

‘RW11-17’, ‘RW11-1860’, ‘RW11-2419’, ‘RW11-2560’, ‘RW11-2910’, and ‘RW11-4923’ Sweetpotato

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Six dual-purpose sweetpotato [*Ipomoea batatas* L. (Lam.)] cultivars, RW1117, RW111860, RW112419, RW112560, RW112910, and RW114923, were approved for release by the Plant Variety Release Committee of Rwanda in Feb. 2013 (RAB, Rwanda Agriculture Board, 2013). Sweetpotato forms a major part of the diet of both rural and urban communities in Rwanda. Moreover, the crop is expected to become more important with time as farmers engaged in mixed crop–livestock systems increasingly use vines as animal feed. Its use for both food and feed makes it attractive in areas where land availability is a constraint. Moreover, the implementation of the Rwandese government policy, which encourages use of zero grazing practice to mitigate soil erosion, emphasizes the use of sweetpotato as an alternative source of animal forage (MINAGRI, 2013).

The six released cultivars have relatively high dry matter content ($\approx 30\%$) and have good to high consumer acceptance. The cultivars also have moderate to high levels of field resistance to sweetpotato virus disease (SPVD) and *Alternaria bataticola* blight and yield higher (8.3 to 22.8 t·ha⁻¹) than the average storage root yield of 6.0 t·ha⁻¹ [FAOSTAT, 2011; International Potato Center (CIP), 1999]. Two of the released cultivars, RW11-2910 and RW11-2560, are orange-fleshed sweetpotato (OFSP), providing consumers with moderate to high beta-carotene (provitamin A) with potential to alleviate vitamin A deficiency. Thus, the official release of these dual-purpose sweetpotato cultivars for both food and animal feed, developed through on-station evaluation and farmer participatory selection, to augment the food and farming systems in Rwanda is reported.

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zones of Rwanda (Table 1). All the 60 parents were used in the polycross as sources of one or a combination of genes controlling important desirable traits. During the evaluation, the six clones were coded as follows: abbreviation for Rwanda, the last two digits of the year (2011) the genotype was initially selected (11), and the genotype selection number. The codes of these cultivars became the official names at cultivar release. All the six cultivars were respectively, the progenies of the following female parents: ‘Ejumula’, an OFSP landrace introduced from Uganda; ‘2000-203’, a RAB breeding line; ‘97-062’, also, known as Gihingamukungu, orange-fleshed, released in 2004; ‘Mugande’, bred and released by RAB in 2004; ‘SPK004’, an OFSP landrace introduced from Kenya; and ‘Ukerewe’, a yellow-fleshed cultivar from Tanzania.

Description and Performance

The International Potato Center (CIP), Asian Vegetable Research and Development Center, and International Board for Plant Genetic Resources (1991) descriptors were used to describe the six sweetpotato cultivars released in Rwanda (Table 2). ‘RW11-17’, ‘RW11-1860’, ‘RW11-2910’, and ‘RW11-4923’ are spreading, whereas ‘RW11-2560’ and ‘RW11-2910’ are semierect with either short or very short internodes. Apart from ‘RW11-2910’ and ‘RW11-2910’, which have vines that are predominantly green with purple pigmentation, the others have green vines. Mature leaf shape is triangular in ‘RW11-17’ and ‘RW11-2419’,

Origin

The six sweetpotato cultivars, RW11-17, RW11-1860, RW11-2419, RW11-2560, RW11-2910, and RW11-4923, are field seedling selections from the sweetpotato program of the Rwanda Agriculture Board (RAB, Rwanda Agriculture Board, 2013). The cultivars were selected from bulked seed from an open-pollinated polycross nursery of 60 parents established in 2010; their male pedigrees are unknown. The 60 parents in the polycross comprised 30 introductions and 30 landraces collected from different major agroecological

Table 1. Origin and main attributes of sweetpotato parents used in the 2009–10 polycross nursery at Rubona, Rwanda.²

