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Development of the Parthenocarpic Eggplant Cultivar 'Anominori'

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Abstract

Using pollinator insects or treating flowers with phytohormones is necessary for stable fruit setting in forcing culture of eggplant using plastic houses. However, these means are costly and/or labor-intensive. Use of parthenocarpic cultivars is considered to be the most cost-effective solution for stable fruit setting under sub-optimal environmental conditions such as lower temperature in forcing culture. 'Anominori', a parthenocarpic eggplant cultivar, was developed by the National Institute of Vegetable and Tea Science in 2006. This cultivar is the F_1 hybrid between two parthenocarpic inbred lines, 'AE-P08' and 'AE-P01'. 'AE-P08' was selected from the cross between an F_3 plant derived from 'Nakate Shinkuro' × 'Talina' and an F_4 plant derived from 'Talina' × 'Nasu Chuukanbohon Nou 1'. 'AE-P01' was selected from the cross between 'Talina' and 'Nasu Chuukanbohon Nou 1'. 'Anominori' can produce sufficient yields for commercial use without treating with phytohormones or using pollinator insects in forcing culture. The plant characteristics of 'Anominori' are the following: high plant height, long internode, thick stem and large leaves. The fruit of 'Anominori' at harvest stage is long egg-shaped and glossy dark purple. The flesh of fruit is very dense.

Discipline: Plant breeding
Additional key words: breeding, parthenocarpy, *Solanum melongena*

Introduction

Using pollinator insects[3] or treating flowers with phytohormones[7] is necessary for stable fruit setting in forcing culture of eggplant using plastic houses. However, these means are costly and/or labor-intensive; it is necessary to keep a plastic house warm for pollinator insects to be active or treating flowers with phytohormones takes about 25–30% of total working hours required for eggplant forcing culture. Use of parthenocarpic cultivars is the most cost-effective solution for stable fruit setting under sub-optimal environmental conditions such as lower temperature in forcing culture.

Several parthenocarpic eggplant cultivars have been bred in Europe. Moreover, transgenic parthenocarpic eggplants have been produced and evaluated under plastic houses and open field cultivation[1,2,4,5]. However, it was very difficult to introduce and distribute these cultivars to Japan because of their undesirable agricultural characteristics for Japanese people such as green calyx, reddish purple fruit and low yield.

In Japan, we started the breeding program to develop a parthenocarpic eggplant cultivar acceptable to Japanese consumers in 1994 using a European parthenocarpic cultivar 'Talina' kindly provided by Dr. Giuseppe Leonardo Rotino, Research Institute for Vegetable Crops, Italy. 'Anominori', a parthenocarpic eggplant cultivar which has glossy dark purple calyx and fruit preferred by Japanese consumers was developed at the National Institute

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of Vegetable and Tea Science (NIVTS) in 2006. Here we introduce the procedure of development and characteristics of 'Anominori'.

Materials and methods

1. Development of 'Anominori'

'Talina', a commercial parthenocarpic F_1 hybrid released by Sluis & Groot Co. Ltd. and widely cultivated in Italy, was used as a breeding material for parthenocarpy (Fig. 1). 'Talina' was crossed to 'Nakate Shinkuro', a Japanese cultivar and also crossed to 'Nasu Chuukanbohon Nou 1', a parental line bred by NIVTS in 1994. Individuals having fruit quality favorable for Japanese people such as glossy dark purple calyx and fruit and exhibiting high parthenocarpic ability had been selected from the progenies. 'AE-P08' was selected from the cross between an F_3 plant derived from 'Nakate Shinkuro' × 'Talina' and an F_4 plant from 'Talina' × 'Nasu Chuukanbohon Nou 1'. 'AE-P01' was selected from 'Talina' × 'Nasu Chuukanbohon Nou 1'. The F_1 hybrid between two parthenocarpic inbred lines, 'AE-P08' and 'AE-P01', was named 'Anominori'.

2. Characteristics of 'Anominori'

Performance of 'Anominori' was tested in forcing culture in 2004 and in open field culture in 2005 at NIVTS using two Japanese leading cultivars, 'Senryou Nigou' (TAKII & CO., Ltd.) and 'Chikuyou' (TAKII & CO., Ltd.) as standard cultivars. Yield of marketable fruits and characteristics of plant and fruit were evaluated.

3. Parthenocarpy in 'Anominori'

(1) Experiment 1. Forcing culture by training three main branches

Ten plants each of 'Anominori', 'Senryou Nigou' and 'Chikuyou' were tested for performance. A steel frame greenhouse, 6 m wide and 20 m long, was covered by plastic polyethylene film. Seeds were sown on 20 August 2006. Plantlets at ten leaves stage were transplanted to the field in raised beds on 5 October. Plants were laid out 0.6 m apart in rows with an inter-row distance of 1.2 m. Three main branches were trained. Phytohormones were not treated during the experiment. Styles of at least five flower buds per each plant were excised from October to November. Percentage of parthenocarpy was calculated as the ratio of the number of fruits grown to marketable size to that of flower buds with the style excised.

