Wild Rice Genetic Resources in Thailand

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ABSTRACT

Thailand is considered as one of the richest rice genetic resources both wild rice and cutivated species that have been found from exploration. There were 807 accessories of five wild rice species that had been collected during 1981 – 2002 from all regions namely the North, Lower North, Central Plain, Northeast I and II; Western, Eastern South I and II and Bangkok area. There are five species of wild rice exit namely *Oryza rufipugon*, *O.nivara*, *O.officinalis*, *O.ridleyi*, *O.granulata* and their descriptions are included. *O.rufipogon* and *O.nivara* as well as spontanea form are recognized as the ancestors of Asian rice and are commonly found throughout the country. All species normally present in diversed water conditions especially in open habitat. *O.nivara* is found more frequently in the North and Northeast than other regions while *O.officinalis* and *O.granulata* are mostly dominant in limited area under shaded habitat with relatively dry land. All collected wild rice samples have been conserved in the National Rice Seed Laboratory for Genetic Resources, Pathum Thani Rice Research Centre, Rice Department. Seed rejuvenation and seed multiplication of wild rice is usually performed as well as seed service of wild rice germplasm for breeding research program both in the country and international organization abroad.

Key words: wild rice, habitat, seed, germplasm

Introduction

Wild rices have been found throughout Thailand and well adapted to a broad range of habitats namely shading forests and deepwater swamp (Suvatabanhdu, 1950;

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Vongsaroj, 1976; Chitrakon *et al.*, 1995). Wild rices are normally called by farmers in Thai as Khao Pa, Khao Pee, Khao Peed, Yalamarn, Yasa ngae and Ya Khao-nok (Suvatabanhdu, 1950; Vongsaroj, 1976) and are recognized as the most valuable; essential genetic resource basic raw material for pest and drought resistance to meet the current and future needs of rice improvement program (Chang,1976, Khus and Brar, 1992; Vaughan, 1994). There are quite a few species of wild rices in Thailand that are relatively concerned with cultivated rice namels spontanea forms (Morishima *et al.*, 1984 : Morishima *et al.*, 1987). Each species normally has specific habitat that is relatively concerned with topography of the region. Wild rice is generally recognized as the ancestor of cultivated species presented in Asia (Chang,1976, Chang,1979). At present, all wild rice species are resistance to specific insect, diseases and environment; *O. nivara* has been used to cross with cultivated rice and highly yielding grassy stunt viruses resistant variety obtained.

The population of wild rice are continually being destroyed because of spreading conglomeration into rural areas as well as the forest habitats of the shaded loving species are also disappear. Then the National Rice Seed Storage Laboratory for Genetic Resources has been established since 1981 at Pathum Thani Rice Research Centre, Pathum Thani province under the Rice Research Institute, Department of Agriculture which is now the Rice Department. The survey of wild rice distribution in Thailand is commonly practice as the task of the centre as well as aqquisition, collection, conservation, multiplication and rejuvenation of wild rice seeds. Exchangeable seeds are also performed with the collaboration network.

1. Species and their Characteristics

Wild rice species have been found totally 5 species in Thailand namely *Oryza rufipogon* Griff., *O. perennis* Moench., *O. nivara Shama* et Shastry, *O.officinalis* Wall ex Watt, *O. ridleyi* Hook.F., *O.granulata* Nees *et* Arn. ex Watt and spontenea forms (Akihama and Watabe, 1970.) (Table 1). Oryza rufipogon was the most dominant for all parts of Thailand and there were quite a number of unidentified species presented in Table 1. (Morishima *et ai.*, 1984; Morishima *et al.*, 1987; Chitrakon *et al.*, 1995).

Table 1. Number and percentage (in parentheses) of wild species found in different regions of Thailand (Chitrakon et al., 1995)