Serial no./ cultivar name	Origin	Skin color	Flesh color	Serial no./ cultivar name	Origin	Skin color	Flesh color
1 2000-040	IB	Red	O	31 NASPOT 8	NU	PR	O
2 2000-203	IB	White	W	32 Silik Omuyaka	NU	C	W
3 2000-179	IB	Red	W	33 Otada	NU	C	C
4 2000-024	IB	Red	Y	34 Porosita	CN	PR	C
5 6-468	I	Red	W	35 Tedolokeren	NU	C	C
6 Mugande	I	Red	W	36 Dimbuka	NU	C	C
7 Karebe	I	Red	W	37 Kyabafuruki	NU	C	W
8 2002-154	I	Red	W	38 New Kawogo	NU	PR	W
9 440034	CN	White	O	39 NASPOT 10	NU	PR	DO
10 440164	CN	Red	W	40 SPK00/6/6-1	NU	PR	DO
11 8-1038	I	Red	W	41 LUW1274	NU	C	O
12 Kwezikumwe	I	Yellow	Y	42 Zapallo	CN	C	O
13 SPK-004	CN	Red	LO	43 Magabari	NU	C	C
14 Cacearpedo	I	Yellow	O	44 Bunduguza	NU	PR	DO
15 Chair orange	I	Red	P	45 Carrot C	CN	C	DO
16 Naspot A	NU	White	W	46 Tanzania	NU	C	LY
17 Ukerewe	CN	Red	O	47 Nsasagatebo	IB	R	C
18 Mayai	CN	Red	O	48 NASPOT 2	NU	PR	C
19 Carrote	CN	Red	O	49 NASPOT 3	NU	C	C
20 Zambezi	CN	White	O	50 NASPOT 6	NU	C	W
21 Naspot 1	NU	White	Y	51 Rushakashaka	NU	R	W
22 Ejumula	NU	Cream	O	52 Rukocoka	I	R	C
23 2005-179	NU	White	W	53 44-0165	I	R	W
24 Gihingamukungu	L	Red	W	54 Rwaserinda	I	R	W
25 Seruruseke	I	Red	Y	55 Gishefe	I	R	W
26 Anyumeli	NU	O	C	56 Giteke	I	W	W
27 Calomex	CN	C	O	57 Melesiyana	I	W	W
28 Araka white	NU	C	W	58 Saturisi	I	R	W
29 Luw	NU	R	C	59 Rwabakungu	I	R	W
30 KM161	NU	W	W	60 Nyiragasimbuka	I	W	W

²Codes used in table—origin: IB = ISAR bred; I = ISAR; CN = CIP/Nairobi; NU = NARO/Uganda; L = landrace; skin color: C = cream; LY = light yellow; DO = dark orange; PR = purple–red; flesh color: O = orange; W = white; Y = yellow; LO = light orange; P = purple; LY = light yellow; DO = dark orange.

Table 2. Morphological descriptors of seven sweetpotato cultivars released in Rwanda in Feb. 2013.^z

