# Utilization of Related Species on Breeding of Sweet Potato in Japan

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The main breeding objectives of sweet potatoes in Japan at present are to breed a variety of high starch content, high yielding, wide adaptation and resistant to diseases and pests suitable for industrial uses. Almost all sweet potato varieties in Japan have more or less hereditary relationship because parental materials of breeding were not so varietal as other crops.

Since 1956, foreign varieties have been used as parents to introduce new genes into indigenous varieties. The L-4-5 (Pelican Processor, a variety in the U.S.A.) and the T.No. 3 (an introduced variety from Indonesia) were employed as the parental materials of high yielding, high starch content and widely adapted new variety "Koganesengan".

Also, related species of sweet potato have been studied to use them as the parental materials of breeding, and more than one hundred species were screened since 1955. As the result, section *Batatas* genus *Ipomoea* was recognized to be profitable for breeding of sweet potatoes.

The accession numbers, names of species and other characteristics of the genetic stocks belonging to this section in Ibusuki are shown in Table 1. There are diploid, triploid, tetraploid and hexaploid species in it. They are short day plant and there is a tendency that low polyploid species show easy flowering.

Some of the diploid species are autogamy and propagated by seed, but the tetraploid and hexaploid species are allogamy and propagated by pencil-like root, and none of them produces a tuberous root as sweet potato.

**Table 1. Accession numbers, names of species and other characters of section *Batatas* genus *Ipomoea* in Ibusuki**

| Polyploid | Accession No. | Species[1] | Place of collection | Chromosome No. | Autogamy or Allogamy |
|---|---|---|---|---|---|
| Diploid | K 61 | *I. lacunosa* | U.S.A. | 30 | Autogamy |
| | K 121 | *I. triloba* | Mexico | 30 | Autogamy |
| | K 221 | *I. leucantha* | Mexico | 30 | Allogamy |
| Triploid | K 222 | *I.* (*trifida* 3*x*) | Mexico | 45 | Allogamy |
| Tetraploid | K 134 | *I. gracilis* | Mexico | 60 | Allogamy |
| | K 233 | *I. littoralis* | Mexico | 60 | Allogamy |
| | K 270 | *I. tiliacea* | Puerto Rico | 60 | Allogamy |
| Hexaploid | K 123, K177 | *I. trifida* | Mexico | 90 | Allogamy |
| | IB 63001–5 | *I.* (*trifida* 6*x*) | bred at Ibusuki | 90 | Allogamy |

Remarks 1) Names of species were designated by Nishiyama and Teramura.

These species are tried to be used as parental materials to introduce their beneficial genes into sweet potato.

## Use of K 123

Among the related species in section *Batatas*, the K 123 (which was designated *Ipomoea* trifida by Nishiyama but Jones objected to it and maintains his opinion as it is an extreme segregate of *I. batatas*) had been used as a parent of crosses with sweet potato varieties, because of its high resistance to root lesion nematode *(Pratylenchus spp.)*.

Up to date, eight strains were bred using the K 123 as the parent. The names and characteristics of the strains are shown in Table 2. Seven of them were developed from the two-times backcross between $F_1$ of K 123 and L-4-5 as a donor and sweet potato varieties as the recurrent parent.

Starch contents of these strains are two or three percent higher and these strains are superior in yield than the standard sweet potato varieties. Some strains possess high degree resistance to black rot (*Ceratostomella fimbriata*), root lesion nematode and root knot nematode (*Meloidogyne spp.*). Another strain was bred from the one-time backcross between the K 123 and sweet potato.

