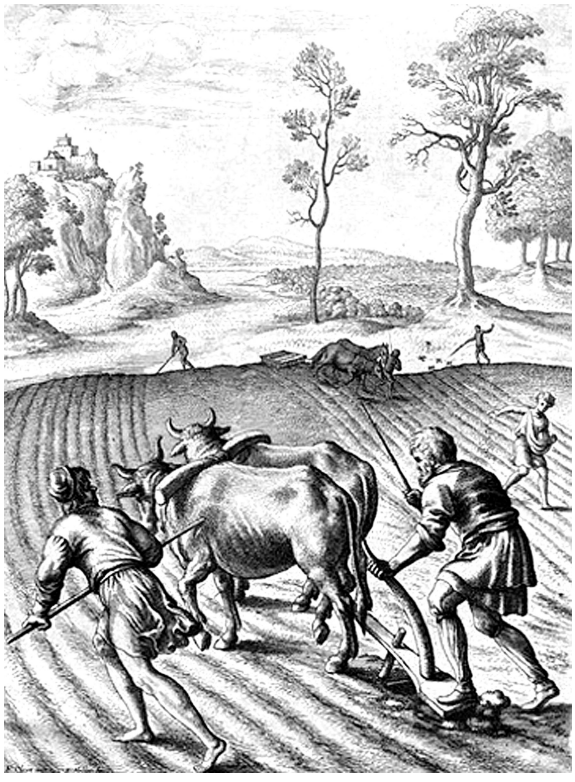
ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY



ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 4 (3): 156-160, 2005
ISSN 1812-5379
© 2005 Asian Network for Scientific Information

Vegetative Growth and Tuber Yields of Micropropagated and Farm-retained Sweet Potato (*Ipomea batatas*) Cultivars

[1]I. Matimati, [1]E. Hungwe and [2]F.S. Murungu
[1]Department of Horticulture, [2]Department of Agronomy,
Faculty of Natural Resources Management and Agriculture,
Midlands State University, P Bag 9055, Gweru, Zimbabwe

Abstract: A trial was carried out at Horticultural Research Centre, 64 km east of the capital city of Harare, to evaluate the productivity of four cultivars of micropropagated sweet potatoes when compared to farm retained planting material. The site received an annual rainfall of 850 mm and a mean temperature of 21°C during the growing season. Survival, vine length and tuber yield of both micropropagated and farm-retained planting material of four sweet potato cultivars was evaluated during the 2002/3 growing season. The evaluated cultivars were Chingova, Chigogo, Mozambique White and Germany II. A 4x2 factorial experiment in Randomized Complete Block Design (RCBD) with three replicates was established. Survival percentages of sweet potatoes did not improve significantly ($p>0.05$) with micropropagation for all the cultivars. There were no significant differences in vine length between micropropagated and farm-retained planting materials for the cultivars Chingova and Germany II whilst Chigogo had longer vines after micropropagation at both six and ten weeks from planting. Mozambique white showed a decrease in average vine length after micropropagation at six weeks from planting. However no significant differences were noted after ten weeks from planting. The magnitude of response to micropropagation differed with cultivar in terms of mean tuber weight. Micropropagated Mozambique white yielded 25t ha^{-1} as compared to the farm-derived Mozambique white, which had 8 t ha^{-1}. Yields from micropropagated Chingova (19 t ha^{-1}) were more than two times higher than those from farm-retained crop (9 t ha^{-1}). Micropropagated Chigogo yielded 21 t ha^{-1} as compared to its farm-retained material, which had 15 t ha^{-1}. Micropropagated Germany II yielded 15 t ha^{-1} and the farm-derived yielded (13 t ha^{-1}). This could imply differences in susceptibility of cultivars to pathogen infection and use of micropropagated planting material may result in increased yields for varieties such as Mozambique White and Chingovha.

Key words: Sweet potato, micropropagation, farm-retained, planting material, yields

INTRODUCTION

Sweet Potato (*Ipomoea batatas* L.) is one of the most important root crops in the world. It is considered a major food crop and a source of raw materials for feeds and industrial processes. The starchy staple type of sweet potato is an excellent source of energy and vitamin A. Nutrients do not only come from the roots but also from tender shoots which are an important source of vegetable fibre. Its multiplicity of uses has seen the crop emerging as an important food crop in smallholder farming areas of Zimbabwe. Despite the importance of sweet potatoes in ensuring food security and the nutritional well being of smallholder farmers, the production levels still fall below expectations. Scientists have attributed low production to many controllable sweet potato disease problems. These include sweet potato viruses, which cause up to 78% loss of potential yield[1] and the 'little leaf mycoplasma-like' organisms, which may cause complete crop loss[2,3].