Descriptor	Cultivar						
	RW11-17	RW11-1860	RW11-2419	RW11-2560	RW11-2910	RW11-4923	Kwezikumwe
Plant type	Spreading	Spreading	Semi-erect	<i>Plant type</i> Semi-erect	Spreading	Spreading	Semi-erect
Length	Short	Short	Short	<i>Vine internode</i> Short	Short	Very short	Very short
Diameter	Very thin	Intermediate	Very thin	Thin	Very thin	Very thin	Very thin
Predominant color	Green	Green with purple	Green	<i>Vine pigmentation</i> Green	Green with purple	Green	Green
Secondary color	Dark purple	Green with purple	Green	Green	Green with purple	Purple tip	Absent
General outline	Triangular	Hestate	Triangular	<i>Mature leaf shape</i> Lobed	Hestate	Lobed	Lobed
Lobe type	Very slight	Moderate	Very slight	Deep	Moderate	Deep	Deep
Lobe number	1	3	1	5	3	5	5
Shape of central lobe	Triangular	Triangular	Triangular	Hastate	Triangular	Hastate	Hastate
Mature leaf	Purple	Green	Green with purple veins	<i>Foliage color</i> Green	Green	Green	Green
Abaxial leaf vein	Purple	Green	Green with purple edge	Green	Purple	Green	Green
Immature leaf	Green	Green	Green	Green	Green	Green	Green
Petiole pigmentation	Purple	Green	Green	Green	Slightly purple	Green	Green
Habit	Sparse	Sparse	None	<i>Flowering</i> Sparse	Sparse	Sparse	Profuse
Stigma exertion	Exerted	Slightly exerted	Exerted	Sparse	Exerted	Exerted	Inserted
Seed set	Sparse	Profuse	Sparse	<i>Capsule</i> Sparse	Moderate	Moderate	Moderate
Stalk	Short	Short	Intermediate	<i>Storage root</i> Short	Short	Short	Short
Formation	Dispersed	Dispersed	Very dispersed	Closed cluster	Closed cluster	Dispersed	Open cluster
Shape	Long elliptical	Long irregular or curved	Long elliptical	Long elliptical	Long elliptical	Long oblong	Long elliptical
Surface defects	Alligator like skin	Veins	Alligator-like skin	Alligator like skin	longitudinal grooves	Alligator-like skin	Alligator-like skin
Predominant Intensity	Red	White	White	<i>Skin color</i> Cream	Red	Purple-red	Cream
Secondary	Dark	Dark	Dark	Intermediate	Dark	Intermediate	Intermediate
	Absent	Cream	Absent	Absent	Purple-red	Red	Absent
Predominant Secondary	Cream	Pale yellow	White	<i>Flesh color</i> Deep orange	Light orange	Intermediate orange	Cream
	Yellow	Cream	Absent	Absent	Absent	Yellow	Absent

^zSelected descriptors according to International Potato Center, Asian Vegetable Research and Development Center, and the International Board for Plant Genetic Resources (1991).

hestate in 'RW11-1860' and 'RW11-2910', or lobed in 'RW11-2910' and 'RW11-4923'. Flowering is sparse in all the cultivars, whereas seed set is sparse in 'RW11-17', 'RW11-2419', and 'RW11-2560'; moderate in 'RW11-2910' and 'RW11-4923, but profuse in 'RW11-1860'. The skin color of the storage root is red in 'RW11-17' and 'RW11-2910', white in 'RW11-1860' and 'RW11-2419', cream in 'RW11-2560', and purple-red in 'RW11-4923'. Their flesh color is white in 'RW11-2419', pale yellow in 'RW11-1860', light orange in 'RW11-2560', intermediate orange in 'RW11-4923', and deep orange in 'RW11-2910'.

Dual-purpose sweetpotato cultivars were developed through farmer participatory selection using the accelerated breeding scheme (Grüneberg et al., 2009). A total of 8000 true seeds from the polycross described in the subsection, origin, were scarified in concentrated sulfuric acid, germinated in a greenhouse, and vine cuttings from the seedlings were used to establish a seedling nursery at Rubona in Rwanda. In total, 5380 well-established genotypes were selected

from the seedling nursery. Five vine cuttings of each genotype were planted on ridges 0.8 m apart and 0.3 m between plants in an observation trial at Rubona, Karama, and Ngoma in a randomized complete block design with two replications during the 2011B season (second rainy season).

The six released cultivars were evaluated for four seasons from 2011 to 2013 on-station at Rubona, Karama, and Ngoma in three major agroecologies, which are the major sweetpotato-producing areas of Rwanda. Rubona is in the midaltitude agroecology, 1650 m above sea level (masl), characterized by low SPVD pressure. Karama is in the low-altitude zone, 1420 masl, characterized by moderate to high SPVD pressure, whereas Ngoma is in the semiarid agroecological zone, 1400 masl, characterized by medium SPVD pressure (Ndirigwe, 2006; RAB, Rwanda Agriculture Board, 2000, 2013).

