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(*Oryza* spp.)

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THESIS

IDENTIFICATION OF WILD SPECIES CARRYING AROMATIC
ALLELE IN RICE (ORYZA SPP.)

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Thailand is riched in aromatic rice germplasm which is widely diversified as local aromatic landraces. The successful identification of aromatic gene in rice open up a new frontier towards the understanding of the origin of aromatic rice. In order to trace the aromatic gene into the wild species, all wild rice species were screened for the 8 bp deletion, the functional part of the gene.

Two hundred and forty-four accessions of wild rice species including *O. nivara* and *O. rufipogon* collected from different geographical areas in Thailand. All morphological characteristic of wild rice were observed at vegetation, reproduction and harvested stage. All 244 accessions were selected and used for genotyping with Aromarker. The presence of aromatic allele were found in six accessions of two wild rice species, *O. rufipogon* and *O. nivara* collected from Phitsanulok, Sukhothai, Chai Nat, Nakhon Ratchasima, Trat and Chantaburi. Twenty nine landrace varieties cultivars collected from the same provinces were also found to carry the same aroma allele.

All 18 wild rice species were screened with Aromarker. Eight species of wild rice consisted of *O. australiansis* *O. brachyantha* *O. latifolia* *O. meridionalis* *O. nivara* *O. officinalis* *O. punctata* and *O. rufipogon* carried aroma allele. All of evidences indicate that aroma gene present in the cultivated rice today may originally come from wild rice ancestor.

Student's signature

Thesis Advisor's signature

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IDENTIFICATION OF WILD SPECIES CARRYING AROMATIC ALLELE IN RICE (ORYZA SPP.)

INTRODUCTION

Wild rice is the important genetic resource for cultivated rice development. From the past to nowadays, it is well known that the ancestor of cultivated rice is wild rice. But it is exciting to know that wild rice is losing day by day with the development of world new technology together with replacement of nature by building more and more. The researchers concerned with wild rice breeding are excited to investigate and now are active to do wild rice collection, conservation worldwide. In Thailand there are also explore and collection of wild rice germplasm in National Rice Seed Storage Laboratory for Genetic Resources Pathum Thani Rice Research Centre (PTTRRC), Rice Department twenty years ago is quite long time, there are no investigation to follow up the resource of nature wild rice. The wild rice researcher nowadays therefore turn back to review this issue. This is the point to light up the wild rice investigation in Thailand.

In terms of aromatic rice, wild rices were used as genetic resources for breeding program to improve some characteristics of cultivated rice. The identification of wild species carrying aromatic allele was no previously reported in rice especially for wild rice species. Since the successfulness of Thailand research team that cloned aromatic gene, Aromarker. The Aromarker can separate all aromatic lines from non-aromatic lines (Vanavichit *et al.*, 2004). The benefit of Aromarker can be applied for aromatic gene finding in the collected wild rice.

This study, the wild rice seed was obtained from National Rice Seed Storage Laboratory For Genetic Resources collected from every part of Thailand 244 accessions include of 2 species and landrace. These seeds were grown in pots contain of soil for characteristic evaluation. The data collection was record for 58 characteristics. Then these samples will be re-planting again for aromatic gene investigation in wild rice. To prove the hypothesis that if aromatic gene was found

in the collected wild rice. Then, will the rice surrounded that area aroma as well? For the purpose to prove the hypothesis that wild rice is the ancestor of cultivated rice. As well as to study the progress of local cultivated rice development in Thailand.

OBJECTIVE

To identify wild rice carrying aromatic allele in rice (*Oryza* spp.).

LITERATURE REVIEW

1. Genetic resource of wild rice in Thailand

Wild rice was the ancestor of cultivated rice and generally characterized similar to cultivated rice especially for the species related to cultivated rice. They were spreaded throughout Thailand (Figure 1). The fine analysis and determination using working key for grouping wild rice were grouped into 6 types (Chang, 1998).

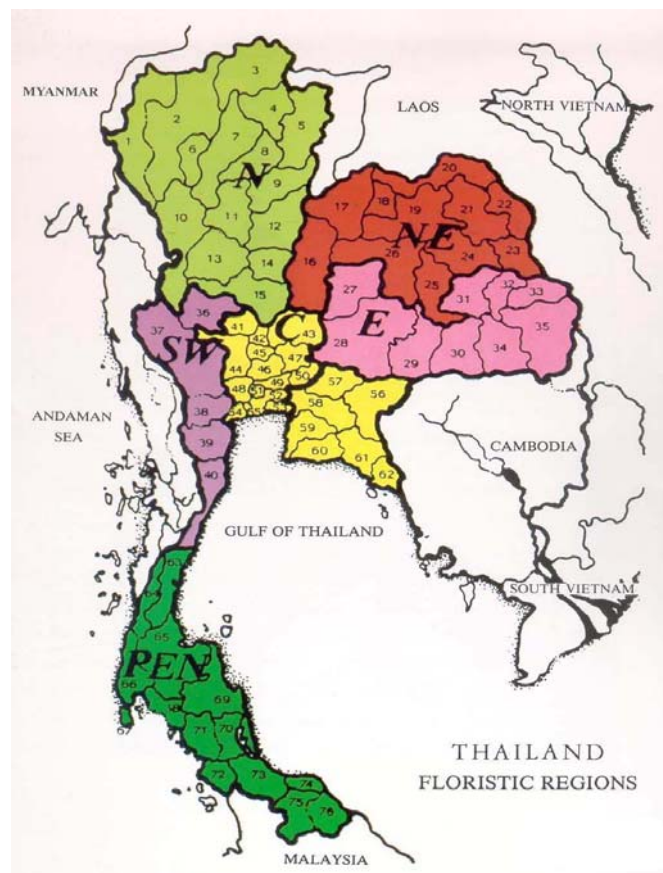


Figure 1 Thailand floristic region

1.1 *Oryza rufipogon* Griff or *Oryza perennis* Moench

This species was called by farmers as Yah La Man, Yah Khao Nok or Khao Phee. It was the AA genome species ($2n = 24$). This type was the perennial wild species found in all parts of Thailand particularly in the central plain and the south. The

open air with shallow to deep water regime environment was appropriated for grow it. The general characteristic of this type was more than 1 meter height, spread tiller to creeping, big stalk, large panicle, long leaf, sterile grain. The matured grain has black color and easy to fall off, rough pericarb, long hair, moderately soft long awn, and high percentage of outcrossing.

1.2 *Oryza nivara* Sharma et Shastry

The annual wild rice was found all over Thailand especially in the Northeast, North and central plain. It can grow under the open air with shallow water regime environment. They are AA genome species ($2n = 24$). This type was also called as Yahlaman, Yah Khao Nok or Khao Phi. Plant height was 80 - 160 cm, . Most of them were high tillering and easy to outcross with others rice cultivars. The seeds had awn, easy to fall off and become black color when it was matured.