Region	Species							Total
	O.rufipogon	*O.nivara*	*O.officinalis*	*O.ridleyi*	*O.granulata*	Spontanea form	Unclassied species	
Central	61(65)	7(7)	4(4)	2(2)	1(1)	7(7)	13(14)	95(100)
East	9(36)	1(4)	0(0)	0(0)	0(0)	10(40)	5(20)	25(100)
Northeast I	28(37)	23(31)	0(0)	0(0)	0(0)	20(27)	5(5)	75(100)
Northeast II	31(39)	30(38)	0(0)	0(0)	0(0)	10(13)	9(11)	80(100)
North I	24(53)	3(7)	2(4)	0(0)	7(16)	7(16)	2(4)	45(100)
North II	81(57)	9(6)	0(0)	0(0)	3(2)	19(14)	29(21)	141(100)
West	34(62)	4(7)	0(0)	0(0)	0(0)	2(4)	15(27)	55(100)
South I	6(40)	1(7)	1(6)	0(0)	0(0)	1(7)	6(40)	15(100)
South II	8(21)	0(0)	0(0)	1(2)	0(0)	2(5)	28(72)	39(100)
Bangkok	5(63)	0(0)	2(25)	1(12)	0(0)	0(0)	0(0)	8100
Total	**287**	**78**	**9**	**4**	**11**	**78**	**111**	**578**

1.1 *O. rufipogon* is dominant in the the Central and the West (Tables 1 and 2), mostly found in the shallow ponded water fully shaded (Tables 3 and 4) (Chitrakon *et al.*, 1995), vegetative crown and stoloniferous (Table 4) (Chitrakon *et al.*,1995). *O. rufipogon* has plant height over 1 m long, internode decumbent to floating, forms a perennial root stock, produce adventitious roots and nodal tillers; panicles well exerted and very loose primary and secondary branches; soft awn >1 cm long; black anther 3-4 mm long; spikelets slender with 7-10 mm long and 2.0-2.5 mm (wide, 1.6-1.9 mm thick (Figure 1a, 1b). Slender shape seed with black colour sets poor, some spikelets sterile and highly shattering. Seed of O.rufipogon is used for propagation and easy to cross with cultivated rice due to the same chromosome number (2n = 24) and genome (AA) (Tables 1, 5) (Vaughan, 1989; Vaughan; 1994).

1.2 *O, nivara* is vegetative crown (Table 4) (Chitrakon *et al.*, 1995), semierect to decumbent with height 50-160 cm (Figure1c,1d). Tillers come from the basal nodes; the basal internodes are mostly spongy; the panicles are not well excerted; the plant has few primary and secondary branches with the following characteristics compact