Trials in the Lowveld Region and at HRC indicated that yields of the sweet potato cultivar Griekwa from virus-free runners were 100% better than from the diseased plants. At the Freednheim Experimental Station in Pretoria, a trial on poor sandy soils resulted in a yield of 42.9 t ha^{-1} from micropropagated Impala compared to infected plants, which had 13.7 t ha^{-1}[1][1]. Meristem-tip culture is a technique of micropropagation, which eliminates carryover of most disease problems and provides true-to-type, asexually propagated stock plants[2].

The Biotechnology Trust of Zimbabwe (BTZ), in collaboration with the Horticultural Research Centre

Corresponding Author: I. Matimati, Department of Horticulture, Faculty of Natural Resources Management and Agriculture, Midlands State University, P Bag 9055, Gweru, Zimbabwe
Fax: +263 54 60233/60311 Tel: +263 54 60464s

(HRC), established centres providing disease-free sweet potato vines in some smallholder irrigation schemes in Manicaland. Despite the provision of relatively cheap and disease-free planting material, some farmers continue to retain their planting material from season to season. Major reason cited is the alleged similarity in productivity of micropropagated and farm-retained planting material. At a field day held at Murambinda Irrigation Scheme in Zimbabwe, farmers requested for a comparative evaluation of the productivity of micropropagated and farmer-retained planting material under smallholder farming conditions.

In this study, the objective was to compare survival, vegetative growth and tuber yield of micropropagated and farm–retained sweet potato cultivars. Comparison was based on number of marketable tubers, numbers of unmarketable tubers and total number of tubers. The growth performance in terms of vine length measured after every two weeks was also analysed.

MATERIALS AND METHODS

The trial was done at HRC, 64 km east of Harare. HRC receives an average rainfall of 800 mm/annum, with temperatures ranging from a minimum of 4°C in June and a maximum of 38°C in October. The site had sandy-loam soils of pH ($CaCl_2$) 5.6. Micropropagated material, of four sweet potato cultivars Chigogo, Chingovha, German II and Mozambique white, was obtained from the tissue culture laboratory at Horticultural Research Centre. Tip cuttings of sweet potato were taken from actively growing vines from the field and potted up in heat treatment soil mix in ceramic pots. When they had four to six mature leaves, they were placed in the heat treatment room at 38°C. Watering was adjusted according to crop water requirements. Pots were maintained in the room at 38°C for 8 weeks before shoots were removed for meristem culture.

Healthy and actively growing sweet potato tip cuttings from the heat treatment room were collected, trimmed and dissected into nodal segments and rinsed in distilled water. They were placed in a solution of sodium hypochlorite and 0.05% Tween-20 solution for 20 min with occasional shaking. After sterilization they were then rinsed in distilled water inside a laminar flow cabinet. Meristems found at the growing tips of the auxiliary and apical buds were aseptically excised at between 0.2-1.0 mm from the tip. The meristems were cultured in Murashige and Skoog media, composed of sucrose (50 g L^{-1}), GA_3 (0.04 g L^{-1}), agar, calcium pantothenate (0.002 g L^{-1}) and myo inositol (0.1 g L^{-1}) at pH 5.8. Cultures were regularly transferred to fresh media every three weeks until normal shoots and roots were developed. After roots and shoot development they were transferred to the rapid multiplication media (1 pine bark: 2 black vlei soil) for virus indexing on *Ipomea setosa* L. Plants that tested negative were potted in polythene bags and transferred to the lathhouse for hardening off. Vine cuttings from clean planting material were further multiplied in a Nematode Free Nursery (NFN).

