

9. Vietnam

Breeding New Rice Variety DT39 Quelamby Gamma Ray

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9.1 Introduction

In 2012, Vietnam rice export reached 7.7 millions of tons and overcomes Thailand and becomes the biggest country for rice export in the world. However, price of Vietnamese rice in international market is often lower than of Thailand's because the quality is lower. Vietnam government conducts many breeding projects for rice quality improvement. One of the most effective methods for rice quality improvement is mutation breeding by irradiation of Gamma rays ^{60}Co source combined with selection process. Generally, mutation breeding by irradiation of Gamma rays has many advantages compared to other breeding methods such as improvement of one or some characteristics while maintaining the rest characteristics of variety. In Vietnam, rice variety Bacthom No.7 has very good cooking quality, easily cultivated, relatively short growth duration, stable grain yield potential but poor resistance to bacterial leaf blight. That's why, Bacthom No.7 is not widely cultivated in many locations, especially in summer season.

For the above reasons and also as a follow up on the sub-project on composition or quality in rice under the FNCA, we carried out the project "Improvement of Bacthom No.7 by irradiation of dried seeds with gamma rays of ^{60}Co source".

Aims of research: Creation of new rice variety with good cooking, high quality, easily cultivated, short growth duration, high and stable grain yield, and good resistance to bacterial leaf blight.

9.2 Materials and Methods

3,000 dry seed at 13% moisture content was used for irradiation by gamma ray ^{60}Co source at the range doses of 150, 200 and 250Gy in the K hospital, Hanoi. The experiment was started in summer season 2008.

9.3 Results and Discussion

9.3.1 Selection Process

9.3.1.1 M_1 generation: All main panicles in M_1 generation were harvested to develop M_2 population.

9.3.1.2 M_2 generation: At the dose of 150Gy, there were no differences observed. However, from 1,753 individual plants harvested from 200Gy, the frequency of variation observed was around 3%. Mutants with changed characteristics consist of morphological traits, growth duration, tillering ability, hard stem, seed size and so on. From those variations observed, 112 mutant lines were harvested individually for M_3 . At 250Gy, obtained variations included high sterility ratio and short plant height. However, most of these variations were not useful for breeding, therefore all plants from this dose were not included in the next experiment.

9.3.1.3 M₃ generation: Single plants were cultivated and evaluated separately, each plant is considered as one family. Selection was continued to discard unfavorable lines for example less seed, less panicle, or sterile plants and so on. Elite individuals in M₃ were selected to develop promising rice lines in M₄ generation. There were some elite individuals with better economic characteristics compared to control variety namely BT15-1, BT15-2, BT15-3 BT20-1, BT20-2, and BT20-4 with long seed, good cooking quality, high grain quality, and resistant to bacterial leaf blight. BT20-2 and BT20-2 have higher 1,000 seeds weight, 25.89g and 31.73g, respectively.

9.3.1.4 M₄ - M₆ generation: From 4 promising lines in M₅, one outstanding lines M₆-20.3 was selected and showed no segregation, hard stem, long seed, stable grain yield potential, and good resistant to bacterial leaf blight. Line M₆-20.3 was named DT39 Quelam and further evaluated in narrow scale for agronomic and biological trait by author. Beside of that DT39 Quelam was officially sent to the National Testing Center for Crop to test for **Value of Cultivation and Use of crop (VCU)** from M₆- M₈ generation (during 2011- 2012).

9.3.2 Evaluation Process

9.3.2.1 Evaluation results of author

Evaluation experiment was carried out in order to compare yield performance and agronomic trait with the control Bacthom 7 in both seasons. The result showed that the yield in spring season was higher than summer season in both varieties, and DT39 Quelam had higher yield than Bacthom 7 in both season.

Table 1: Evaluation agro-biological characters and yield of DT39 Quelam by author
(Spring and summer 2010 in Tuliem, Hanoi)*

Variety	Growth duration (days)	Plant height (cm)	No panicle/ plant	Panicle length (cm)	Number seed/ panicle	Seed set ratio (%)	Yield (tons/ha)
DT39 Quelam	Spring: 132	102,2 ± 0,30	5,5 ± 0,28	30,2 ± 0,24	162,3 ± 6,13	89,5 ± 0,32	6,3 ± 0,31
	Summer: 105	112,2 ± 0,22	5,0 ± 0,30	28,5 ± 0,27	147,3 ± 6,05	88,2 ± 0,25	5,9 ± 0,30
Bacthom Control	Spring: 134	98,6 ± 0,27	5,2 ± 0,22	22,3 ± 0,30	152,5 ± 5,76	87,5 ± 0,31	5,6 ± 0,26
	Summer: 106	107 ± 0,32	5,2 ± 0,30	20,6 ± 0,23	140,2 ± 6,20	82,3 ± 0,28	5,0 ± 0,31

*Transplanting 1 seedling per hill, 45 hills per square meter.

