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Sweetpotato Research Front

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Contents

NARO/KARC Embarks on a New Stage

Fuminori Terada

Director General, NARO Kyushu Okinawa Agricultural Research Center

Ten years have already passed since NARO started as an independent administrative agency. The agency must set mid-term plans every five years, and NARO entered its third period in 2011. NARO also modified its research system to promote the development of innovative agricultural technology and extensions. The new system adopts a program-project management system, and research activities are controlled by professional leaders monitoring all NARO research areas. Each institute takes charge of human resources and their training, as well as the extension of new varieties and technologies. Moreover, the institute established a professional research division that works as the core of regional innovations.

SPORF also changed to conform with the reconstituted research system, and we should offer new information as quickly as possible. We have much information about research outcomes of breeding, cultivation, and functions concerning the sweetpotato. We will provide valuable information not only in the Kyushu Okinawa region but also in Japan and throughout the world.

The most visible recent achievements of our sweetpotato research include utilizing functional components in foliage, new cultivar “BENIHARUKA” with a very sweet and moist taste, another new cultivar “KONAMIZUKI” with unique low-temperature starch pasting and processing technologies, promising breeding materials suitable for a direct-planting system, and planting technologies using small cuttings. In the agency’s third research period, we are developing innovative and interesting new technologies for you!!

SPORF aggressively provides information about the extension of our technologies as well as the research results. NARO/KARC established a forward-looking section for publicity and technology extension. The objective this period is to accelerate the growth of bilateral relationships between researchers and users. In particular, industrial, -academic, and -government cooperation has become more important in scaling up the results of our research and for speeding the extension of new technologies.

NARO/KARC will continue striving to promote the future of food culture of human beings and to pioneer new-ways of local development through technologies with researchers, producers, and consumers.

Research Paper

Genetic Analysis of Genes Involved in Southern Root-knot Nematode Resistance of Sweetpotato

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The southern root knot nematode (SRKN) *Meloidogyne incognita* is one of the major pests of the sweetpotato and severely degrades its yield and quality. To understand the inheritance of SRKN resistance and to develop molecular markers useful for breeding SRKN-resistant sweetpotato cultivars, genetic analyses were performed using an F_1 population obtained by a cross between cultivars "Hi-starch" (resistant to SP1 and SP2 races of SRKN) and "Koganesengan" (susceptible to both races).

Segregation of resistance in the F_1 population suggested that the race-specific resistance of Hi-starch is mostly controlled by single genes and that the genes for resistance against each race are closely located on the same chromosome. Bulked-segregant analysis and subsequent analysis of 86 F_1 progeny plants identified nine amplified fragment-length polymorphism (AFLP) markers associated with SRKN resistance and a single linkage map consisting of seven of these markers (Fig. 1a).

Quantitative trait locus (QTL) analysis using the segregating resistance data of the F_1 progeny enabled mapping both a locus with a large effect on resistance to the SRKN race SP1 and another affecting resistance to SP2 to the region around E33M53_090 that was designated as *qRmi(t)* (Fig. 1b). Two AFLP markers near *qRmi(t)*, E33M53_090 and E41M32_206, were sequenced and converted to locus-specific sequence-characterized amplified region (SCAR) markers based on their internal and adjacent DNA sequences (Fig. 2). Segregation patterns of these SCAR markers in the F_1 population were identical to those of the original AFLP markers. These markers might be useful for marker-assisted selection of SRKN resistance in sweetpotato breeding and as a first step to map-based cloning of the responsible QTL(s).

REFERENCES

(1) Nakayama et al., Euphytica 188, 175-185 (2012).