1.3 *Oryza officinalis* Wall

There are 2 sets of chromosome which $2n = 24$ and belong to CC genome species. It is perennial wild species, Plant height is between 30-200 cm. Whole year flowering, erect tiller, broad leaf with no hair, black stigma. Seed has round shape black color as mature, with awn easy to fall off. Found in shading area in durian orchard or in the forest beside water flow line in Nonthaburi, Bangkok, Chumphon, Chiang Rai and Saraburi province.

1.4 *Oryza ridleyi* Hook

This type is critical status due to the germplasm nearly loose. There are 4 sets of chromosome which $4n = 48$. It is perennial wild species. Plant height is between 30 - 100 cm erect tiller, slightly thick leaf with deep green color and long, dark purple pistil, the glume length is more than $\frac{1}{2}$ of the seed length, long and slender seed shape with slightly long awn, high sterility and seed easy to fall off. Found in Nonthaburi, Saraburi, Songkla Surin and Prachin Buri province.

1.5 *Oryza grannulata* Nees

There are two sets of chromosome which $2n = 24$. It is perennial wild species with small stalk as match stick or Buddhist scent stick. The height is about 80 cm, low tillering, small leaf size as bamboo leaf with sharp blade, whole year flowering, single spikelet no branch out, white stigma with high sterility, seed has awn and rough skin. Found in shading area on the hill in the north part near the water fall in Nan, Chiang Mai, Lampang, Uttaradit and Phitsanulok province.

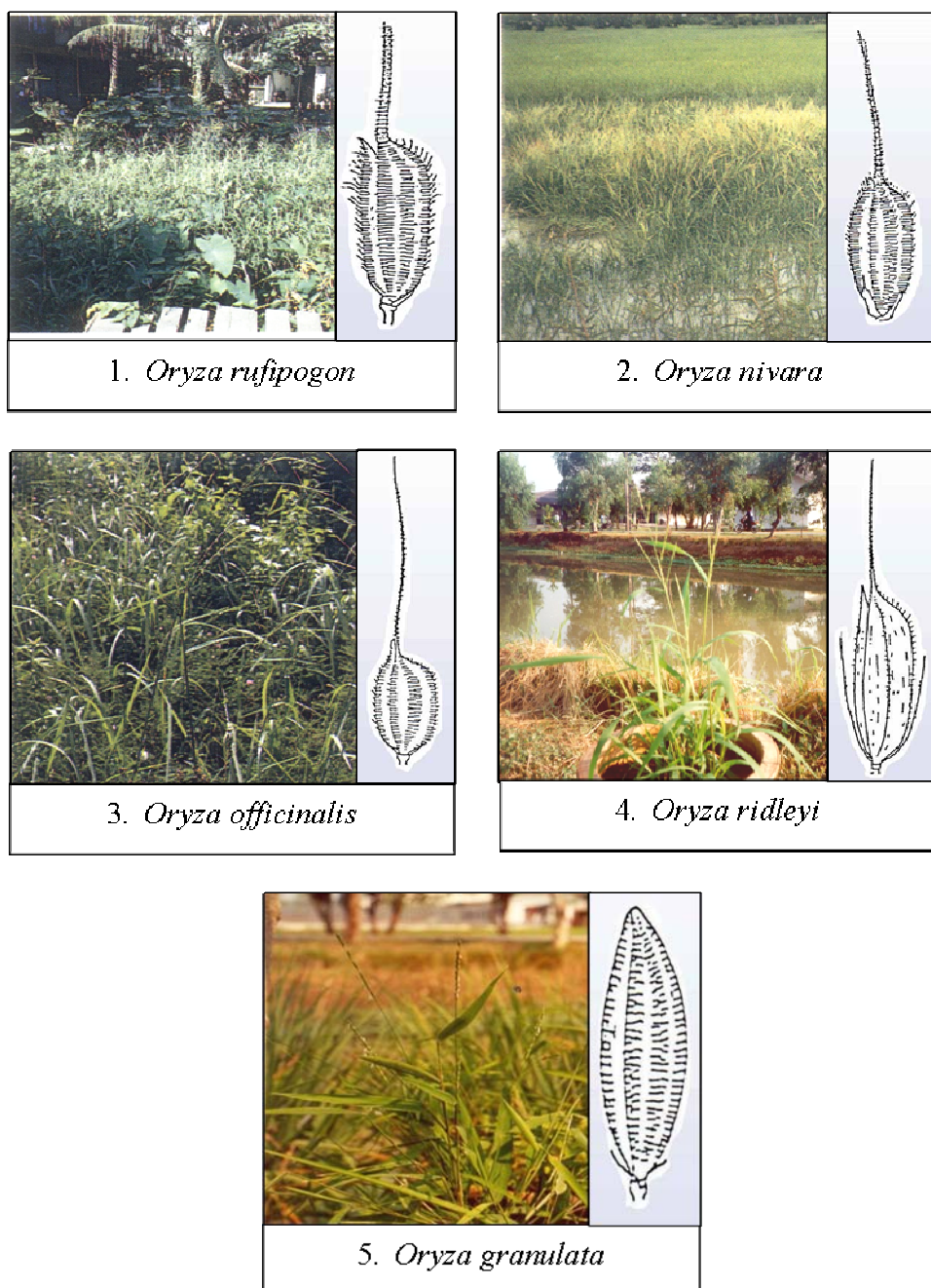


Figure 2 Wild rice in Thailand

2. Origin and distribution of wild rice

Rice is one of the Graminae family, *Oryza* species. Vaughan (1989) reported that this species compose of 23 types of plants and divided into 2 groups e.g. wild rice and cultivated rice. There are two types of cultivated rice; *Oryza glaberrima* grown

only in tropical zone of west Africa and *O. sativa* grow almost all around the world especially, in Asia. This two types of cultivated rice has the same genotypic character, they belong to AA genome species with $2n = 24$. While the other group, wild rice occurs in the world by nature, there are 21 types. According to their genotypic character therefore can be grouped into 21 groups; the group which no relationship to cultivated rice consist of 15 types, distributed around the world with limited area. And the group which relate to cultivated rice there are 6 types namely *O. nivara*, *O. rufipogon*, *O. barthii*, *O. longistaminata*, *O. glumaepatula* and *O. meridionalis*. This rice group is very important rice species due to there ability to cross easily with cultivated rice and diversity of there genetic which require by the breeder. Vaughan (1989, 1994) illustrated the morphological characteristic and distribution are of this 6 types of wild rice as follows.