The results in the above table showed that mutant line DT39 Quelam and Bacthom 7 have the same growth duration. Panicle length of DT39 Quelam is longer than Bacthom 7 and number of seeds was also higher. The resulting grain yield of DT39 Quelam was higher than that of Bacthom 7.

Table 2 shows the main characteristics of DT39 Quelam and Bacthom 7.

Table 2: Some main characteristics of mutant DT39 Quelam and control Bacthom 7

	Characteristics	Bacthom 7 (control variety)	DT39 Quelam (mutant variety)
1	Growth duration (days) - Spring - Summer	130-135 105-108	130-135 104-106
2	Plant height (cm)	106	110
3	Tilerring ability	Medium	Medium
4	Leaf colour in harvest	Ligh yellow	yellow
5	Flag Leaf type	short, narrow, incline	short, narrow, arrect
7	Stem hardness	Hard	Harder
8	Flowering duration (days)	5	5
9	No. of panicle/hills	5.4	5.5
10	Panicle length (cm)	25.2	28.2
12	No. of seeds/panicle	140	155
13	Abort grain ratio (%)	12-15	12-17
14	Awn	Absent	Short and partly
15	Weight of 1000 seeds (gram)	19.2	23.8
16	Seed type	Small, short (2.0-7.2 mm)	Small, length (2.2-9.3 mm)
17	Husk color	Light brown	Dark brown

The data in table 2 showed that mutant variety DT39 Quelam7 was not so much different from Bacthom 7 in 17 phenotype characters. In some main characters such as length of panicle, grain weight of 1,000 seeds, number of seeds per panicle DT39 Quelam was higher than Bacthom 7. DT39 Quelam had harder stem, darker husk color than Bacthom 7.

9.3.2.2 Evaluation results of The National Testing Center for Crop (NTCC)

The National Testing Center for Crops (NTCC) is the unique office that is responsible for independently evaluating and testing new varieties in Vietnam before release.

DT39 Quelam had been sent to NTCC for testing and evaluation in three continuous seasons (summer season 2011, spring and summer season 2012).

Table3: Assessment for agronomic traits of DT39 Quelam variety by NTCC (Source: NTCC)*

Seasons	Variety	Seedling vigor (points)	Flowering duration (points)	Plant hardness (points)	Plant height (cm)	Growth duration (days)
Summer 2011	BT7 (control)	5	5	3	112.8	106
	DT39 Quelam	5	5	1	120	105
Spring 2012	BT7 (control)	5	5	1	101	139
	DT39 Quelam	1	5	1	106	140
Summer 2012	BT7 (control)	5	5	1	108.5	107
	DT39 Quelam	5	5	1	112.8	104

*points: from 1 to 9 means best to worst

The result of NTCC for Crop for three continuous seasons (Table 3) showed that generally, DT39 Quelam and Bacthom 7 (BT7) have the appropriate growth duration for rice production in many locations in spring season and shorter in summer season, 104-105 days (DT39 Quelam), 106-107 days (Bacthom 7). In spring season 2012, seedling vigor of DT39 Quelam was point 1 (cold tolerant) better than Bacthom 7, point 5. Plant height of DT39 Quelam was higher than Bacthom 7, flowering duration was similar in both varieties.

Table 4 induced that grain weight of DT39 Quelam was higher than Bacthom 7 in three tests. But the data also showed the disadvantage of DT39 Quelam. The abort ratio in three test was higher than Bacthom 7 and the purity (point 1, 5 and 3 for each season) was lower than Bacthom 7 (point 1) in three tests. However, field purification index of variety could be improved by selection process.

Evaluation of 1,000 grain weight of DT39 Quelam and Bacthom 7 (table 5) showed clearly different between two varieties. 1,000 grain weight of origin variety, Bacthom 7 was from 18.5g to 19.2g meanwhile that of DT39 Quelam was from 23.2g to 25.2g in three seasons. It may result that the yielding performance of DT39 Quelam is often higher than Bacthom 7 (table5).

