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GENETIC EVALUATION OF POLYCROSS HYBRIDS OF SWEET POTATOES

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ABSTRACT

Sweet potato is an important staple crop in Papua New Guinea (PNG). Evaluation of polycross hybrids of sweet potato to identify tuber bearing progenies was conducted at PNG University of Technology farm, LAE, between March and November 1991. Sweet potato seeds were obtained from a polycross nursery of nine sweet potato clones adapted to PNG. Nine hundred and eight seeds were scarified and sown. Out of 689 germinated and established seedlings, 77 mature plants (11%) were selected as having the potential to produce tuberous roots. These selected progenies were advanced into their first clonal generation for further yield evaluation. The highest yielding half-sib progeny was obtained from a hybrid parent UIB-52. Heritability values for tuber yield, tuber number and vine weight were 0.80, 0.62 and 0.10, respectively. Parental clones UIB-37, K-42 and Merikan showed good general systems in improving sweet potato in the lowlands of PNG.

Key Words: **Polycross hybrids, sweet potatoes**

RÉSUMÉ

La patate douce constitue un des aliments de base en Nouvelle Guinée. Une évaluation des hybrides issus de croisements multiples en vue d'identifier les lignées productrices de tubercules a été conduite à la ferme LAE de l'Université de Technologie de la Nouvelle Guinée entre Mars et Novembre 1991. Les semences de patate douce ont été obtenues d'une pépinière de croisements multiples de clones adaptés à la Nouvelle Guinée. 908 semenceaux ont été coupés et mis en terre. A partir de 689 plantules bourgeonnées et etablies, 77 plants matures (11%) ont été sélectionnés pour leur potentialité tubéreuse. Un clone de première génération a été obtenu des lignées sélectionées pour leur rendement en tubercules. La descendance la plus productive est obtenue du parent hybride UIB-52. Les indices d'héritabilité pour le rendement en tubercules, le nombre de tubercules et le poids de la liane ont été respectivement de 0,8, 0,62 et 0,10. Les clones parentaux UIB-37, K-42 et Merikan ont montré de bonnes aptitudes pour l'amélioration de la patate douce dans les basses plaines de la Nouvelle Guinée.

Mots Clés: **Croisement multiple, patate douce.**

INTRODUCTION

The importance of sweet potato, *Ipomoea batatas* (L.) LAM., as one of the staple root crops in Papua New Guinea (PNG) is well documented. The highlands and parts of the lowlands depend on this crop for their source of energy (60–90%) and it is worth over K200 million for its annual production (Bourke, 1985).

Self incompatibility is observed in sweet potato (Martin, 1982), thus it is a cross-pollinated crop. In PGN, the crop flowers and sets seeds (Yen, 1974). The spontaneous germination of seeds results in the development of new sweet potato clones which are retained naturally or selected by farmers and have contributed to the wide genetic diversity of the crop within the country. Papua New Guinea has a large genetic base with an estimated 5,000 clones; because of this diversity, the country is considered a secondary centre for sweet potato (Yen, 1981; Bourke, 1985).

Although sweet potato is an important staple food, production is low due to factors such as low yield, susceptibility to pests and diseases, and poor soil fertility. Thus, research on this crop should be directed to the improvement of yield components as well as the production of pest and disease resistant, and more environmentally adapted varieties. This paper presents results of an evaluation and selection of sweet potato hybrids for high yielding progenies, heritability (h^2) estimates of tuber yield, tuber number, vine weight and other yield related characters, and the preliminary yield of the advanced selected sweet potato progenies in their first clonal generation.

MATERIALS AND METHODS

Sweet potato seeds were collected from nine selected parental clones of sweet potato raised in a polycross nursery at PNG University of Technology farm in Lae, 147° E and 641° S, altitude 54 m (Table 1). The parents were selected based on high yield, flowering ability and other desirable horticultural traits. The collected seeds were scarified by soaking in concentrated sulphuric acid for 20 minutes (Steinbauer, 1937). Heavy, scarified seeds were separated from light seeds (floaters) by immersing the seeds in beakers containing water and were sown in small plastic pots, containing a medium of three parts top soil and one part sand.