2.1 *Oryza nivara*

It is annual wild species and distribute in continental of Australia, United state of America, and Asia especially lowland area in South-East Asia. If found in normal cultivated paddy field we will considered that it is very important weed and very hard to control (Hyakutake, 1984). The general characters of annual wild species is short to medium height (50-60 cm), medium to high fertile anther, early flowering, long awn, the seed is easy to fall off and long duration of dormancy. The cultivation were carried using seed and node for propagation.

2.2 *Oryza rufipogon* or *Oryza perennis*

It is perennial wild species. Distribute in continental of Australia, United state of America, and Asia especially in South-West Asia. Oka (1977) believed that *O. rufipogon* is the ancestor of *O. nivara* and Asian rice (*O. sativa*). General character of this rice is perennial wild species long stem and recline to creep on the soil surface, has ability to extend the internode as the water levelchange, root and shoot germinate from node or part of node. Seed length about 8-9 mm. In Latin America sometime longer about 11 mm. Anther length is 3 mm. Found in the area where whole year with

stagnant water or in deep swamp and distribution of this rice type is far away from cultivated rice area, rarely found in cultivated rice land. In case found in cultivated area will be in deep water rice field. This species can be grow well in 0.2 – 4 meters water dept.

2.3 *Oryza barthii* or *Oryza longistaminata*

This type was distributed in Africa continental. General character of this rice were erect to recline stem, large size, easy to fall off seed, red color of awn with longer than 10 cm length. Panicle has branch out. In Africa considered this species as weed in important cultivated rice paddy filed, found in open air area i.e. Savanna or Sadama grass field. It can be grow well in 0.2 – 4 meters water dept.

2.4 *Oryza glumaepatula*

It is perennial wild species. Distribute in middle and south of America in the area far away from cultivated rice field. There is no report that found any of this rice species occur in cultivated rice field. General character of this rice is similar to *O. rufipogon* but its seed and awn is longer. However the information of this species is still limit.

2.5 *Oryza meridionalis*

It was the perennial wild species distributed in Australian continent. General character of this rice is similar to *O. rufipogon*, the annual wild species with compact panicle and has branch, long awn about 7.8 – 10.3 cm. Seed length, width and thick were 7.6 – 8.0 mm, 1.9 – 2.2 mm and 1.3 mm, respectively. It was found in fresh water area or lowland area with water dept of 15 – 20 cm and no shading field.



Figure 3 Distribution of wild species in Thailand

3. Variation of wild rice

Wild rice is a rice evolution by nature and no selection by human. Therefore, wild rice still has high diversity in both rice type and genetic. Though, they are the same type but some characteristic is different from each other and very as environment. For example wild rice as perennial species found in Asia with stem creep along the soil surface (stolon), root and shoot germinate from the part of node on leaf part. In Africa the stem is under the soil (rhizome). The stem part can germinate to shoot and continue propagation. (Morishima *et al.*, 1984). Wild rice has ability to adapt to the environment render this species compose of both annual and perennial species. The annual species mostly found in drought prone area and high temperature. The specific character is short stem, high tillering, anther has short filament, long duration of dormancy. The perennial species found mostly all year round with stagnant water. The character of this species is tall stem, the internodes can extend according to the water level, anther has long filament and long seed size (Oka and Morishima, 1967).

The life cycle variation of wild rice, Oka (1988) reported that rice cycle of wild rice divided as the character of development of rice growth. For annual species, after harvesting the plant die then the new generation develop from seed only. While perennial species new generation will be developed from both seed and the node of stem which attach to the soil.

Morishima (1980) found that the species *Oryza rufipogon* or *Oryza perennis* which found in Asia can be divided into 4 groups i.e. perennial, annual and perennial, annual, and weed in cultivated paddy field which the last group was developed from the breeding between wild rice and cultivated rice.

For Thailand, Morishima *et al.* (1984) were collected 146 samples of wild rice from different regions. These samples were grown under the same control condition for the purpose to study the life cycle of these wild rice. They found that this wild rice can be divided into 3 groups i.e. perennial species consisted of 41 samples, annual and

perennial consisted of 21 samples annual species consisted of 25 samples and 59 samples which were not able to group. Sommut (1998) studied the character of wild rice *Oryza rufipogon* perennial type in wild rice resource conservative paddy field under natural condition and found that *Oryza rufipogon* has life cycle between perennial type and annual type.

The growth of wild rice, Chitrakon (1996) found that *Oryza rufipogon*, perennial type has continuous variation both for plant height, tiller type, awn length and 100 seed weight. Sommut (1997) found that wild rice is able to germinate to new shoot for 10 -20 plants about 10 days after flowering, which this character make the species differ from cultivated rice. The cultivated rice stop tillering when reach panicle initiation period. But wild rice continue shooting though it reach reproductive period.

Flowering period, wild rice, *Oryza rufipogon* perennial type has longer flowering period than cultivated rice. It begins to flower from September to December. Sommut (1998) and Hyakutake (1984) found that at the same area perennial wild species flower 1 month later than annual type. Wild rice in the north and northeast flower early than in the central plain and the south. Chitrakon *et al.* (1996) reported that wild rice in the north and northeast flower during November to December. For central plain and the south flower during December to January.

Seed of wild rice is easily to fall off. Vaughan (1994) divided the level of fall off as follows; hard threshing, easy threshing, very easy threshing, easy shattering, very easy shattering and spontaneous shattering. The type, easily shattering begin to fall off 8 days after flowering. Dormancy of wild rice varies between 3 months to 1 year after shattering (Vaughan, 1994; Watanabe, 1996).

Evaluation of wild rice, mostly evaluate for resistant to disease, insect and tolerant to constraint condition. However, the study of wild rice mostly to divided the type, genome, and science of cell. For agronomic character information of wild rice still limit.

Table 1 Chromosome numbers, genome symbols, and geographical distributions of *Oryza* species (Chang, 1976).

Species name	(x = 12)	Genome group	Distribution
Synonym	2n =		
<i>O. alta</i>	48	CCDD	Central and South America
<i>O. australiensis</i>	24	EE	Australia
<i>O. barthii</i>	24	AA	West Africa
<i>O. brachyantha</i>	24	FF	West and central Africa
<i>O. eichigeri</i>	24, 48	CC	East and central Africa
<i>O. glaberrima</i>	24	AA	West Africa
<i>O. grandiglumis</i>	48	CCDD	South America
<i>O. granulata</i>	24	GG	South and Southeast Asia
<i>O. latifolia</i>	48	CCDD	Central and South America
<i>O. longiglumis</i>	48	HHJJ	New Guinea Indonesia
<i>O. longistaminata</i>	24	A1A1	Africa
<i>O. meyeriana</i>	24	GG	Southeast Asia, southern China
<i>O. minuta</i>	48	BBCC	Southeast Asia, New Guinea, Philippines
<i>O. nivara</i>	24	AA	South and Southeast Asia Southern China, Australia
<i>O. officinalis</i>	48	CC	South and Southeast Asia Southern China, New Guinea
<i>O. punctata</i>	24,48	BB,BBCC	Africa
<i>O. ridleyi</i>	48	HHJJ	Southeast Asia
<i>O. rufipogon</i>	24	AA	South and Southeast Asia
<i>O. rhizomatis</i>	24	CC	Sri Lanka
<i>O. sativa</i>	24	AA	Asia
<i>O. schlechteri</i>	48	HHKK	Papua New Guinea

Table 2 The taxonomy of rice (*Oryza* spp.).