Table4: Variety purity and other traits (Source: NTCC)*

Seasons	Variety	Purity (points)	No.panicl e per hill	No. Seeds per panicl e	Abort ratio (%)	Grain Weight of 1,000 seeds (g)
Summer 2011	BT7	1	5.2	141	17.6	18.5
	DT39 Quelam	1	5.0	147	22.0	23.2
Spring 2012	BT7	1	5.2	152	13.0	18.6
	DT39 Quelam	5	4.9	148	16.6	24.8
Summer 2012	BT7	1	5.6	139	11.9	19.2
	DT39 Quelam	3	5.6	145	22.5	25.2

*points: higher means better.

Table5: Yield performance evaluation in rice production trials (Source: NTCC)Unit: tons/hectare

Season	Variety	Location												Aver.
		Hung Yên	Hải Dương	Nghệ An	Thái Bình	Thanh Hoá	Vĩnh Phúc	Hòa Bình	Hà Tĩnh	Hải Phòng	Tuyên Quang	Bắc Giang	Điện Biên	
Summer 2011	BT7	5.47	5.18	-	3.79	4.28	5.07	-	4.81	6.24	4.99	-	-	4.98
	DT39 Quelam	5.67	5.39	-	3.83	4.13	5.59	-	5.15	6.60	5.59	-	-	5.23
Spring 2012	BT7	5.23	3.87	6.00	3.56	4.81	5.10	5.73	4.76	-	-	-	-	4.88
	DT39 Quelam	5.47	4.24	5.57	3.41	5.67	6.13	5.63	5.23	-	-	-	-	5.17
Summer 2012	BT7	5.79	5.74	-	3.90	4.83	3.47	4.97	-	-	-	5.77	5.37	4.98
	DT39 Quelam	6.06	6.00	-	5.03	5.44	4.60	4.67	-	-	-	6.73	6.20	5.59

In three continuous seasons of the test for value of cultivation and use, the mutant variety gave higher yield compare to Bacthom 7. In summer 2011, DT39 Quelam gained 5% compare to Bacthom 7. Especially at 6/8 location trail test in summer 2012, the yield of DT39 Quelam reached average 5.59 t/ha higher by 12.24% while that of Bacthom 7 was 4.98 t/ha.

For the rice production in northern part of Vietnam, Bacthom 7 variety is mainly grown in spring season, because this variety often gives high yield, good quality and moreover but it is very sensitive to bacterial leaf blight in summer season. Therefore, the cultivation area is significant decreased even the quality is accepted for consumption. The result from the NTCC indicated that new mutant variety DT39 Quelam could be used for summer season.

Table6: Resistant ability for pests and diseases (Source: NTCC)

Seasons	Variety	Blast		Sheath blight	Bacterial Leaf blight	Brown blight	Stem borer	Leaf roller	Brown hopper
		In leaf	In panicle						
Summer 2011	BT7	-	-	0-1	3-5	-	1-3	0-1	0-1
	DT39 Quelam	-	-	0-1	1-3	-	0-1	1-3	1-3
Spring 2012	BT7	0-1	-	1-3	0-1	0-1	0-1	0-1	0-1
	DT39 Quelam	0-2	-	1-3	0-1	0-1	0-1	0-1	1-3
Summer 2012	BT7	1-3	0-1	1-3	1-3	1-3	1-3	1-3	1-3
	DT39 Quelam	1-2	0-1	1-3	1-3	0-1	0-1	1-3	1-3

*points: smaller means better.

Vietnam is tropical country, where pests and diseases appear every year. So, resistance to pests and diseases in rice is a very important criterial standard for commercial production. The data from table 6 indicated that the resistance to pests and diseases in the field condition for blast, bacterial leaf blight, brown blight, and stem borer of DT39 Quelam was similar to Bacthom 7. Especially, in summer season 2011, DT39 Quelam showed resistance to bacteria leaf blight at 1-3 point while Bacthom 7 showed it at 3-5 point.

Table7: Grain quality evaluation of DT39 Quelam (Source: NTCC, 2012)

Variety	Milled rice ratio (%)	Amylose Content (%)	Husked rice length (mm)	Rice ratio of length/width	Collagenic temp.	Gel Durability	Protein content (%)
DT39 Quelam	71.25	17.82	6.47	3.09	(70 – 74°C)	medium	9.10
BT7	69.40	15.65	5.59	2.83	(70 – 74°C)	soft	8.21

Evaluation for the quality according to phenotype of milled and cooked rice indicated that DT39 Quelam had some advantage characters (table 7), and amylose content (17.82%) was higher than Bacthom 7 (15.8%). In this case, the higher amylose content leads to the better quality because low amylose content results in sticky cooked quality. In this experiment, after mutation induction protein content was increased from 8.21% of Bacthom 7 to 9.10% in DT39 Quelam. The most important character of new mutant variety DT39 Quelam is that the cooked rice is soft, not so sticky, high protein and with light aroma.