Farmers selected promising clones in preliminary trials (two rows, 15 plants, two replications, 2012A season, the first rainy season), advanced trial (four rows, 17 plants,

two replications, 2012B season), national performance trial (four rows, 17 plants, two replications, 2013A), and on-farm trials (14 farmers in each of three major agroecologies, each farm was considered a replication, 2012B and 2013A season). The planting distance, 0.3 m × 0.8 m, was used in all trials except the seedling nursery. During evaluation, both SPVD and *Alternaria bataticola* blight were scored according to Grüneberg et al. (2010) on a scale of 1 to 9, where 1 = no disease symptoms, 2 = unclear disease symptoms, 3 = clear disease symptoms at one plant per plot, 4 = clear disease symptoms at two to three plants per plot, 5 = clear disease symptoms at 5% to 10% of plants, 6 = clear disease symptoms at 10% to 25% of plants, 7 = clear disease symptoms at 25% to 50% of plants, 8 = clear disease symptoms at nearly all plant per plot, and 9 = clear disease symptoms with clearly reduced growth in all plants.

Data were collected on storage root weight, marketable roots (root diameter greater than 25 mm), vine weight, and biomass. To assess dry matter (DM) of storage roots and vines, 200 g from each

Table 3. Performance of the six sweetpotato released cultivars on-station across three locations, Rubona, Karama, and Ngoma in 2013A.^z

Cultivar	Storage root yield (t·ha ⁻¹)		Vine yield (t·ha ⁻¹)	SPVD	Alternaria blight
	Total	Marketable			
RW11-17	21.9	14.5	31.6	1.3	1.0
RW11-1860	20.8	14.3	25.6	2.2	1.3
RW11-2419	20.7	15.1	31.5	2.8	1.3
RW11-2560	22.8	17.9	26.3	2.2	1.0
RW11-2910	20.0	13.1	28.2	2.5	2.0
RW11-4923	19.0	11.8	28.4	2.0	1.0
Kwezikumwe	14.1	11.3	30.6	1.7	1.0
Mean	19.9	14	28.9	2.4	1.3
LSD _{0.05}	6.0	6.9	6.7	1.7	1.0
CV (%)	16.1	19.2	32.0	35.6	36.3

^zRubona, situated 2.59° S and 29.73° E is in the midaltitude agroecology, 1650 m above sea level (masl), with 1050 to 1200 mm rainfall, 18.7 °C, low sweetpotato virus disease (SPVD) pressure, and light gravel soil texture; Karama, situated 1.94° S, 30.06° E is in the low-altitude, semiarid agroecology, 1400 masl, with 700 to 900 annual rainfall, 20.8 °C mean annual temperature, high SPVD pressure, in the semiarid, drought-prone zone; Ngoma, situated 2.16° S, 30.55° E is in the low-altitude agroecology, 1420 masl, with 850 to 1000 mm rainfall, 20.3 °C, medium SPVD pressure, and clay soil.

LSD = least significant difference.

Table 4. Yield quality attributes and reaction to pests and diseases on-farm of six sweetpotato cultivars released in Rwanda in Feb. 2014.

Attribute	RW11-17	RW11-1860	RW11-2419	RW11-2560	RW11-2910	RW11-4923	Local control (Kwezikumwe)
Mean storage root (SR) yield (t·ha ⁻¹)	12.9	9.8	11.8	13.4	8.3	9.1	6.9
Mean SR yield (% of local control)	186.9	142.0	171.0	194.2	120.4	131.8	100.0
Dry matter (DM) content of SR (%)	30.8	37.8	24.9	21.0	31.1	37.3	30.0
DM content (%) of vines	17.0	20.7	17.6	20.6	18.3	19.2	18.0
DM yield of roots (t·ha ⁻¹)	4.0	3.7	2.9	2.8	2.6	3.4	2.1
DM yield of vines (t·ha ⁻¹)	4.1	4.8	3.4	2.7	3.9	4.4	2.6
Fresh weight root to vine ratio	2.0	1.9	1.9	2.0	2.0	2.0	2.1
Maturity (days)	135–150	120–135	135–150	120–135	120–135	135–150	120–135
Taste test rank (n = 32; 19 female, 13 male) ^z	Excellent	Excellent	Good	Good	Good	Very good	Very good
Field reaction to SPVD ^y	MR	MR	MR	MR	MR	MR	MR
Field reaction to Alternaria stem blight	MR	MR	MR	MR	MR	MR	MR
Field reaction to weevils	MR	MR	MR	MR	MR	MR	MR

^zTaste test rank was based on aggregate pairwise comparison by the panel (farmers) evaluating taste, flavor, flesh color, skin color, and general acceptability.