Farm-retained planting material was obtained from communal farmers in Murambinda Irrigation Scheme and had been retained for 6 seasons. A 4x2 factorial experiment in a Randomised Complete Block Design (RCBD) with three replications was established. Each gross plot had six ridges spaced at 0.9 m and length of 16 m. The net plot size was 4 ridges of 15 m in length. The plant-to-plant spacing was 0.4 m, giving a plant population of 44 444 plants ha^{-1}. A basal fertilizer, compound C (6% N:17% P:15% K) was applied at a rate of 300 kg ha^{-1}. Cuttings of 30 cm in length were planted in such a way that at least two thirds of the cuttings were buried in the soil. This offered a large surface area for root initiation and development. Irrigation thereafter was carried out according to crop water requirements. The plants were top dressed with 400 kg ha^{-1} of Ammonium Nitrate (34.5% N) after four months.

Crop stand count was done 3 weeks from planting. Survival percentage was calculated as number of cuttings that had established out of the cuttings that were planted and multiplied by a 100. Data was collected on number of vines per plant and the vine length 6 weeks from planting. Five randomly selected plants in each plot were selected and assigned sample numbers using tags. Data was measured at 6 and 10 weeks after planting. Data was analysed using GENSTAT Version 7.0 statistical package.

A tractor drawn tine ridger and hand labour were used to dig up the roots after 4 months. The total number and weight of large roots (marketable tuber yields) and total number and weight of small roots (unmarketable tuber yields) were measured. Roots with diameters of less than 2.5 cm were classified as small and unmarketable.

RESULTS

Significant differences were noted in percentage survival of the four cultivars, three weeks after planting. Germany II had the lowest survival percentage, whilst the cultivar Mozambique White had the highest survival percentage. However, there was no interaction in survival percentages between the type of planting material used and the cultivar (Fig. 1).

There was a significant ($p<0.05$) interaction between cultivar and type of propagation material at 6 weeks after planting on vine length (Fig. 2). A comparison of

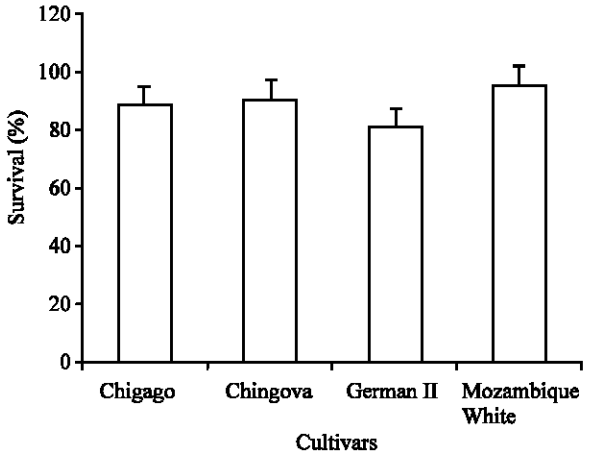


Fig. 1: Percentage survival of the four cultivars three weeks from planting

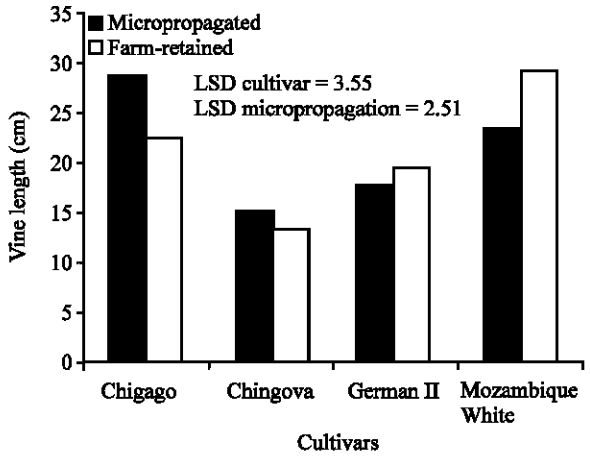


Fig. 2: Average length (cm) of vines of the four cultivars six weeks after planting