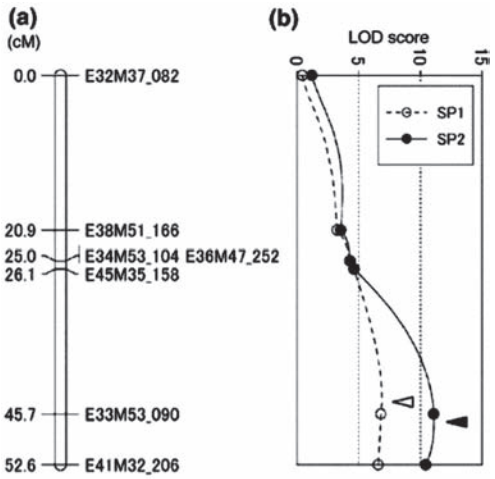

Fig. 1. Interval mapping of quantitative trait loci (QTL) for SRKN resistance to races SP1 and SP2. **a** Partial linkage map of AFLP markers identified by bulked-segregant analysis. **b** LOD scores for resistance to SRKN races as indexed by the mean number of egg masses. The open (solid) arrowheads show the putative QTL positions for SP1 (SP2).

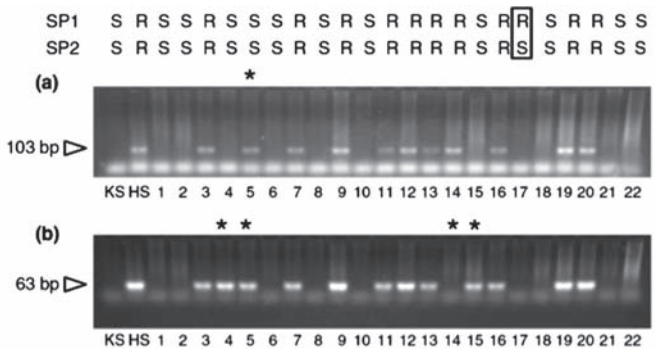

Fig. 2. Segregation of SCAR markers in mapping parents and F_1 progeny plants along with the reaction to SRKN race SP1 and SP2. **a** SCAR marker for E33M53_090. **b** SCAR marker for E41M32_206. KS: Koganesengan. HS: Hi-starch. 1-22: F_1 progeny plants. The reaction to the two SRKN races of F_1 plants was shown on top of each lane. R (S) indicated resistant (susceptible) reaction. In some F_1 progeny plants, the reaction to the SRKN races did not correspond with the presence or absence of the SCAR markers (as indicated by asterisk).

Research Paper

Koganemasari: New Sweetpotato Cultivar for Sweetpotato Shochu (Spirits)

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Introduction

"Koganemasari" is a newly released cultivar with high starch content for shochu developed at the NARO Kyushu Okinawa Agricultural Research Center. It was evaluated at prefectural agricultural experiment stations as breeding line "Kyushu No. 160" and submitted for variety registration in 2012.

Origin

The Koganemasari breeding program was initiated in 2002, and “Starch Queen” and “Kyukei236” were used as the crossing parents. Both parents have a high starch content and high yield. Three hundred forty three seeds were sown in the nursery. Selection was based on field performance and brewing properties.

Description

Koganemasari exhibits slightly better sprouting ability and is a slightly prostrate plant type. The top leaves are light green. The mature leaves are green and cordate. Anthocyanin does not accumulate in the vein and node. The tuber is short and fusiform with yellowish white skin and white flesh (Fig. 1). The appearance of the tubers is slightly better, but the steamed tuber is not palatable.

Performance

The tuber yield, dry matter content, and starch content of Koganemasari exceed those of Koganesengan, a leading cultivar for shochu in Japan (Table 1). The starch yield is 20% higher than that of Koganesengan under standard cultivation conditions. The alcohol yield of Koganemasari exceeds that of Koganesengan in the brewing of shochu (Table 1). The flavor of shochu made from Koganemasari is similar to that of Koganesengan.

Koganemasari is resistant to root-knot nematode and root-lesion nematode. The storability of Koganemasari tubers is superior to that of Koganesengan.