Entry	Name	Chromosome (2n)	Genome
1	<i>Sect. Padia</i>		
	<i>Ser. Meyerianae</i>		
	- <i>O. granulata</i>	24	GG
	- <i>O. meyeriana</i>	24	GG
	- <i>O. neocaledonica</i>	24	GG
	<i>Ser. Ridleyanae</i>		
	- <i>O. longiglumis</i>	48	HHJJ
	- <i>O. ridleyi</i>	48	HHJJ
	<i>Ser. Schlechterianae</i>		
	- <i>O. schlechteri</i>	48	HHKK
2	<i>Sect. Brachyantha</i>		
	<i>Ser. Brachyanthae</i>		
	- <i>O. brachyantha</i>	24	FF
3	<i>Sect. Oryza</i>		
	<i>Ser. Latifoliae</i>		
	- <i>O. alta</i>	48	CCDD
	- <i>O. eichingeri</i>	24, 48	CC
	- <i>O. grandiglumis</i>	48	CCDD
	- <i>O. latifolia</i>	48	CCDD
	- <i>O. minuta</i>	48	BBCC
	- <i>O. officinalis</i>	48	CC
	- <i>O. punctata</i>	24, 48	BB, BBCC
	- <i>O. rhizomatis</i>	24	CC
	<i>Ser. Australienses</i>		
	- <i>O. australiensis</i>	24	EE
	<i>Ser. Sativae</i>		
	- <i>O. barthii</i>	24	AA
	- <i>O. glumaepatula</i>	24	AA
	- <i>O. longistaminata</i>	24	AA
	- <i>O. meridionalis</i>	24	AA
	- <i>O. nivara</i>	24	AA
	- <i>O. rufipogon</i>	24	AA
	- <i>O. glaberrima</i>	24	AA
	- <i>O. sativa</i>	24	AA

Table 3 Key to wild species of rice (*Oryza* spp.).

Key no.	Character	Species
1a	Spikelets < 2mm long, nodes hairy	<i>O. schlechteri</i>
1b	Spikelets > 2mm long, nodes usually not hairy	→ 2
2a	Spikelets awnless, surface of lemma and palea granulate or with hooked hairs	→ 3
2b	Spikelets with awns or short apiculus at the tip of lemma, not granulate	→ 5
3a	Surface of lemma and palea with hooked hairs	<i>O. neocaledonica</i>
3b	Surface of lemma and palea granulate	→ 4
4a	Spikelets slender, >6.5 mm long	<i>O. meyeriana</i>
4b	Spikelets more or less rounded, <6.5 mm long	<i>O. granulata</i>
5a	Sterile lemma subulate or setaceous	→ 6
5b	Sterile lemma linear or linear-lanceolate	→ 8
6a	Annual, small plants, spikelets < 1.6 mm wide	<i>O. brachyantha</i>
6b	Perennial, large plants, spikelets > 1.8 mm wide	→ 7
7a	Spikelet 7.6-12.7 mm long, sterile lemma 0.3-0.8 times as long as spikelets	<i>O. ridleyi</i>
7b	Spikelets about 7-8.2 mm long, sterile lemma 0.8-1.3 times as long as spikelets	<i>O. longiglumis</i>
8a	Spikelets with comma-shaped rachilla, oblique articulation, mucronate lemma	→ 9
8b	Spikelets with straight rachilla, horizontal or slightly oblique articulation, non-mucronate lemma	→ 14
9a	Ligule of lower leaves usually <10 mm long, tip rounded or truncate, panicle rarely has secondary branching	<i>O. barthii</i>
9b	Ligule of lower leaves >10 mm long, tip acute or two-cleft, panicle usually has secondary branching	→ 10
10a	Annual, anthers usually <2.5 mm long	→ 11
10b	Perennial, anthers usually >3 mm long	→ 12
11a	Spikelets slender, usually <2mm wide, base of awns thick	<i>O. meridionalis</i>
11b	Spikelets board, usually > 2 mm wide, base of awns not thick	<i>O. nivara</i>
12a	Rhizomatous habit	<i>O. longistaminata</i>
12b	Plant usually not rhizomatous	→ 13
13a	Plants with brittle culm near the base, spikelets 6.6-11 long, anthers occupying 2/3 or 3/4 of the spikelets	<i>O. glumaepatula</i>
13b	Plants with high nodal tillering, spikelets 4.5-10.6 long, anthers occupying the entire length of the spikelets	<i>O. rufipogon</i>

Table 3 (Continued)

Key no.	Character	Species
14a	Rhizomatous, axis of the panicles hispid-scabrous towards the tip	<i>O. australiensis</i>
14b	Sometimes rhizomatous, axis of the panicle branches glabrous or hairy	→ 15
15a	Plants large, leaf blades >2 cm wide	→ 16
15b	Plants relatively small, leaf blades <2 cm wide	→ 18
16a	Sterile lemma almost as long as the fertile lemma	<i>O. grandiglumis</i>
16b	Sterile lemma much shorter than the fertile lemma	→ 17
17a	Leaf blades <5 cm wide, spikelets <7 mm long	<i>O. latifolia</i>
17b	Leaf blades >5 cm wide, spikelets >7 mm long	<i>O. alta</i>
18a	Panicle base usually with 2 or more (often 3-5) equally long branches	→ 19
18b	Panicle base lacking whorl of branches, usually 1-2 branches	→ 20
19a	Tufted habit, awns usually >2 cm long	<i>O. punctata</i>
19b	Usually shortly rhizomatous, awns <2 cm or absent	<i>O. officinalis</i>
20a	Rhizomatous, open panicles, spikelets usually >6 mm long	<i>O. rhizomatis</i>
20b	Non-rhizomatous, semi-open panicles, spikelet <6 mm long	→ 21
21a	Tufted habit, spikelets usually >5 mm long	<i>O. eichingeri</i>
21b	Creeping habit, spikelets usually <5 mm long	<i>O. minuta</i>

Table 4 Related genera in the tribe Oryzae.