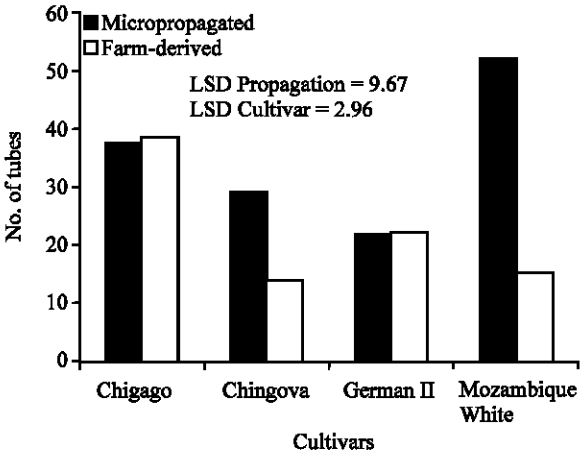


Fig. 3: Number of marketable tubers at harvesting

Table 1: Average number of vines per plant six weeks from planting

Treatments	Mean number of vines
Micropropagated	6.2500
Farm-derived	5.2500
Mean	5.7500
SED	0.2764
CV%	16.7000

Table 2: Average number of vines per plant

Cultivars	Average number of vines/plant at 10 weeks
Chigogo	22.26
Chingova	15.66
German II	17.00
Mozambique White	14.16
Mean	17.27
LSD	9.38 NS
CV%	18.86

NS- not significantly different at $p<0.05$

Table 3: Vine length of micropropagated and farm-retained sweet potatoes after 10 weeks from planting.

Cultivars	Micropropagated	Farm-derived
Chigogo	1683.067a *i*	1087.00c *j*
Chingova	757.133d e *i*	663.467e *i*
German II	1313.467b *i*	1049.200c *i*
Mozambique White	879.733d *i*	1107.733c *i*
Mean	1067.600	
LSD cultivar	152.600	
Propagation	516.900	
CV%	15.180	

a, b, c, d Cultivar means followed by the same letter(s) are not significantly different, *i, j* propagation means with different letters were significantly different

micropropagated material showed that micropropagated Chigogo had the longest vines whilst micropropagated Chingova had the shortest vines. However, a comparison of farm-retained material showed different trends. Farm-retained Mozambique White had the longest vines whereas farm-retained Chingova had the shortest vines after six weeks. Comparison of the two types of planting material for each of the cultivars showed significant differences ($p<0.05$) between micropropagated and farm-derived Chigogo. Micropropagated Chigogo had longer vines than the farm-retained Chigogo. However farm-retained Mozambique White had significantly longer vines than the micropropagated Mozambique White. There were no significant differences in vine length between micropropagated and farm-retained planting material for cultivars Chingova and Germany II.

Significant differences ($p<0.05$) were noted in number of vines per plant between micropropagated and farm-derived varieties six weeks from the day of planting (Table 1). There were no varietal differences in the number of vines amongst the cultivars at six weeks after planting. Similar results were noted at ten weeks from planting (Table 2).

There was a significant ($p<0.05$) interaction between cultivar and type of planting material on vine length.

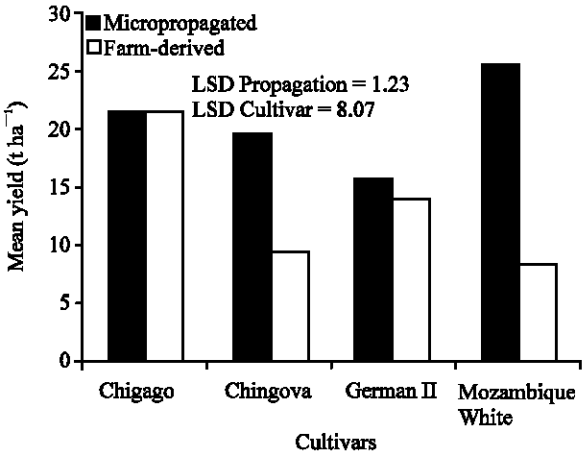


Fig. 4: The mean yields (t ha^{-1}) of the four cultivars at harvest four months after planting

Micropropagation improved the length of vines for varieties Chigogo, Chingova and German II whilst shorter vines were observed for micropropagated Mozambique white than the farm-derived Mozambique white ten weeks from planting material (Table 3).

There was an interaction ($p<0.05$) between type of planting material and the cultivar type. The number of tubers harvested from micropropagated Chigogo and German II did not significantly differ from the number of tubers obtained after using farm-retained material. However, more tubers were recorded in micropropagated Chingova and Mozambique White than the number of tubers harvested from farm-retained material (Fig. 3).

There was also an interaction ($p<0.05$) between cultivar and type of planting material ($p<0.05$) for final tuber weight. All cultivars yielded higher after micropropagation, compared to farm derived planting materials, in terms of mean yield, four months after planting. The greatest yield difference between micropropagated and farm-retained planting material was experienced with Mozambique White while it was least with German II (Fig. 4).