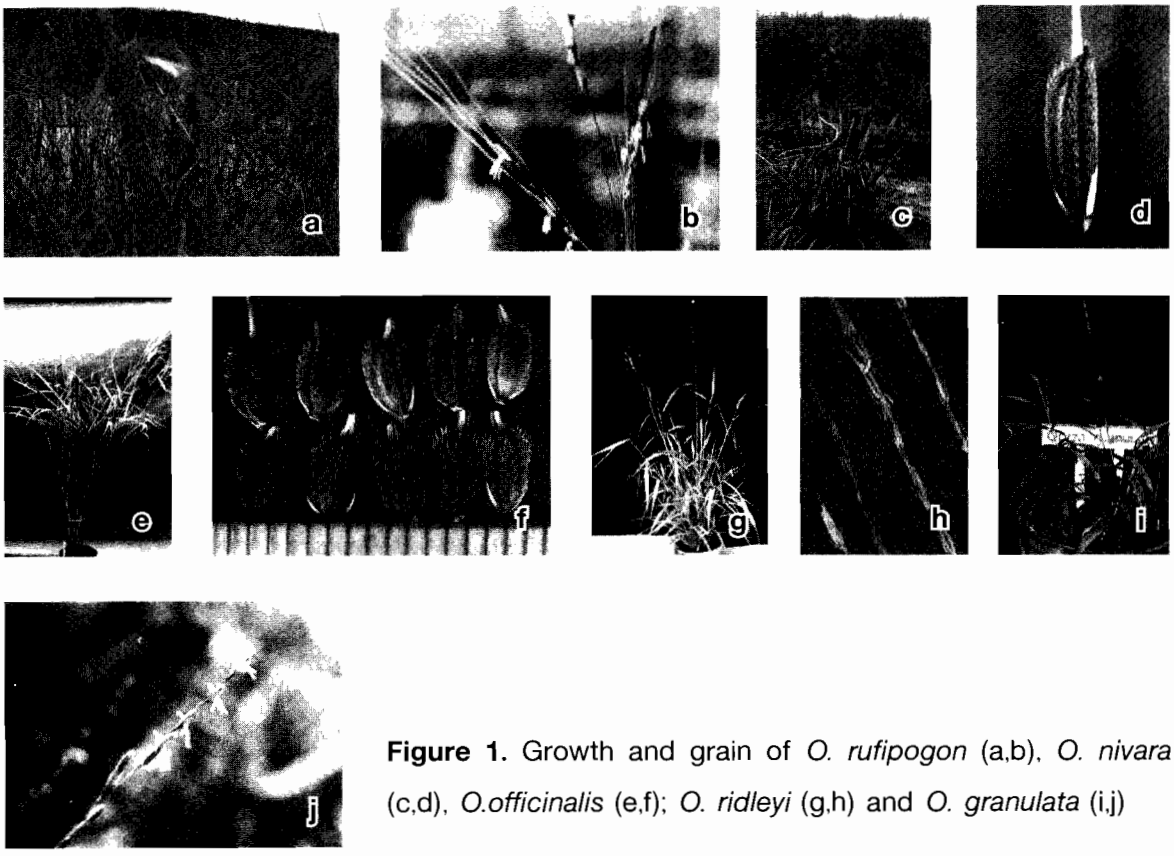

Figure 1. Growth and grain of *O. rufipogon* (a,b), *O. nivara* (c,d), *O.officinalis* (e,f); *O. ridleyi* (g,h) and *O. granulata* (i,j)

to semliopen (varies considerably from very compact to wide open); awn strong thick, >1 mm long ; rachis stout; spikelets 6-8 cm long ; 2-3 mm wide,1-2 mm thick. Panicles and spikelets resemble the cultivated from (Figure 1c,1d). *O. nivara* has the same chromosome number (2n= 24) and genome (AA) (Table 5) with cultivated rice (Vaughan, 1989, Vaughan, 1994). So, there are no barrier for crossing with cultivated rice then it has been used as a parental material for brown plant hopper resistance program at the International Rice Research Institute (IRRI). *O. nivara* is commonly occurred in the Northeast (Tables 1 and 2) in shallow ponded water and fully sun (Tables 3 and 4) (Chitrakon *et al.*; 1995).

1.3 *O. officinalis* is usually rhizomatous (Table 4) (Chitrakon *et al.*, 1995) is perennial with erect, leaf 1.5-2 m tall; leaf sheath margin pubescent; peduncles 10-12 cm long; panicles well excerted; spikelets 5 mm long; length >1 cm awn (Figure 1e,1f). It flowers throughout the year, has high fertile short bold seed, mostly propagated by seed and is easy shattering. Most of *O. officinalis* found in shading, (Chitrakon *et al.*,1995). *O.officinalis* has the same chromosome

Table 2. Characteristics of wild rice in Thailand (Chitrakon,1999)

Species	Distribution	Life cycle	Characteristics			
			Panicle	Anther	Seed shape	Awn length
O.rufipogon	All regions	Perennial	Branching	Black	Slender	>1cm
O.nivara	All regions	Annual	Branching	Black	Slender	>1 cm
O.officinalis	North, Central, South	Perennial	Branching	Black	Short bold	>1cm
O.ridleyi	Central, South	Perennial	Branching	Dark red	Slender	>1cm
O.granulata	North, Central	Perennial	No branching	White	Slender	No
Spontanea form of *O.* spp.	All regions	Annual	Branching	Mostly black	Slender	>1 cm

Table 3. Number and percentage (in parentheses) of wild rice species found in different habitats (Chitrakon *et al.*, 1995).

Species	Habitat					
	Deep ponded water	Shallow ponded water	Swamp	Pool	Dry	Others
O. rupogon	111(40)	152(24)	12(4)	1(0.5)	6(2)	-
O. nivara	8(12)	52(75)	5(7)	-	4(6)	-
O. officinalis	-	1(12.5)	-	6(75)	-	1(12.5)
O. ridleyi	-	1(12.5)	-	3(50)	1(25)	-
O. granulata	33(30)	60(57)	10(9)	2(2)	2(2)	-
Spontanea form of *O.* spp.	13(7)54(69)	8(10)	-	-	3(4)	

number (2n=24) but the same genome (CC) (Table 5)(Vaughan, 1994). *O. officinalis* is normally found in the Central (Tables 1 and 2).