Table8: Testing for cooking quality of DT39 Quelam (Source: NTCC, 2012)

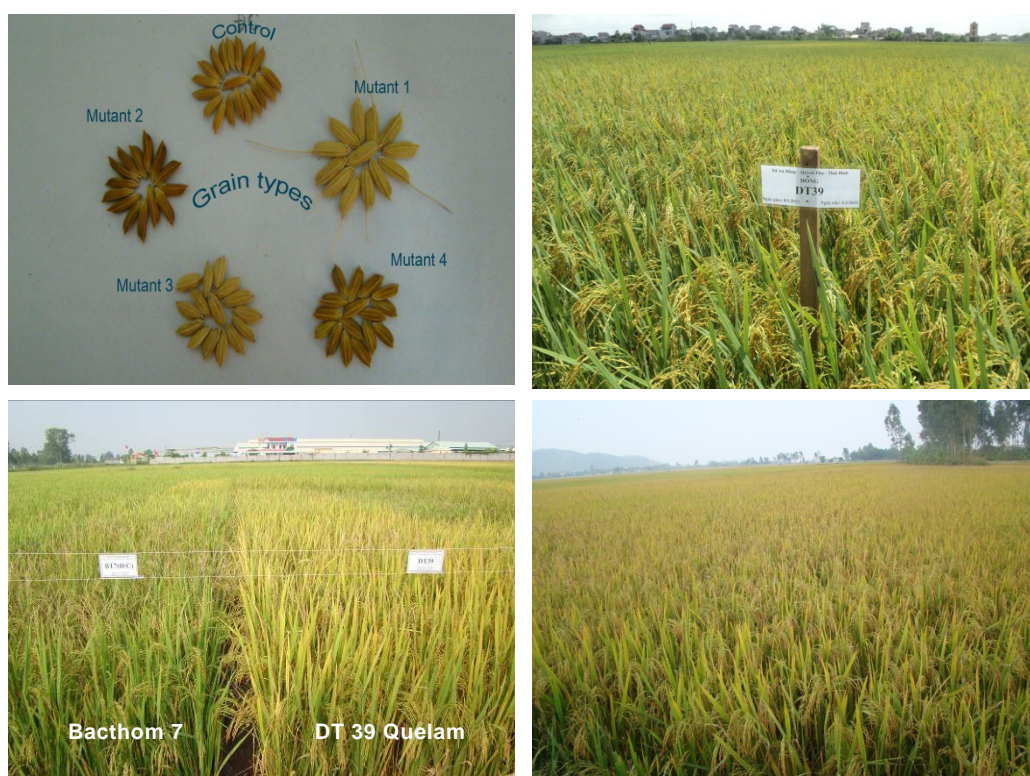
Variety	Aroma	Softness	Stickness	Whiteness	Polish	Attractive
DT39 Quelam	1	4	4	5	3	3
Huongthom 1	2	3	4	5	3	2
Bachthom 7	2	4	4	5	3	3

*points:

- Aroma: bigger means better; - Softness: smaller means harder

- Stickiness: bigger means stickier ; - Attractive: bigger means better cooking

Test for cooking quality of DT39 Quelam was carried out by committee consisted of 7 persons who worked independent evaluation. The result showed that in most indexes, DT39 Quelam was similar to Bachthom 7 except for aroma which was lower in DT39 Quelam. Due to irradiation treatment, aroma character of Bachthom 7 was decreased in DT39 Quelam.



Photos of DT39 Quelam in experiment and exhibition field

9.4 Conclusion

- 1) New rice variety DT39 Quelam was created by gamma ray irradiation of cobalt source at the dose of 200Gy from Bachthom 7.
- 2) Main characteristics of DT39 Quelam: Grow duration in spring season: 130-135 days, summer season: 104-105 days; good tolerance to main pest and disease. Good cooking quality, high yield, hard stem, high protein, better resistance to bacteria leaf blight and better cold tolerance compared to the original variety.

3) DT39 Quelim has been planted in some provinces in northern part of Vietnam in more than 87 ha. In most locations of trial fields, the mutant variety gave higher yields around 5-14% from the original variety.

9.5 Acknowledgement

The authors wish to express sincere thanks to the IAEA and FNCA for its long time supports on our rice mutation breeding programs and my attendance at the annually FNCA workshop 2009-2013. I also wish to thank Dr. Atsushi Tanaka, Dr. Hirokazu Nakai and Ms. Aki Koike for their kind hospitality and help me during the meeting.

9.6 References

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