Genus	No. of species	Distribution	Chromosome (2n)
<i>Chikusiochloa</i>	3	China, Japan (t)	24
<i>Hygroryza</i>	1	Asia (t + T)	24
<i>Leersia</i>	17	Worldwide (t + T)	24
<i>Luziola</i>	11	North and south America (t + T)	48, 60, 96
<i>Maltebrunia</i>	5	Tropical and Southern Africa (T)	24
<i>Oryza</i>	24	Pan-tropical (T)	Unknown
<i>Porteresia</i>	1	South Asia (T)	24, 48
<i>Prospytochloa</i>	1	Southern Africa (t)	48
<i>Potamophila</i>	1	Australia (t + T)	Unknown
<i>Rhynchoryza</i>	1	South America (t)	24
<i>Zizania</i>	3	Europe, Asia, N. America (t + T)	30, 34
<i>Zizaniopsis</i>	5	North and South America (t + T)	24

T = tropical area, t = temperate area

4. Benefit of wild rice

Rice is one of the natural resource and genetic resource which at present the wild rice were used as genetic resource for breeding program to improve some character of cultivated rice, for instant resistant to disease and insect and tolerant to constraint condition. In IRRI (1990) reported that *Oryza rufipogon* has high ability to internode elongation and has salt tolerant genetic which found in *Oryza rufipogon* from Srilanka. While the genetic for brown plant hopper resistant, Chang (1985) reported that *Oryza rufipogon* and *Oryza nivara* have brown planthopper resistant characteristic for 3 biotypes.

Chitrakon *et al.* (1989) reported that *Oryza nivara* (Acc. 101508) 1 out of 80 samples collected from India is resistant to grassy stunt disease. This germplasm has been used to cross with cultivated rice and success to develop the new cultivated rice which resistant to grassy stunt disease by The International Rice Research Institute (IRRI) e.g. IR30, IR32, and IR42 Another one important role of wild rice is the use of genetic resource for hybrid rice breeding. Lin and Youan (1980) reported that wild rice *Oryza rufipogon* from Hunan province in China has genetic type as Cytoplasmic male sterility and the character has been successfully used for genetic resource for hybrid rice breeding in China.

Vaughan (1994) reported that wild rice can be used for consumption as cultivated rice in Brazil and India.

In Thailand, Tasnee (1995) reported that Chainat 1 and Suphanburi 90 have highly resistant ability to blown plant hopper. These 2 rice varieties have genetic from *Oryza nivara*. Chitrakon (1996) reported that *Oryza rufipogon* found in Thailand has protein content in seed about 9-12 %.

Thai landrace aromatic rice, mostly non resistant to important disease and insect e.g. blast, bacterial leaf blight, yellow orange leaf, brown plant hopper, white back plant hopper, green leaf hopper, and gall midge (Rice Research Institute, 1990).

The report of aromatic rice collection from Hansa was found that aromatic rice collected in the year 1974 had several different characteristics e.g. leaf color, seed shape, seed color, seed size, harvested time, amylose content and aroma.

Natee (1977) reported about the collection of aromatic rice that some varieties which have the same character but have different name where in different location or the same name but are different plant type and seed character.

Though Thailand has several kind of aromatic rice varieties, but the popular aromatic rice in world market and in country is Khao Dawk Mali 105 or Khao' Hawm Mali or Jasmine rice. Which is highly consumed by most of consumer due to good taste, soft and fragrance when cooked while another rice variety which similar qualities as Hawm Mali such as Hawm Nang Mon, Hawm Om, and Hawm Dong but were not interested as Hawm Mali. The aromatic rice which improved by Department of Agriculture and recommend to grow nowadays include 5 varieties with 4 non-glutinous rice. (Nangmon S-4, Khao Dawk Mali 105, RD15 and Pathumthani 60) and 1 glutinous rice (RD6) which have different history and character Wasana (1988).

5. Aromatic rice

Aromatic rice is defined to be special quality rice as it has good cooking quality, aroma, soft good taste, highly prefer by consumer, has higher price than general rice, it is required by most world consumer especially, Khao Dawk Mali 105 (*Oryza sativa* cv. KDML 105). Which is popular grow by the farmer in the North and Northeast Thailand where as rice growing has done for a long long time ago in south-east Asia (Toojinda *et al.*, 2004). At present, aromatic rice trade has enormous value and well-known in the world. The price of aromatic rice is much higher than non-aromatic rice. Therefore, most countries who produce rice tend to increase on producing aromatic rice for commercial benefit. For example Basmati from India and Pakistan which has long grain and fragrance as well. This rice variety is now well-known in the rich market as Unites State of America, middle east, and Europe. In the

future, the trend of KDML 105 demand will be higher in China where the growth of economic increase enormously. The population has more purchasing power. This situation increase high degree of competition for aromatic rice production in the world (Reuters, 2004).

6. Aromarker

The Thailand research team successes to cloned aromatic gene in rice from KDML105 x CT9993 population. Markers were screened with 11 generation of KDML105 x CT9993 progeny to narrow down aroma region. Functional marker of aromatic gene, Aromarker, were test with many aromatic and non-aromatic lines, the result shown that Aromarker can separate all aromatic lines from non aromatic lines (Vanavichit *et al.*, 2004).

7. Aromatic rice in Thailand

Rice (*Oryza sativa* L.) is a cereal crop which widely consume in country of Asia, America, Europe and Australia which an devided into different types depend on the criteria using. For instant, consider by starch component in rice grain we are able to group rice into 2 groups: nonglutinous and glutinous rice (Prapath, 1974). Some rice variety has more special property than the others such as aroma or good smell which is called “aromatic rice”. Therefor, aromatic is nonglutinous or glutinous rice which has aromatic scent as special specific property. Due to it has aromatic compound at higher level than non aromatic rice. Rice contains different amount of aromatic compound in different aromatic varieties. The level of aromatic scent of rice depend on 2-acetyl-1-pyrroline content in rice grain. Environment is one factor affecting level of aronomic scent in rice, Basmati variety has aromatic scent when grow in Zing region and Panjab region in India and Pakistan. The aromatic level decrease when grow in another place (Efferson, 1985; Sooksan and Piboon, 1985; Pratet, 1986). Similar to Khao Dawk Mali 105 Thai rice variety which has high level of aroma when grow at Surin and Chacherngsao province (Rice Research Institue,

1985; Sooksan and Piboon, 1985). The aromatic rice, aside from aromatic occur in grain it also occur in leaves which we can observe when walking pass aromatic rice field. In some rice arieties aromatic occur from seedling stage, tillering till flowering stage.