1.4 *O. ridleyi* is vegetative crown and stoloniferous (Table 4) (Chitrakon *et al.*, 1995) and has erect-tuffed grass, growing to a height of 30-100 cm; profusely tillering from base; panicle poor exerted; primary branches very few, no secondary branches; spikelets 9-10 cm long, 1.5-2 cm wide, with row of trichemes down the length of the papery palea, lemma and awn length >1 cm (Figure 1g,1h). *O. ridleyi*

has slender black colour seed with less fertile and easy shattering. The chromosome number (4n=48) and genome (HHJJ) are different from cultivated rice (Vaughan, 1994). *O. ridleyi* is rarely found in Thailand with the habitat of pool and partial shade (Tables 3 and 4) (Chitrakon *et al.*, 1995) but there are a few in the Central and in the South (Tables 1 and 2).

1.5 *O. granulata* is vegetative crown (Table 4)(Chitrakon *et al.*, 1995), has 80 cm tall, few tillers, broadleaves, short and lanceolate, peduncles long, small, panicles well exserted; no primary and secondary branches; 4-5 mm long spikelets no awn, perennial (Figure 1i,1j). It is commonly found in partially shade (Table 4) (Figure 1i,1j) but rarely occurred in the North and the Central (Tables 1 and 2) with shallow ponded water (Table 3) (Chitrakon *et al.*,1995).

Besids all 5 species mentioned, there is another type of wild rice which is commonly occurred as a weed namely weedy rice. This kind of wild rice has high variation which is not discriminate from each other and is called spontanea form of cultivarted rice. Their characteristics are between wild rice and cultivated rice. and habitat is shallow to deep ponded water (Tables 3 and 4) (Chitrakon *et al.*, 1995).

2. Collection

In general, collection has been made by the researchers who are working at the Rice Research Centre, located at every part of the country. The collection is normally started at the early stage of maturity of rice, with either seed or the whole plant. The primary record is made with plant characteristics, habitat, distribution, location and data of collections. Eight hundred and seven samples of wild rice seeds have been collected (Table 6) and labeled; wild rice seeds were dry by the sunshine to reduce the moisture content to 10%. After being dry, all samples were sent to the National Rice Seed Storage Laboratory for Genetic Resource for further purpose of conservation.

3. Documentation

Recording is the most important step for wild rice gene bank of every county in the world. The procedure is started with daily rice activity sample registration, primary data of seed sample characteristics of species evaluation,

Table 4. Number and percentage (in parentheses) of wild rice species found in different shading conditions (Chitrakon *et al.*, 1995).

Species	Habit	Shading conditions			
		Fully sun	Partial shade	Full shade	Mixture
O. rupogon	Vegetative crown and stoloniferous	267 (93)	17 (6)	3 (1)	-
O. nivara	Vegetative crown	70 (92)	3 (4)	-	3 (4)
O. officinalis	Usually rhizomatous	2 (22)	6 (67)	1 (11)	-
O. ridleyi	Vegetative crown and stoloniferous	-	4 (80)	1 (20)	-
O. granulata	Vegetative crown	2 (25)	3 (38)	1 (20)	-
Spontanea form of *O.* spp.	-	7 (92)	11 (9)	1 (1)	-
Unclassified	-	104(88)	-	1(1)	2(2)

Table 5. Chromosome number, genome group, and potential use of wild rice (adapted from Vaughan, 1994)

Oryza species	Chromosome no	Genome group	Useful or potentially useful traits
O. rupogon	24	AA	Resistance to bacterial blight, sheath spot, ragged stunt tolerance for acid soil; source of cytoplasmic male sterility and perennial
O.nivara	24	AA	Resistance to grassy stunt virus, blast, stem rot; cytoplasmic male sterility and drought avoidance
O. officinalis	24 or 48	CC or BBCC	Resistance to thrips, brown planthoppper, white backed planthopper, stem rot and ragged stunt
O. ridleyi	48	HHJJ	Resistance to yellow stem borer, whorl maggot, blast, bacterial blight and ragged stunt

rejuvenation and data to service to interested person, research breeder, student, private sector the reason for recording is the accuracy of data and the facility to evaluation of all steps of management.

Table 6. Number of wild rice samples and location collected in 1979-2002 (the National Rice Seed Laboratory for Genetic Resources, Rice Department).