(2) Experiment 2. Forcing culture by training one main branch

Six plants each of 'Anominori', 'AE-P08', 'AE-P01', 'Senryou Nigou', 'Chikuyou', 'Nakate Shinkuro', 'Talina 2/1' (a parthenocarpic doubled haploid line of 'Talina', provided by Dr. G. L. Rotino in 1994), and 'Mileda' (Novartis Seeds B. V.) were tested for performance. A steel frame greenhouse, 8 m wide and 20 m long, was covered by F-CLEAN® (ASAHI GLASS CO., LTD) film. Seeds were sown on 20 August 2006. Plantlets at ten leaves stage were transplanted to the field in raised beds on 5 October. Plants were laid out 0.4 m apart in four double rows, with an intra-row distance of 0.6 m and an inter-row distance of 1.8 m. A main branch was trained. Phytohormones were not treated during the experiment. Styles of at least five flower buds per each plant were excised from October to November. Percentage of parthenocarpy was calculated as the ratio of the number of fruits grown to marketable size to that of flower buds with the style excised.

(3) Experiment 3. Summer cultivation by training three main branches

A steel frame greenhouse, 6 m wide and 20 m long, was covered by plastic polyethylene film. Seeds were sown on 21 August 2006. Plantlets were transplanted to the field in raised beds on 1 November. Plants were laid out 0.6 m apart in rows with an inter-row distance of 1.2 m. Three main branches were trained. Phytohormones were not treated during the experiment. Styles of at least five flower buds per each plant were excised from June to July in 2007. The percentage of parthenocarpic fruits was calculated as the ratio of the number of fruits grown to marketable size to that of flower buds with the style ex-

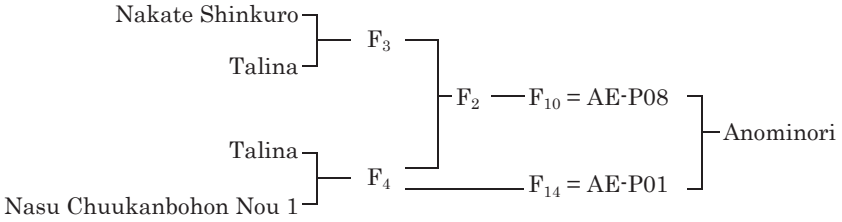

Fig. 1. The pedigree of 'Anominori'

cised.

Results and discussion

'Anominori' is the F_1 hybrid between two parthenocarpic inbred lines, 'AE-P08' and 'AE-P01' (Figs. 1 & 2), and was registered as 'Nasu Nourin Kou 4' by the Ministry of Agriculture, Forestry and Fisheries of Japan in 2006.

The plant morphological characteristics of 'Anominori' are the following: high plant height, long internode, thick stem, and long petiole (Table 1). The fruit of 'Anominori' at harvest stage is long egg-shaped and glossy dark purple (Table 2 & Fig. 2). The flesh of fruit is very dense. The yield of marketable fruits of 'Anominori' was 456 kg/a, which is adequate for practical use in forcing culture, compared to 67 and 151 kg/a in 'Senryou Nigou' and 'Chikuyou', respectively (Table 3). On the other hand, the yields of 'Anominori' were lower than those of 'Senryou Nigou' and 'Chikuyou' in open field culture both in 2004 and in 2005 (Table 3).

(1) Experiment 1. Forcing culture by training three main branches

In order to compare the parthenocarpic ability

Fig. 2. Fruits of 'AE-P08' (upper left), 'AE-P01' (upper right), 'Anominori' (lower right) and plants of 'Anominori' (lower left)
Each bar is 10 cm.

Table 1. Plant characteristics of 'Anominori'

Cultivar	Plant height	Internode length	Stem thickness	Stem color	Petiole length	Plant branching
Anominori	slightly tall	slightly long	thick	purple	slightly long	slightly weak
Senryou Nigou	intermediate	intermediate	intermediate	purple	intermediate	slightly strong
Chikuyou	tall	slightly short	slightly thick	purple	slightly long	slightly strong

Table 2. Marketable fruit of 'Anominori'

Cultivar	Length		Diameter		Weight		Shape	Color of calyx
	(mm)	SE	(mm)	SE	(g)	SE		
Anominori	138.3	9.3	55.0	2.9	119.2	4.1	long egg-shaped	purple-black
Senryou Nigou	143.0	2.1	48.0	1.0	102.1	3.3	long egg-shaped	purple-black
Chikuyou	174.0	8.7	44.7	0.3	102.7	3.5	slightly elongated	purple-black

Table 3. Yield of 'Anominori'

Cultivar	Yield of marketable fruits (kg/a)		
	Forcing culture in 2004	Open field culture in 2004	Open field culture in 2005
Anominori	456	908	784
Senryou Nigou	67	1,021	843
Chikuyou	151	1,102	929

No cultivars were treated with phytohormones.
Fruits were harvested from 25 October 2004 to 22 March 2005 in forcing culture of 2004, from 23 June to 29 September in open field culture of 2004, and from 6 June to 30 September in open field culture of 2005.