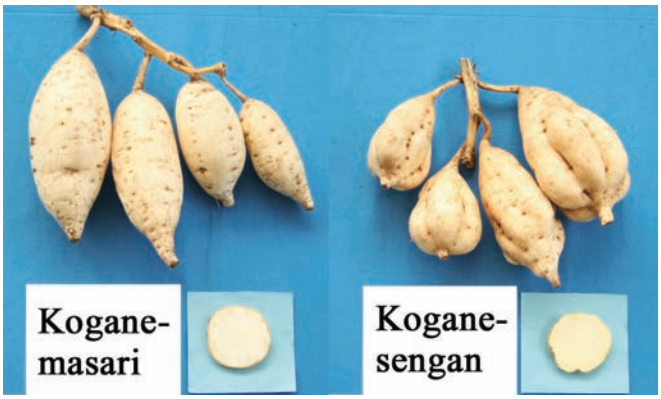

Fig. 1. Tuber with cross-section of Koganemasari

Table1. Yield and other traits of “Koganemasari” in yield trial (2007-2011, standard harvesting)

Traits	**Koganemasari**	Koganesengan
Tuber yield (t/ha)	**26.9**	26.5
Tuber size (g)	**244**	215
Dry matter content (%)	**38.7**	34.1
Starch content (%)	**26.9**	22.8
Starch yield (t/ha)	**7.3**	6.1
Root-knot nematode resistance[1)]	**R**	M
Root-lesion nematode resistance[1)]	**R**	MS
Storage ability[2)]	**H**	SL

1) R: resistant; M: moderately; MS: moderately susceptible.
2) H: High, SL: Slightly Low.

Table2. Results of brewing test of "Koganemasari" shochu at Miyazaki Prefectural Food and Development Center

Year	Cultivar	Alcohol yield (L/t of raw materials)	Sensory evaluation	
			Score*	Comments
2008	**Koganemasari**	225	**1.0** (n=5)	**Clear, Aromatic, Sweetness, Nonirritating, Harmonious**
	Koganesengan	194	1.6	Sweetpotato like, Aromatic, Umami, Nonirritating, Sweet
2009	**Koganemasari**	213	**1.4** (n=8)	**Aromatic, Sweetpotato like, Flowery, Sweet, Nonirritating, Sharp**
	Koganesengan	172	1.8	Aromatic, Sweetpotato like, Sweet, Nonirritating

* Evaluations were performed using a 3 point scale: 1 (very good), 2 (good) and 3 (bad).

Good Tasting Sweetpotato Cultivar "Beniharuka"

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Baked or steamed sweetpotatoes are usually eaten without seasoning in Japan. Japanese consumers thus expect sweetpotato cultivars for table use to taste good by themselves. Sweetness is most important, in addition to good mouthfeel and good flavor. In Japan, baked sweetpotatoes with a slightly dry mouthfeel had been preferred to moist ones for a long time. Recently, however, the number of people, especially young people, who like baked sweetpotatoes with a soft and slightly moist mouthfeel has been increasing.

"Beniharuka" is a new sweetpotato cultivar for table use developed by the National Agricultural Research Center for Kyushu Okinawa Region (KONARC) in 2007. The Beniharuka storage root has relatively uniform size and shape (Fig. 1) with a slightly moist mouthfeel and strong sweetness when cooked. Soluble solid content (brix) of its steamed root is higher than that of Kokei No. 14, the leading cultivar in western Japan, for all methods of cultivation in our trial (Fig. 2). Total sugar content of Beniharuka is also higher than that of Kokei No. 14, because the maltose and sucrose contents are higher (Fig. 3). These results clearly indicate that the quality traits of Beniharuka are stable and superior to those of Kokei No. 14.

Beniharuka is also used as processed food material. For example, steamed and dried slices are made from it in some areas (Fig. 4). The total cultivation area of Beniharuka increased year after year in Japan and has already reached over 500 ha in 2012. We hope Beniharuka will spread much more and be consumed by many people in the future.

Fig. 1. Storage root of "Beniharuka"

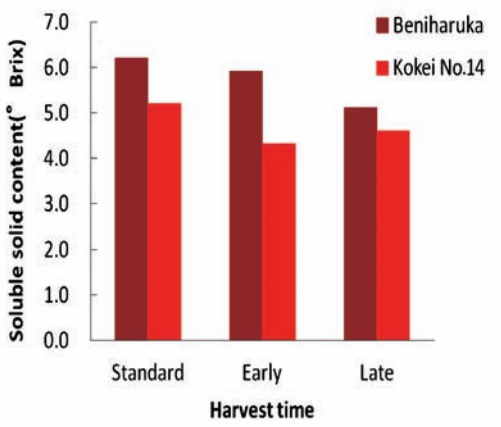

Fig. 2. Soluble solid content of steamed root
Measured of exudates from steamed root mash with 3 times weight of water.
The harvest time of "Standard" is early to middle of October, "Early" is beginning of August, and "Late" is the end of October. The transplant time of "Standard" is early May, "Early" is the end of April, and "Late" is early June.