^ySPVD = sweetpotato virus disease; MR = moderately resistant, moderate damage resulting from disease or moderate numbers of insects present or moderate damage (in case of insect damage). Classifications of the resistance were based on field evaluation in Rwanda.

clone was oven-dried at 65 °C to constant weight, and DM was computed as a percentage of the fresh weight. Selection of dual-purpose clones was based on the ratio of roots to vines in terms of dry matter yield, where a clone with a ratio of 1.5 to 2.0 was classified as dual purpose (Claessens et al., 2009). The data were analyzed using the GenStat 12th edition statistical software (GenStat, 2009).

Following the accelerated breeding scheme of Grüneberg et al. (2009), the six released cultivars performed as well as the local control in on-station tests for marketable storage root yield, vine yield, SPVD, and Alternaria blight resistance. 'RW11-2910' and 'RW11-4923' had similar total and marketable storage root yields to the local control, whereas the other four cultivars had significantly higher storage root yields than the control (Table 3). Compared with the local control ('Kwezikumwe'), cultivar RW11-2560 had higher mean total storage root yields across the three locations as well as in on-farm trials, 22.8 t·ha⁻¹ and 13.4 t·ha⁻¹, respectively (Tables 3 and 4). Yields reported here are higher than yields reported by DONATA (2012), FAOSTAT (2011), and RAB, Rwanda Agriculture Board (2013) survey where the storage root yield average was 6 to 7 t·ha⁻¹. Based on the field evaluations, the

six released cultivars had a root-to-vine ratio more than 1.5 and therefore are suitable for dual-purpose use in the mixed farming systems of Rwanda. Apart from 'RW11-2419' and 'RW11-2560' with 24.9% and 21.0% DM, respectively, the other four cultivars had high storage root DM of greater than 30% (Table 4), fitting well with Rwandan starch and sugar level preferences in sweetpotato (Ndirigwe, 2006). Cultivars RW11-2560 and RW11-2910 are orange-fleshed with potential to contribute to reduction of vitamin A deficiency if consumed by the communities in Rwanda (DONATA, 2012). In general, all cultivars showed moderate resistance to SPVD, Alternaria stem blight, and sweetpotato weevil attack.

Based on taste tests by a total of 32 farmers, aggregate pairwise comparison of taste, flavor, flesh color, skin color, and general acceptability, the farmers ranked 'RW11-2419', 'RW11-2560', and 'RW11-2910' as good; 'RW11-4923' and the local control, 'Kwezikumwe' as very good, whereas 'RW11-17' and 'RW11-1860' were ranked as excellent.

Diffusion of Cultivars

Of a total of 30 districts in Rwanda, the released cultivars have been disseminated

in seven districts, namely, Huye, Nyamagabe, Ruhango, Muhanga in the southwest, Kamonyi in central, Bugesera in the south, and Ngoma in the southeast. Dissemination was mainly through farmer-to-farmer exchange or sale of planting material. Most seed companies do not disseminate sweetpotato planting material. Sweetpotato planting material reached farmers in the mentioned districts through RAB projects and various development partners such as Catholic Relief Services, Young Women Christian Association, the farmers' federation (Imbaraga Syndicate), World Vision, and Africare.

Availability

The released cultivars are currently maintained in the open field of RAB at Rubona, Rwanda. Requests for planting material

should be addressed to: Sweetpotato Program, RAB, P.O. Box 5016 Kigali, Rwanda.

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