As far as the number of backcrosses are concerned, the one-time backcross seems to be not enough to exhibit the yielding ability from the sweet potato varieties, and rather pulled down the yield by low yield of the K 123, and two-times backcrosses appear to

**Table 2. Names and characteristics of strains using K 123 as the parent**

| Names of Strains | Cross[1] | | Using generation | Percentage[2] of yield | Starch content | Resistance to diseases[3] | | |
|---|---|---|---|---|---|---|---|---|
| | ♀ | ♂ | | | | R.L.N. | R.K.N. | B.R. |
| Kyushu 58 | Kanto 48 | LM 17 | $B_1$ | 121% | 26.1% | R[4] | R | R |
| Kyushu 60 | I 95-57 | Ariakeimo | $B_2$ | 115 | 24.9 | S | R | M |
| Kyushu 61 | I 95-193 | N 7-1095 | $B_2$ | 149 | 24.7 | R | R | R |
| Kyushu 63 | I 95-193 | Konasengan | $B_2$ | 131 | 25.6 | M | R | M |
| Kyushu 64 | I 95-193 | Kyushu 52 | $B_2$ | 132 | 24.7 | R | R | S |
| Kyushu 65 | I 95-193 | Kyushu 52 | $B_2$ | 119 | 26.3 | R | R | R |
| Kanto 73 | I 95-193 | Kanto 41 | $B_2$ | 125 | 19.4 | | S | R |
| Kanto 75 | I 95-193 | Kanto 41 | $B_2$ | 111 | 19.6 | | M | R |

Remarks 1) LM 17: L-4-5×K 123-11, I 95-57 and I 95-193: Kanto 48×LM 17
2) Yield of Kyushu strains were compared with Norin 2 and that of Kanto strains with Norin 1.
3) R.L.N.: root lesion nematode, R.K.N.: root knot nematode B.R. : black rot
4) R: resistant, M: medium, S: susceptible

**Table 3. Crossability between related species**

| ♀ \ ♂ | K 221 | K 233 | K 222 | IB 63001-5 | K 123 | Sweet potato | K 61 | K 121 | K 134 | K 270 |
|---|---|---|---|---|---|---|---|---|---|---|
| K 221 (2$x$) | + | + | − | − | − | − | − | − | − | − |
| K 233 (4$x$) | + | + | + | + | + | + | − | − | − | − |
| K 222 (3$x$) | + | + | + | + | + | + | − | − | − | − |
| IB 6001-5 (6$x$) | + | + | + | + | + | + | − | − | − | − |
| K 123 (6$x$) | − | + | + | + | + | + | − | − | − | − |
| Sweet potato (6$x$) | − | + | + | + | + | + | − | − | − | − |
| K 61 (2$x$) | − | − | − | − | − | − | + | + | + | + |
| K 121 (2$x$) | − | − | − | − | − | − | + | + | + | + |
| K 134 (4$x$) | − | − | − | − | − | − | − | − | + | + |
| K 270 (4$x$) | − | − | − | − | − | − | − | − | + | + |

Remarks: + : Possible to cross − : Impossible to cross be good enough for this purpose.

The strains which were backcrossed two times do not exhibit a twining slender stem, and their morphological characteristics are almost similar to that of sweet potato. From this result, it is recommended that two-times backcross of sweet potato into K 123 is necessary to breed an economical variety of sweet potato.

## Interspecies hybrid of related species

The K 222 (it was designated as triploid of *I. trifida*), K 233 and the IB 63001-5 (which were hexaploid doubled chromosome number by the hybridization between strains of K 222) were used as parental materials of crossing with sweet potato varieties besides K 123. Use of one species of related plant would be able to introduce good characters of the same species but related species of sweet potato do not possess many desirable characteristics in one species.

So as to combine all useful genes in one species, it was designed to make interspecies crossing among different species. For example, K 123 possesses high resistance to root lesion nematode as mentioned above, K 222 and IB 63001-5 show resistance to root knot nematode and K 233 is presumed to be resistance to drought from its stem character. It is very important and interesting to breed a strain which combines all these characters.

As a first step of this work, crossability between the related species of the section *Batatas* was investigated. The result of crossability is shown in Table 3. Nine species of this section were divided into two groups due to their crossability. The K 221 ($2x$), K 233 ($4x$), K 222 ($3x$), IB 63001-5 ($6x$, derived from K 222) and K 123 ($6x$) belong to Group 1 and the strains of this group are able to cross with the sweet potato directly or through the bridge plant.