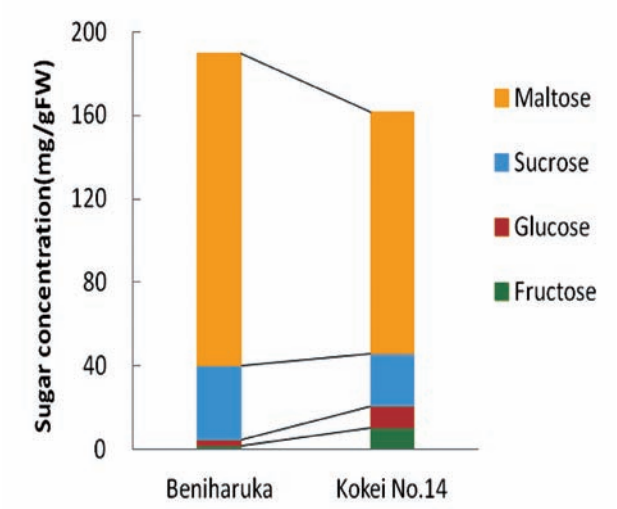

Fig. 3. Sugar concentration of steamed root

Fig. 4. Steamed and Dried Slices of "Beniharuka"

Effect of Fall Cropping New Oat Cultivar "Sniper" Which Suppresses Root-knot Nematode on Sweetpotato Yield

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Oats are mainly used as forage in the Kyushu region in Japan. We reported that the fall cropping of oat cultivar "Tachiibuki" causes poor reproduction of the southern root-knot nematode (*Meloidogyne incognita*) and has the potential as a nematode- suppressive agent. However, Tachiibuki doesn't reach the heading stage and the yield is low when seeded in late September. In order to overcome these faults, we developed new oat cultivar "Sniper" that suppresses root-knot nematodes and evaluated its characteristics.

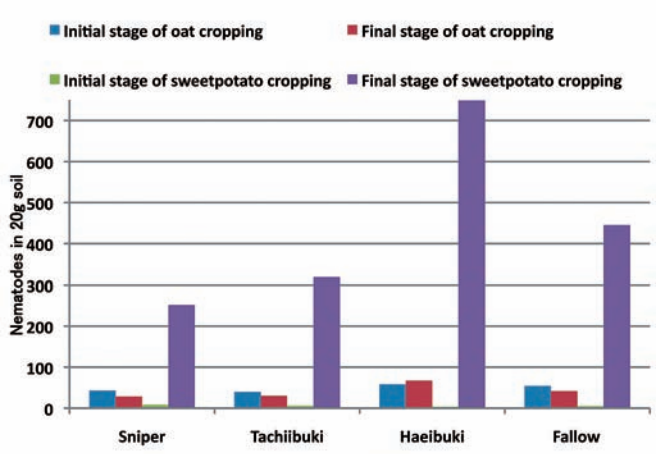

Fig. 1. Population densities of the second-stage juveniles of roof-kont nematodes in field plot soil before and after fall cropping of oat cultivars.

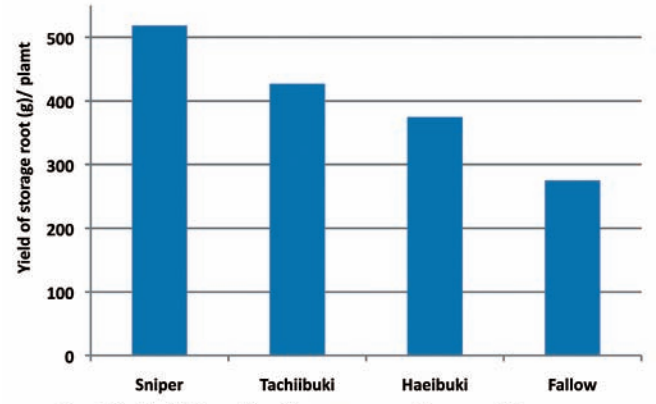

Fig. 2. Yield of "Miyazakibeni" storage root with no or slight defects caused by the root-knot nematodes in field plots previously cropped with oat cultivars.