Aromatic rice was grown at long time ago in some country of south and southeast Asia and other several country. In Thailand, aromatic rice were grown in every region. Collection of rice variety in over all country by Breeding Division department of rice in 1950-1967. We are able to collect 803 varieties which if considering from their local name, we found that it's difficult ti identify which one is aromatic rice. Due to some variety which name as "Hawm" for example: Hawm Tawng Leuang Hawm Hawm Dong Hawm Surin and Daw Hawm While in some varieties name has no "Hawm" word but later on we found that this rice has aromatic scent i.e. Khao Dawk Mali and Naipon Ber1 (Breeding Division). Result of survey and rice collection by Natee (1977) and National Rice Seed Storage Laboratory for Genetic Resources, Pathum Thani Rice Research Center, Department of Aggriculture. in 1983-1990, there are 120 verieties compose of 77 non-glutinous rice and 43 glutionous rice growing in several provinces in country. Some rice varieties such as Hawm Mali, Leuang Hawm ,Hawm Jan, Hawm Dong, Hawm Pamah,Hawm Tung and Hawm Nahng Nuan are varieties which grow in several province (Table 5).

Table 5 Aromatic rice each region in Thailand

Regions	Name	Total
Central	Khao Howm	116
North	Khao Howm	201
Northeast	Khao Howm	319
South	Khao Howm	81
West	Khao Howm	48
East	Khao Howm	24
	Total	789

Collection of aromatic rice investigating report by Hansa (unknown year) found that aromatic rice varieties collected in the year 1974 have several different characters such as leaf color, grain shape, seed color, grain size, harvested duration,

amulose content, and aroma. Natee (1977) reported for survey of aromatic rice variety that some varieties which have same property but were named different in different location. While some lines have the same name but plant type and seed character are different. National Rice Seed Storage Laboratory for Genetic Resources, Pathum Thani Rice Research Center is studying rice collected in the year 1983-1990. To evaluate characters of new rice varieties by growing these varieties, determine the specific character and using isozyme to evaluate the different between variety.

Though, Thailand has several types of aromatic rice but the well known variety in world market is Khoa Dawk Mali 105 or Hawm Mali rice or Jasmin rice, the name given by other countries. This rice variety is popular for consumer due to its good taste, soft and aroma. Aside from this variety, there are some good cooking quality rice such as Hawm Nahng Mon Hawm Om and Hawm Dong but are popular as Khoa Dawk Mali.



Figure 4 Aromatic landrace rice

8. Out country aromatic rice

When mention about aromatic rice people recognize Thai aromatic rice, but in fact aroma rice are growing only in Thailand. There are several other countries which growing aroma rice and have different names. The aromatic rice which also well known are Barmati rice, Texmati rice, Wehani rice, and Wild pecan rice.

Basmati variety from India and Pakistan is special property rice as the grain size is long, aroma, good elongation, soft and good taste when cooked. The word “Basmati” is Hindi language which means “Queen of aroma”. Department of Agriculture has carry Basmati 370 variety to grow and study. From the study, the data indicated that Basmati is weakly photo sensitive rice variety with growing period 120-135 days, plant height about 140-150 cm. good tillering ability, quite small stem thus lodging, narrow leaf, long panicle, no branching, slender grain shape, straw color leaf with awn, brown rice length is 7.1-7.5 mm., high chalkiness, brown rice and milled rice color is opaque similar to sticky rice, milling quality ranging from intermediate to good (filled grain 32-53%), amylase content 21-22%, Intermediate gelatinization temperature, low gel consistency, good cooking quality, soft, good elongation (length of cooked rice is twice that of raw rice), has aromatic scent. Yielded about 300-500 kg/rai, rough rice weight is light (100 grain weight 2.1 - 2.3 g), response to nitrogen fertilizer is low, Medium resistant to bacterial leaf blight and blast during seedling stage but is not resistant to rice ragged stunt disease, brown planthopper, white back planthopper and green leaf hopper (Rice Research Institute, 1987; 1994). In India, beside growing basmati there are about 200 other aromatic varieties such as Baspatri, Badsahbhog, Ramtulsi, Sukhdsa and Randhunipagal.

Texmati rice is aromatic variety from the cross between long grain American rice and Basmati. It has better taste and smell than American rice but lower than Basmati.

Wehani rice is one of aromatic rice. It has smell like pop corn. This rice is developed from Basmati, start to grow in California, United State of America. Wild Pecan rice is aromatic rice. It has smell like popcorn similar to Wehani.

A side from aromatic rice mension above, our neighbor also grow and develop aromatic rice as well such as Cambodia, Laos, especially Vietnam which has exported aromatic rice but still not clear information for the name of their aromatic variety. While in Thailand we believe that Vietnam aromatic rice variety is coming from Thai rice especially Pathumthani rice variety.

Recently, There is news concerning aromatic rice which is interesting to know. Malaysia government is about to campaign their people to consume aromatic rice grown and developed by agricultural development office in Malaysia. This aromatic rice the Malaysian called “Mar Wangi Malaysia” and refered that has better quality than rice imported from Thailand. The government expected that if their people change their behavior to consume in-country aromatic rice then Malaysia will decrease import rice from Thailand about 30% and will increase Malaysian income.

Aromatic rice grown in each location is different depend on preferable of consumer or farmer which sometime consider on grain character or cooking quality. In the east and south of Thailand they prefer slender shape rice, medium or short grain, soft cooked rice. While people in the north prefer long grain rice (Tripathi, 1982). Breeding of aromatic rice in India, beside from Basmati 370 (BMT370) they laso have Pusa, Basmati 1, Kasturi and Mahi Suganda. In Japan Tomio (1993a) reported from the study of 69 local aromatic rice, there are 2 long grian variety, 10 glutinous rice and 2 red pericarp variety. They have grown aromatic rice spread out in their country but in small more than 1000 year ago for daily consuming and for apecial occasion such as religious celebration or other celebration and to service their guest. Nowaday, the number of variety and growing area is decrease due to replacing by new rice variety with high yield and good quality. However, there are some areas still growing rice in Japan i.e. Tohoku, South Kinki, South Shikoku and Kyushu.

Nowaday farmer and consumer have crossed between 5-10% aromatic rice with non aromatic to improve the taste of popular rice variety i.e. Hierl, Miyakaori, Haginokaori and Sari Queen (Tomio, 1933 b). Aromatic rice in another countries are Malahkit Sungong, Azucena and Milahrosa grown in Philippines, Seratus Malam in Indonesia, Goolarah in Australia and Della variety of America.