Other species, K 61, K 121 ($2x$), K 134 and K 270 ($4x$) form Group 2 which does not cross with the sweet potato and strains of Group 1. The method of the crossability test is to investigate the percentage of germinated pollen on the stigma and the degree of growth of pollen tube in the style at several hours after the artificial pollination.

Cross-incompatibility is observed in related species as similar as the sweet potato. At present, there are eight groups of cross sterile in the K 123 and K 177 respectively, four groups in the K 221 and K 270 respectively, three groups in the K 222 and one group in the K 134. Some groups of cross-incompatibility show similar response to that of the sweet potato.

## Result of interspecific hybridization

From the interspecific hybridization, the following polyploid was bred from 1962 up to date. Some of them had been used as parental materials of crossing with the sweet potato.

*1) Synthesized hexaploids*

(1) K 233 × K 221 : K 233 ($4x$) was crossed with K 221 ($2x$) and progeny of $3x$ had doubled the chromosome number with colchicine. There are five strains and arranged by putting a letter *H* on the top of the number. These strains are used as the parent, and $F_1$ hybrid of sweet potato with them had been tested about the economical characteristics.

(2) K 61 × K 134 : K 61 ($2x$) was crossed with K 134 ($4x$), both species belong to Group 2 and $F_1$ ($3x$) plants were treated with colchicine for doubling the chromosome number. Synthesized hexaploid was crosed with the sweet potato and species of Group 1, but it had failed. The relationship between groups 1 and 2 are believed to be quite far.

*2) Triple hybrid*

(1) (IB 63005 × K 221) × K 233 : IB 63005 ($6x$, which was induced from K 222) was crossed with K 221 ($2x$) and $F_1$ of this cross was $4x$ and was mated with K 233 ($4x$). Progeny of triple hybrid arranged with the TR on the top and these strains possess good crossability with the sweet potato. The seed developed from the cross between the triple

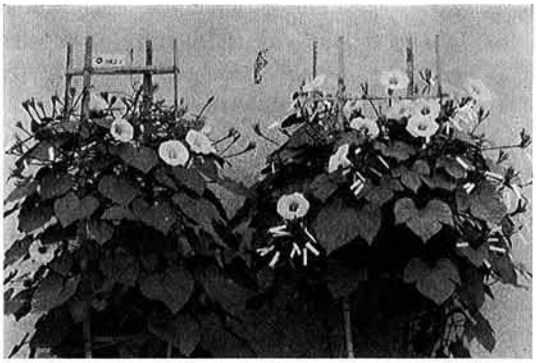

Fig. 1. Strains of interspecific hybrid.
Left: triple hybrid (IB 63005 × K 221) × K 233
Right: synthesized hexaploid K 233 × K 221

hybrid and sweet potato will be examined to utilize in practical cultivation.

(2) (K 233 × K 221) × K 123 and (K 233 × K 221) × IB 63005: Synthesized hexaploid as mentioned above was made by hybridization between K 123 and IB 63005. The progeny of both crosses are put on HT and HD on the top of number for arrangement respectively.

*3) Triple hybrid*

(1) ((IB 63005 × K 221) × K 233) × K 123: Triple hybrid as mentioned above was used as the parent of cross with K 123. There is a possibility to combine the useful characters in different species such as resistance to diseases and pests in one plant.

Besides this hybrid, more than ten crosses were made between related species, and some of them were considered to be used as parental materials for breeding purposes of the sweet potato. At present, crosses between interspecies hybrid and sweet potato are progressing. Hybrid of these crosses will be tested for economical characters at the breeding laboratories of Central (Chiba), Chugoku (Fukuyama) and Kyushu (Kumamoto) Agricultural Experiment Stations from the generation of seedling.

To increase the efficiency of sweet potato breeding, it is considered to be necessary to find out a suitable screening method for diseases, pests and other physiological characters on the early generation of breeding. Also to collect and introduce more strains of related species is an urgent program facing us.

## References


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