Table 4. Parthenocarpy in 'Anominori'

Cultivar	Abscised flowers		Malformed fruits		Parthenocarpic fruits	
	(%)	SE	(%)	SE	(%)	SE
Anominori	11.3	2.8	4.0	4.0	84.8	4.8
Senryou Nigou	31.7	4.1	68.3	4.1	0.0	0.0
Chikuyou	51.9	5.5	47.0	5.9	1.1	1.1

Parcentages of abscised flowers, malformed fruits and parthenocarpic fruits were calculated as the ratio of numbers of abscised flowers, malformed fruits and fruits grown to marketable size to that of flower buds with the style excised.

Table 5. Comparison of parthenocarpic ability in some eggplant cultivars

Cultivar	Abscised flowers		Malformed fruits		Parthenocarpic fruits	
	(%)	SE	(%)	SE	(%)	SE
Anominori	45.0	12.6	0.0	0.0	55.0	12.6
AE-P08	40.0	11.0	0.0	0.0	60.0	11.0
AE-P01	42.0	9.2	0.0	0.0	58.0	9.2
Mileda	100.0	0.0	0.0	0.0	0.0	0.0
Talina 2/1	100.0	0.0	0.0	0.0	0.0	0.0
Senryou Nigou	95.0	5.0	5.0	5.0	0.0	0.0
Chikuyou	80.0	8.2	20.0	8.2	0.0	0.0
Nakate Shinkuro	90.0	10.0	10.0	10.0	0.0	0.0

Parcentages of abscised flowers, malformed fruits and parthenocarpic fruits were calculated as the ratio of numbers of abscised flowers, malformed fruits and fruits grown to marketable size to that of flower buds with the style excised.

among three cultivars, the development of fruits after excision of styles was observed. Three patterns were observed: flower abscission, malformed fruit set and parthenocarpic fruit development. The percentage of parthenocarpic fruits was 84.8% in 'Anominori', but 0.0 and 1.1% in 'Senryou Nigou' and 'Chikuyou' (Table 4). On the other hand, the number of flowers abscised and that of malformed fruits were higher in 'Senryou Nigou' and 'Chikuyou' than in 'Anominori'.

(2) Experiment 2. Forcing culture by training a main branch

Parthenocarpic fruits of marketable weight and size were produced from 55.0, 60.7 and 58.0% of flower buds after excision of styles in 'Anominori', 'AE-P08' and 'AE-P01', respectively (Table 5). However, no fruits of marketable size set in European parthenocarpic cultivars, 'Mileda' or 'Talina 2/1' (Table 5). No fruits of marketable size were also produced in non-parthenocarpic 'Senryou Nigou', 'Chikuyou' or 'Nakate Shinkuro'. The reason why the expression of parthenocarpy in 'Anominori' was weaker in experiment 2 than in experiment 1 is unknown. It might be affected by culture conditions, methods of training branches, temperature, etc.

(3) Experiment 3. Summer cultivation by training three main branches

Parthenocarpic fruits of marketable weight and size were produced from 10% (39/381) of flower buds after excision of styles in 'Anominori' under the summer conditions. It was thought to be difficult to express parthenocarpic trait under hot conditions. This does not mean that 'Anominori' is not suitable for summer cultivation in Japan because fertilized fruits of 'Anominori' can be produced in summer season (Table 3).

The parthenocarpic eggplant cultivars so far available still need phytohormone applications to produce fruits of marketable size in Europe[2]. Also in our results, the European parthenocarpic cultivars, 'Talina 2/1' and 'Mileda' could not produce commercial fruits in forcing culture, while 'Anominori' could produce sufficient yields. It may be possible that 'Anominori' can produce sufficient yields even in European winter conditions. Although the European parthenocarpic cultivars seemed to have high ability to elongate fruits once set without pollination, they have low ability to set fruits. By contrast, Japanese cultivars have high ability to set fruits without pollination but low ability to elongate the fruits. 'Anominori' is thought to have both these abilities. Now we are trying to breed a new parthenocarpic and perfectly seedless cultivar using cytoplasmic male sterility[6].

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