Observations of the germination were recorded 2–3 weeks after sowing. The seedlings and cuttings of the respective parents were transplanted at spacing of 0.3 m between plants and 0.8 m between

TABLE 1. Origin and characteristics of vine, leaf shape, flower, and tuber of the parental clones of sweet potato used to produce hybrids

Parental clone	Origin[a]	Vine colour	Leaf shape	Flowering habit	Days to flower	Tuber skin colour	Tuber flesh colour
UIB-52	UPNG[b]	Moderate purple	Lobed	Profuse	142	Orange	Orange
UIB-37	UPNG	Green	Lobed	Moderate	160	Yellow	Yellow
K-142.	HRC-Laloki[b]	Moderate purple	Lobed	Prolific	151	Pink	White
K-42	HRC-Laloki	Green/ purple	Digitate	Profuse	126	Purple	White
Koitaki-2	HRC-	Green	Lobed	Sparse	197	Purple	Yellow
W/Murua	HRC-Laloki	Purple	Lobed	Moderate	187	Purple	White
KAV-57	Kerevat	Green	Lobed	Profuse	168	White	White
Kekori	HAES-Aiyura[c]	Moderate purple	Lobed	Profuse	134	White	White
Merikan	HAES-Aiyura	Green/ purple	Lobed	Sparse	193	White	Yellow

[a]Information on origins were adapted from Tumana (1986), Bang (1987) and Wamala (1987).
[b]Lowland
[c]Highland

rows of 3.0 m length. A Randomized Complete Block Design (RCBD) was used with three replicate blocks. Optimum conditions of management were maintained throughout the cropping period.

The parent/progeny evaluation trial was harvested three months after planting. All underground parts were washed, cleaned and air dried. The roots were separated into young roots (thin roots about 10–15 cm long), non-tuberous roots (thin roots of about 10–60 cm long), pencil-like roots (thick pencil-like soft roots) and tuberous roots (enlarged roots). Only progenies with tuberous roots were selected and advanced to the first clonal planting. The rest were discarded.

Parent regression coefficient for tuber number, weight and vine weight per plant were calculated by parent-offspring regression using ten sets of values for each character. Heritability estimates were computed by multiplying the regression coefficients by a factor of 2 ($h^2 = 2 \times b$). This estimates the narrow sense heritability of progenies from polycross mating system. The Average General Combining Ability of the parents for tuber yield was estimated as the difference between performance of hybrids for each maternal clone and the overall mean of all hybrid progenies (Simmonds, 1979).

Five cuttings from each of the 77 selected progenies were planted in four replicated rows 1.2 m long, 0.8 m wide and 0.3 m between plants in July, 1991. This preliminary yield trial was harvested after three months and observations on tuber characters and yielding ability were recorded.

RESULTS AND DISCUSSION

The nine parental clones varied in vegetative, floral and tuber characteristics (Table 1). They also showed variation in seed production and germination rate and production of potential tuber bearing progenies. Parent Kekori, a highland clone produced significantly ($P \leq 0.05$) high number of seeds (276) and seedlings (226), followed by two lowland clones, UIB-52 with 222 seeds and 173 seedlings and K-42 with 210 seeds and 170 seedlings (Table 2). These clones were among the profuse flowering ones. In general, cultivars such as Kekori, adapted to a highland environment, would not be expected to perform well in the lowlands immediately after transfer there. This result, however, showed the cultivar's potential for acclimatization.

Out of 908 heavy seeds sown, 716 (79%) germinated and produced seedlings. Seed germination rate for the clones ranged from 44.1% (clone Merikan) to 92.3% (clone Wanmun Murua) with an average germination rate of 76%. Scarification of sweet potato seeds by sulphuric acid is a standard practice (Steinbauer, 1937; Wang, 1982). However, the floatation technique following the standard practice of seed scarification improves the germination rate. This is because poor, infertile seeds were eliminated and only the heavy seeds which are likely to have fully formed endosperm with viable embryos were sown.

From the 689 transplanted seedlings, 77 (11%) matured plants were selected as tuber bearing types. Over half (66%) of the selections were from parental clones K-42 (24), UIB-52 (15) and Kekori

TABLE 2. Seed production in parental clones, germination rate and percentage of half-sib progenies selected in sweet potato

Parental clone	No. of seeds scarified and planted	No. of seedlings obtained	% germinated	No. of progenies grown	No. of progenies selected	% selected
UIB-52	222	173	77.9	17	15	88
UIB-37	11	7	63.6	7	3	42.9
K-142	54	48	88.9	46	7	15.3
K-42	210	170	81.0	168	24	14.3
Koitaki-2	27	25	92.6	25	5	20.0
W/Murua	13	12	92.3	12	1	8.3
KAV-57	61	40	65.6	27	4	14.8
Kekori	276	226	81.9	221	12	5.4
Merikan	34	15	44.1	13	6	46.2
TOTAL	908	716	76.4	689	77	11.2

TABLE 3. Mean tuber yield (kg), tuber number and vine weight per plant in parents and offsprings of sweet potato and their heritability estimates