9. Aromatic compound in aromatic rice

The aromatic scent of rice is in evaporated essential oil form. In some varieties such as Khoa Dawk Mali 105 and Basmati 370, the aromatic scent appear since seedling stage, tillering, flowering stage till become complet grain and continue to brown rice and milled rice or even during cooking and cooked rice. During growing season, if we walk pass that field we will smell the aroma from leaf and flower of rice. There is hypothesis that aroma compound might accumulate in leaf and transfer to grain. Because when chewing rice in mount or during cooking we can smell the aroma. Tsuzuki *et al.* (1981) has done the chemical analysis using gas-chromatograph and found that in aromatic rice has higher content of oleic acid but lower linoleic acid than non aromatic rice. And aromatic glutinous rice has higher myristic acid, palmitic and linoleic acid but lower oleic acid than non glutinous rice. Ramarathnam *et al.* (1984) has studied the compound which cause aroma scent in Basmati by extract evaporate compound from the distillation system boiling with isopentane using Likens and Nickerson equipment. Measurement of compound by using silica gel in thin layer chromatography (TLC) and gas liquid chromatography (GLC) which can separate evaporate compound from each other. The important component of aromatic compound extracted from aromatic rice is similar to nonaromatic rice. Consider the result of TLC found that those compound is polar type. And the result from GLC found that one evaporate compound in Basmati has short duration for aromatic expression about 2.5 minute compare to another aromatic rice varieties which express aromatic scent about 3-17 minute.

The International Rice Research Institute (IRRI) has cooperate with United States Department of Agricultural (USDA) and in late 1981 the Western Regional

Research Center (WRRC) has analysed aromatic rice using objective gas-chromatographic screening method to study aromatic rice from several countries such as Seratus Malam variety from Indonesia, Hieri variety from Japan, Basmati 370 from Pakistan, Khao Dawk Mali 105 from Thailand, IR841-76-1 line from IRRI, Malagkit, Sungsong, Milagrosa and Azucena from Philippines. The study has compared with 2 checks i.e. Labelle and Calrose from America. The result showed that there are different compound causing aromatic in brown rice and cooked rice. The compound 2-acetyl-1-pyrroline is one compound in the group which causing fragrance in bread (“cracker-like” odor compounds). Aside from this compound there are 2-acetyl-1, 4, 5, 6-tetrahydro-pyridine, 2-acetylpyrazine and 2-acetyl-2thiazoline (IRRI 1983).

From the study we found that the 2-acetyl-1-pyrroline content in brown rice is higher than in milled rice. In brown rice has this compound 0.1-0.2 ppm (microgram per gram) while in milled rice is 0.04-0.09 ppm. When compare with non aromatic rice which has very small content of this aromatic compound it is less than 0.006-0.008 ppm. This result showed that aromatic rice has higher 2-acetyl-1-pyrroline content than nonaromatic rice and indicated that the concentration of this compound is higher in bran than in milled grain.

As aromatic rice has different amount of 2-acetyl-1-pyrroline, therefore the level of aromatic scent in aromatic rice can be divided into 3 levels; light, medium and strong. The study of IRRI and USDA found that the aromatic glutinous rice Malagkit, Sungsong from the Philippines has 0-09 ppm. 2-acetyl-1-pyrroline which higher than another varieties and considered as strong aromatic scent rice. Thai aromatic rice Khao Dawk Mali 105 contain 0.07 ppm. 2-acetyl-1-pyrroline lower than Malagkit, Sungsong but is considered strong aromatic rice. Study of 64 aromatic rice of Central Rice Research Institute (CRRI) in India found that 4 varieties Randhunipagal, Govindabhog, Badshabhog and Banspatri have stonger aromatic scent than another varieties tested (Choudhury and Ghosh, 1978).

The 2-acetyl-1-pyrroline compound aside from appear in rice it also found at high content in *Pandanus amaryllifolius* Roxb., fragrant screw pine with about 1

microgram per gram. The concentration of this compound found in *Pandanus amaryllifolius* Rokb is 10 times higher than in aromatic rice and 100 times higher than nonaromatic rice (Buttery *et al.*, 1983). Therefore, to make more fragrance in rice the people in India and another country prefer to put *Pandanus amaryllifolius* Rokb into nonaromatic rice cooking process.

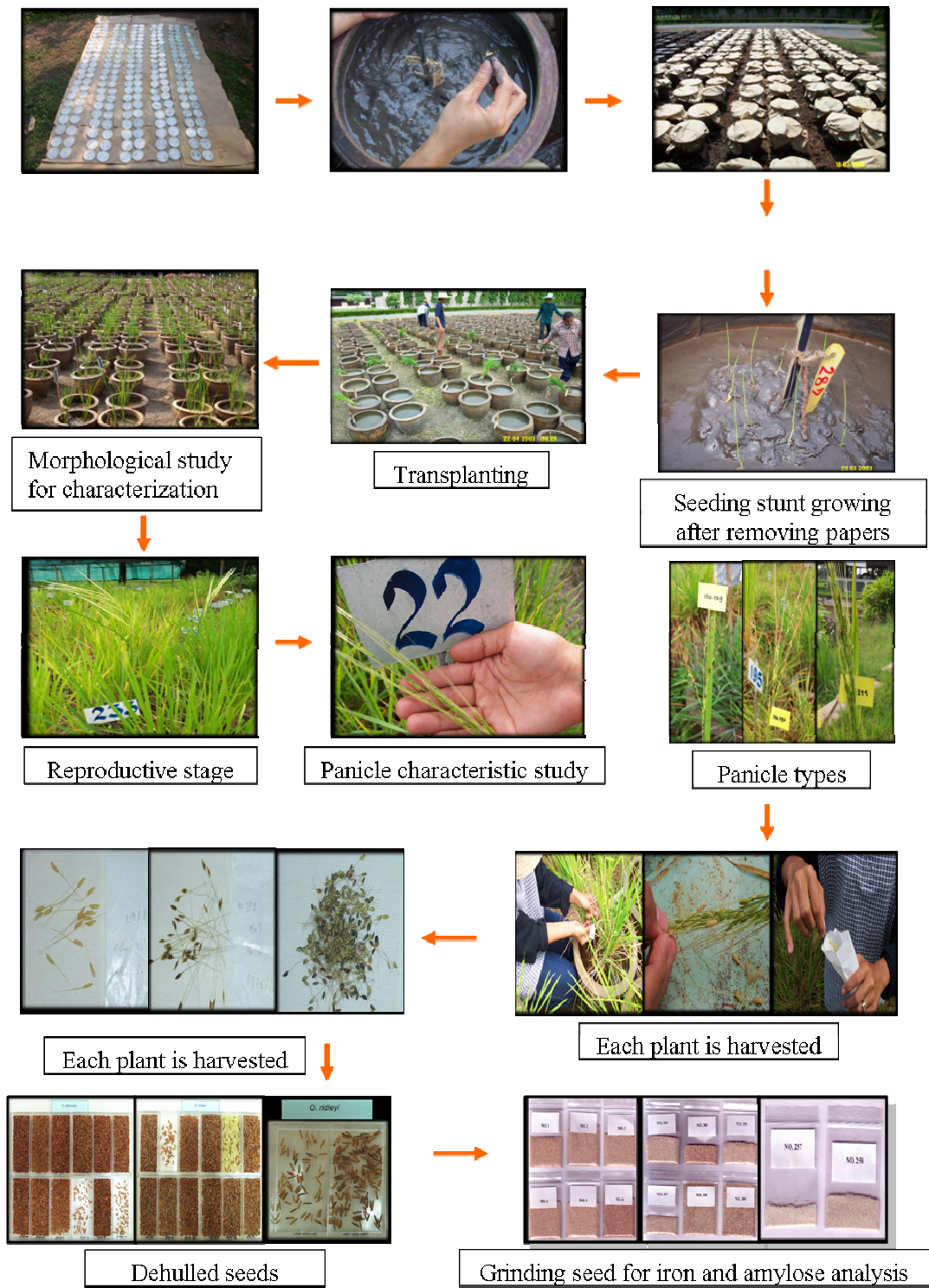
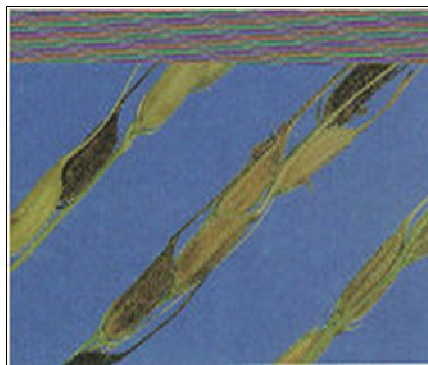


