potato in south-western Uganda, and certified seed still stands out with field superiority compared to own saved seed and seeds from local markets.

Potato seed size. The findings that large sized seed tubers resulted in taller plants, more main stems and total tuber yield compared with small sized seed tubers (Table 3) may be attributed mainly to the higher food reserves associated with large sized seed tubers, which supply optimal nutrients to the growing plants; consequently enhancing the potato growth and total tuber yield (Sadik *et al*., 2018). Furthermore, the greater number of sprouts recorded in large sized seed tubers than small sized tubers likely influenced the higher number of stems produced, and subsequently total tuber yield (Dagne *et al*., 2019). This implies that where possible, the first choice among potato tuber seed sizes in south-western Uganda, should be accorded to large tubers,

irrespective of seed sources. Unfortunately, this option stands to compete directly with the more lucrative consumptive markets which are elastically expanding in the country.

Seed fungicide treatment. The induction of seed tubers to produce more main stems, taller plants and higher total tuber yield due to seed fungicidal dressing (Table 4) may be due to its possible toxicity effect of new sprouts, as well as reduction in diseased sprouts (Wharton and Kirk, 2007), which consequently gave opportunity for proliferation of more productive plants with enhanced growth and yields. Furthermore, the increase in total tuber yield by the fungicide seed treatment, irrespective of seed source or tuber seed size, may be due to the higher number of main stems and plant height recorded (Table 4). The high late blight incidence noted from treated seed in this study (Table 4) could be due to existence of soil borne Phytophthora infenstans that the fungicide seed treatment did not protect against (Seifu, 2017). Overall, seed treatment with fungicides increased potato growth and yields: hence it should be considered as a potential practice for improving overall potato productivity, when supplemented by future research efforts.

Conclusion

Although the certified seed source remains superior to the available informal sources of potato seed in Uganda, incorporation of seed dressing with fungicides considerably improves sprouting, growth and total yields of tubers in south-western Uganda. Also, large potato seed size provides several folds superior attributes to small size possibly due to differences in nutrient reserves.

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