Parental clone	Mean tuber yield per plant (kg)		Mean tuber number per plant		Vine weight per plant (kg)	
	Parent	Offspring	Parent	Offspring	Parent	Offspring
UIB-62	0.65	0.43	5.41	3.87	1.82	0.77
UIB-37	0.53	0.77	3.14	5.20	0.75	0.87
K-142	0.34	0.29	2.59	3.51	2.25	1.00
K-42	0.28	0.53	2.54	4.66	0.84	0.88
Koitaki-2	0.03	0.17	1.59	3.00	0.87	0.64
W/Murua	0.04	0.23	4.28	4.93	1.03	1.18
KAV-57	0.33	0.03	3.68	2.98	0.80	1.19
Kekori	0.13	0.24	3.38	4.56	0.80	0.73
Merikan	0.27	0.65	3.93	6.75	1.37	1.35
Grand mean	0.29	0.39	3.39	4.38	1.19	0.96
Regression	0.401		0.312		0.050	
Heritability 2 x b	0.80		0.62		0.10	
Standard error	0.35		0.90		0.15	

TABLE 4. Average combining ability for tuber yield, tuber number and vine weight among the selected parental sweet potato clones

Parental clone	Average combining ability: Tuber yield	Tuber number	Vine weight
UIB-52	-0.05	0.05	-0.19
UIB-37	0.38	0.82	-0.09
K-142	-0.10	-0.87	0.04
K-42	0.14	0.28	-0.08
Koitaki-2	-0.22	-0.38	-0.32
W/Murua	-0.16	0.55	0.22
KAV-57	-0.09	-1.40	0.23
Kekori	-0.15	0.18	-0.23
Merikan	0.26	2.37	0.39

(12). The large number of selections from lowland parental clones such as K-42 and UIB-52 probably indicates the role of environmental adaption in polycross nursery system (Tumana and Kesavan, 1987). The 11% selected progenies represents a fairly high selection intensity compared to the low selection intensity of 27% practiced by Tumana and Kesavan (1987). Selection intensities less that 10% have been used by the Asian Vegetable Research Development Centre (AVRDC), but under such intensities, some desirable genotypes were lost (Wang, 1982). On average, the offsprings performed better than the parents in terms of mean tuber yield (weight) and tuber number per plant in the seedling generations (Table 3). This could be due to a heterosis effect

TABLE 5. Mean yield per plant and projected yields (t ha^{-1}) of selected progenies of sweet potato in the first clonal generation

Parental clone	No. of selected plants	Mean tuber no. per plant	Mean tuber wt. kg plant^{-1}	Yield (t ha^{-1}) Range	Yield (t ha^{-1}) Mean
K-42	24	3.5	0.54	7.9–40.4	23.5
UIB-52	14	3.9	0.62	9.2–49.6	25.7
Kekori	11	3.6	0.48	11.3–38.3	20.0
K-42	7	4.0	0.62	10.8–42.9	25.7
Merikan	6	3.0	0.39	6.3–21.7	16.1
Koitaki-2	5	3.2	0.57	13.3–38.3	23.7
Kavieng-57	4	2.8	0.44	12.9–27.9	18.1
UIB-37	3	4.0	0.54	16.3–33.3	22.6
W/Murua	1	3.0	0.49	–	20.4

which also possibly coupled with a favourable genotype-environment interaction. However, further trials and analysis are required to confirm this.

From the parent-offspring regression method, the heritability estimates obtained for tuber yield and number per plant were relatively high, 0.80 and 0.62, respectively. However, a low heritability estimate (0.10) was obtained for vine weight per plant. These estimates for tuber yield and tuber number are comparable to those reported by Jones *et al.* (1986), and Tumana and Kesavan (1987). The heritability estimates for vine weight, however, were high, ranging from 0.83 (Thibodeau *et al.*, 1977) to 0.86 (Sakamoto, 1982). The relatively high heritability estimates with the wide genetic variation of sweet potato in PNG indicate a possibility of good progress in breeding programmes. Parental clones UIB-37, K-42 and Merikan showed good general combining ability for tuber yield and tuber number whereas Wanmun Murua and Kekori tuber number only (Table 4).

Tuber yield of the half-sib progenies ranged from 6.3 to 49.6 t ha^{-1} (Table 5). These yields are comparable to yields in the lowland environment of PNG (Bourke, 1985; Tumana and Kesavan, 1987). However, an experimental yield of over 70 t ha^{-1} has been reported by Enyi (1977). As expected the three best yielders were obtained from progenies of the lowland parents UIB-52, K-42 and K-142, indicating also the role of environmental adaption. These parents are hybrids known for their high yielding performance. Thus, hybrids and high yielding parents tend to produce also high yielding progenies.

It was concluded that the polycross mating system used in this study resulted in significant improvement of the yield of tubers and some hybrids. Three lowland parents, UIB-52, K-42 and K-142 produced high yielding hybrid progenies. The best yielding progeny (49.6 t ha^{-1}) was obtained from parent UIB-52. The medium to high heritability estimates for yield characters along with the wide genetic variability of sweet potato within the country provide the base for successful breeding programmes if carefully utilized. Parental clones UIB-37, K-42 and Merikan have positive general combining ability for tuber yield, thus they would be suitable parents for breeding.

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