Location of collection	Number of sample	Species					
		1 *O. rupogen*	2 *O. nivara*	3 *O. officinalis*	4 *O. ridleyi*	5 *O.granulata*	Unclassified
North	211	53	4	4	-	14	136
East	713	43	32	-	-	1	137
South	175	17	-	-	24	-	134
Central	208	65	7	10	5	-	121
Total	**807**	**178**	**43**	**14**	**29**	**15**	**528**

4. Wild rice conservation

Wild rice is recognized as a perfect genetic resource of cultivated rice (Chang, 1979). As literature reviewed, wild rice in the world is being destroyed because the unsuitable environmental to wild rice has been destroyed as well as cultivation area expanded. Recently wild rice has a big role in term of breeding program as resistance to some insects and diseases. Villareal *et al.*, (1974) had found that one of eighty samples of *O. nivara* was resistant to brown plant hopper (BPH) and ragged stunt. Then urgent conservation of wild rice is really needed for that purposes but it will not be so easy in spite of heterogenous population, hardly seed setting, easily shattering as well as variable name called such as spontanea form (Villareal *et al.*, 1974) but it had been solved especially with chromosome studied.

The procedure for conservation is to dry after being collected from all over country and to reduce moisture content to approximately 10%. Then put in glass container prior to conservation (short term). For sufficient seeds, conservation will be made as medium and long terms at 5 and -10 °C after seed moisture is reduced to 7-8% and 80g of seed put in a vacuum can as container.

The local rice experiment centre had collected 807 samples of wild rice seeds from natural resources all over the country. All seeds are classified as 211 samples from the North, 203 samples from the Northeast 208 samples from the Central, 175 samples from the South and unidentified at 528 samples from all parts, during 1979-2002 (Table 6).

Wild rice collection has been in

Table 7. Wild rice seed samples served for research program in the country of the National Rice Seed Laboratory for Genetic Resources, Pathum Thani Rice Research Centre, Rice Department.

Year	Number of sample	Objective
1994	116	For research
1995	11	For research
1996	76	For research
1997	86	For research
1998	314	For research
1999	107	For research
2000	40	For research
2001	41	For research
2002	830	For research
Total	**1,621**	

practice since 1950 for cultivated rice collection and reserved at local Rice Experiment Station. Every one in three years, all reserved seeds were planted to collect variable seeds for conservation as rice germplasm. And the following years the seeds have been kept in controlled temperature at 20-30 °C. Then, all conserved seeds are transferred to the Centre at Pathum Thani province. Conservation has been made with 3 method of conservations namely short, medium and long terms under 50% relative humidity and 5 and - 10 °C respectively. All of three methods are quite similar, the distinction is for short term which seed moisture has reduced to 11-12% and 300 g seed weight cover of contained in glass bottle with for vaccuum can, contained 80 g of seeds with seed moisture content at 7-8%.

5. Seed rejuvenation

Wild rice seed samples after being stored and conserved for 1-3 years have to carry out for seed viability test by germination as a schedule. If the seed has low germination percentage (5%) or does not germinate, then this seed will be needed to rejuvenate immediately in 81 inches pot. then new seeds will be harvested and conseved as conventional testing.

6. Service of wild rice germ plasm

The utilization of wild rice seed during 1994-2002 had been made for breeding program in the country as well as abroad. In case of the country, there were 1,621 seed samples distributed (Table 7). And the exchange has been made for abroad with IRRI and other organizations. IRRI had made a crosses between improved rice varieties such as

IR 8, IR 20, IR 24 and *Oryza nivara*. Highly yielding grassy stunt viruses resistant varieties were obtained such as IR 28, IR 30, IR 32, IR 34, IR 36 and released for cultivation across rice-growing countries (Ling *et al*., 1970).

7. Conclusion

7.1 Wild rice has been found with different habits and habitats and are classified into 5 species and 1 form namely *O. rufipogon*, *O. nivara*, *O. officinalis*, *O. ridleyi*, *O. granulata* and spontenea form.

7.2 All wild rice species are resistant to specific insect, diseases tolerant and environment and O.nivara has been used to cross with cultivated rice and highly yielding grassy stunt viruses resistant variety obtained.

7.3 Eight hundred and seven species of wild rice in Thailand are conserved in the National Rice Seed Storage Laboratory for Genetic Resources, Rice Department for research program service both national and international level.

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