DISCUSSION

Survival percentages of sweet potatoes did not improve significantly with micropropagation, for all the cultivars. This implies that if the viral diseases were present in the farm-retained planting material, they did not affect survival percentages of sweet potato planting material. On the other hand it might be a result of mild infection or absence of infection. An interaction between cultivar and type of planting material in terms of vine length showed that different cultivars respond differently to micropropagation. There were no significant differences between micropropagated and farm-derived planting materials for the cultivars Chigogo and Germany II on total tuber yield. This can imply that these cultivars had more resilience when exposed to pathenogenic environments such as those on farmers' fields. Chigogo had longer vines after micropropagation at both six and ten weeks after planting. On the contrary Mozambique white showed a decrease in average vine length after micropropagation at six weeks from planting. This may be explained by the genotypic differences between the cultivars. However no significant differences were noted after ten weeks from planting. This inconsistency makes vine length a poor indicator of growth since it varied with the cultivar and growth phase.

The magnitude of response differed with cultivar in terms of mean marketable tuber weights. Chingova doubled the yield after micropropagation, whilst for Mozambique White the yield almost trebled. For Chigogo and German II the differences, though significant were not very high. This could imply differences in susceptibility of cultivars to pathogenic infections.

Generally micropropagated material yielded better than farm-derived material for all the four cultivars. Farmers producing Chingova and Mozambique White, which highly responded to micropropagation, should obtain micropropagated material after fewer production seasons than farmers growing Chigogo and German II. The extend to which farmers can use retained planting material will depend on cultivar, thus recommendations need to be tailor-made for each cultivar. Rate of reinfection after micropropagation, to economically significant levels, should hence be studied individually for each cultivar, because it is cultivar specific.

An interaction between cultivar and type of planting material, which was observed in terms of marketable number of tubers confirms the relatively poor response of cultivars Chigogo and Germany II to micropropagation. The significant planting material X genotype interaction also suggests the feasibility of breeding planting materials that will last longer on farmers' fields. For Chigogo and German II there were no significant differences in number of tubers after micropropagation, whilst micropropagation increased the number of tubers in Chingova and Mozambique white. A similar trend was noted for mean tuber weights, hence it can be assumed that the two cultivars are relatively tolerant to the local range of yield reducing pathogens in the area of study.

CONCLUSIONS

The type of cultivar and type of planting material interact in determining the number and weight of sweet potato tubers. Micropropagating Chingova doubled the yields whilst in Mozambique White the yields almost trebled. Cultivars Chigogo and German II poorly responded to pathogen elimination through micropropagation. Optimum production of Chingova and Mozambique white would require constant pathogen elimination through micropropagation. Varietal response to micropropagation in terms of vine length was more pronounced at early growth stages (six weeks from planting) than at later growth stages (ten weeks from planting). The lack of consistence in growth of vine length makes it a poor indicator of sweet potato plant growth. Considering the increase in yield realized, micropropagation could hence be selectively used as a technique of improving the productivity of sweet potato. This now requires scaling up of the technology through establishment of more satellite nurseries to service the smallholder sweet potato farmers in Zimbabwe.

RECOMMENDATIONS

There is need to assess the response of other cultivars to micropropagation. Such studies would help in ascertaining a cost effectiveness of their micropropagation. Cost benefit analyses of using pathogen-tested material would be of much importance to farmers in decision-making. There is need of scaling up of the technology through establishment of more satellite nurseries to service smallholder farmers in Zimbabwe.

REFERENCES

1. Yencho, F.B., 2000. Sustainable food production in Sub Saharan Africa. International Institute of Tropincal Agriculture. IITA'S Contributions, IITA, Ibadan, Nigeria.
2. Hartman, H.T., D.E. Kester, F.T. Davies, Jr. and R.L. Geneve, 2002. Plant Propagation and Nursery Management. 6th Edn., Prentice-Hall of India, New Dehli, p239-274.
3. Karyeija, R.F., J.F. Kreuze, R.W. Gibson and J.P.T. Valkonen, 2001. Variability of sweet potato feathery mottle virus in Africa. African Crop Sci. J., 9: 293-299.