Reproduction of *M. incognita* on Sniper and Tachiibuki was examined in a greenhouse. Egg masses produced on oat roots inoculated with 500 second-stage juveniles were counted. There were zero or few egg masses on Sniper and Tachiibuki (data not shown). The same results were obtained for *M. arenaria, M. javanica* and *M. hapla* (data not shown).

Fall cropping of three oat cultivars was conducted in an experimental field infested with *M. incognia* and *M. arenaria*. Fall cropping of Sniper suppressed the density increase of the nematodes in the soil as well as that of Tachiibuki (Fig. 1). Nematode damage to storage roots of susceptible sweetpotato Miyazakibeni was also suppressed following Sniper fall cropping compared to following Haeibuki and following the fallow period (Fig. 2). These results demonstrate that Sniper also has potential as a nematode- suppressive agent.

Characteristics of Sniper in fall cropping trials are presented in Table 1. Sniper heads earlier than Tachiibuki for seeding in the second half of September and yields more than Tachiibuki. We believe Sniper is an easy-to-use and effective means to promote collaboration between sweetpotato cultivation farms and livestock farms.

Table 1. Characteristics of "Sniper" in fall cropping trial

	Days to heading	Dry matter yield (kg/a)	Dry matter ratio (%)	Plant length (cm)
Seeding of the first half of September [1)]				
Sniper	**47**	**73.0**	**18.9**	**122**
Tachiibuki	65	76.1	16.1	120
Seeding of the second half of September [2)]				
Sniper	**53**	**65.1**	**16.3**	**112**
Tachiibuki	82	59.2	14.2	101

1) Average of 6 examinations in Miyazki, Kumamoto and Chiba in 2009 to 2010.
2) Average of 5 examinations in Miyazki, Kumamoto and Chiba in 2009 to 2010.

Research News

Report of the 5th Korea-China-Japan Workshop on Sweetpotato

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The 5th Korea-China-Japan Workshop on Sweetpotato was held at Ramada Plaza Hotel, Cheju Island, Korea, from 17 to 19 September 2012 to commemorate the 50th anniversary of the National Institute of Crop Science (NICS), RDA, Korea. The workshop was organized by NICS and the Korea Research Institute of Bioscience and Biotechnology (KRIBB). They gathered about 120 participants including three persons from Peru and Indonesia, where the International Potato Center (CIP) is located, and the USA (Cornell University). The symposium consisted of five sessions: (1) biotechnology, (2) pest control, (3) genomics, (4) functionality and bioenergy, and (5) genetic resources and cultivation. Twenty-eight research papers were presented orally and about 40 papers were delivered by posters. The theme of the symposium was "Sweetpotato for sustainable agriculture and beyond". It should be noted that the special session genomics was held in the center of workshop, which consisted of five excellent topics including research activities in CIP and Cornell University. Very recent research activities in CIP, Korea, China, and Japan such as omics, genetic and genomic analysis in polyploidy crop species, genome and transcriptome sequencing and molecular breeding were presented by invited speakers. The current status and prospects of sweetpotato genomic research and the value of forming an international consortium for sweetpotato genome sequencing were discussed. Furthermore, in the general discussion session, participants discussed forming a Sweetpotato Research Association for three countries and decided to launch this research association (Trilateral Sweetpotato Research Association, TSRA). On the final day of the workshop, we visited the Agricultural Research Center for Climate Change, RDA, Korea, and the mountain area of Mt. Halla. The 6th China-Japan-Korea Workshop on Sweetpotato will be held in Japan in November 2014.

Fig. 1. Workshop sign in the Hotel

Fig. 2. Display of Korean sweetpotato cultivars and products

Editor's note

Now (October) is the most busy-harvesting season of sweetpotato in Japan.I pray for a good harvest and a plentiful crop of sweet sweetpotatoes this year! (H.I).

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