Figure 5 Morphological and Characterization of wild rice.



1. *Oryza alta*



2. *Oryza australiensis*



3. *Oryza barthii*



4. *Oryza brachyantha*

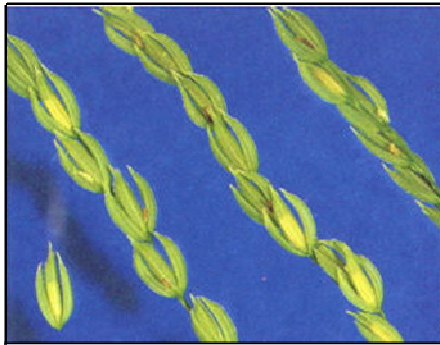


5. *Oryza eichingeri*



6. *Oryza glumaepatula*

Figure 6 International wild spp.



7. *Oryza glandiglumis*



8. *Oryza granulata*



9. *Oryza latifolia*



11. *Oryza meridionalis*



10. *Oryza longiglumis*



12. *Oryza longistaminata*

Figure 6 (Continued)



13. *Oryza meyeriana*



14. *Oryza minuta*



15. *Oryza nivara*



16. *Oryza neocaledonica*



17. *Oryza punctata*



18. *Oryza officinalis*

Figure 6 (Continued)

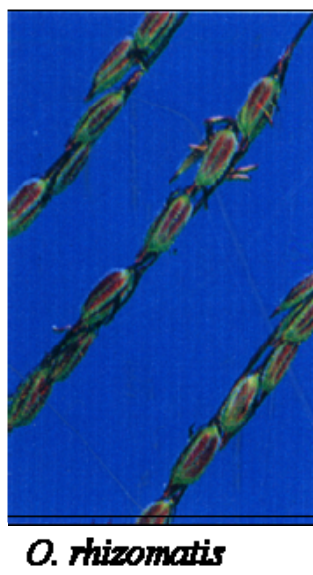


Figure 6 (Continued)

MATERIALS AND METHODS

1. Genetic resources

1.1 Local wild rice

Screening of the aromatic allele was carried out extensively in wild rice species and landraces collected at the National Rice Seed Storage Laboratory for Genetic Resources (NRGR), Pathum Thani Rice Research Center, (Thanya Buri, Pathum Thani, Thailand). More than 800 wild rice accessions and 5928 local landraces were collected throughout Thailand and stored at the NRGR since 1981 by the Rice Department, Ministry of Agriculture and Cooperative (MOAC). Two-hundred and forty-four accessions were sampled based upon locations of the species for the screening concluding 148 and 60 accessions of *O. rufipogon* and *O. nivara*, respectively, as shown in appendix 1 and summarized in Table 6.

Table 6 Summary of the wild rice accessions used for screening the aromatic allele in this study

Wild rice species	Locations	Accession
<i>Oryza nivara</i>	Buri Rum	9
	Chaiyaphum	1
	Chiang Mai	1
	Kalasin	1
	Kamphaeng Phet	1
	Lop Buri	3
	Nakhon Ratchasima	8
	Nakhon Sawan	3
	Nong Khai	4
	Phayao	1
	Prachin Buri	1
	Roi Et	1
	Sakon Nakhon	8
	Si Sa Ket	3
	Surin	3
	Udon Thani	4
	Yasothon	2
	Phitsanulok	3
	Saraburi	2
	Suphan Buri	1

Table 6 (continued)

Wild rice species	Locations	Accession
<i>Oryza rufipogon</i>	Ang Thong	2
	Buri Rum	2
	Chachoengsao	1
	Chanthaburi	1
	Chumphon	1
	Khon Kaen	2
	Mukdahan	1
	Nakhon Ratchasima	6
	Nakhon Sawan	11
	Nakhon Si Thammarat	2
	Narathiwat	6
	Nong Khai	2
	Pathum Thani	2
	Pattani	1
	Phetchaburi	1
	Phichit	2
	Phitsanulok	13
	Phra Nakhon Si Ayutthaya	12
	Ratchaburi	10
	Rayong	2
	Saraburi	20
	Si Sa Ket	1
	Sing Buri	3
	Songkhla	1
	Sukhothai	25
	Suphan Buri	8
	Surat Thani	2
	Surin	4
	Trat	1
	Udon Thani	9
	Uttaradit	6
	Utthai Thani	3
	Chai Nat	5
	Chiang Mai	2
Chiang Rai	1	
Kamphaeng Phet	2	
Kanchanaburi	2	
Lampang	1	
Nakhon Nayok	4	
Sakon Nakhon	4	

1.2 Landrace rice

Further screening of the aromatic allele was extended to 241 accessions of landraces based on the specified locations where the aromatic wild species were found. Landraces from the six locations was presented in appendix 2 and summarized in Table 7.

In this study, we used 242 local rice varieties from 6 provinces i.e. Phitsanulok, Sukhothai, Trat, Chantaburi, Chai Nat, and Nakhon Ratchasima. These samples were collected and stored at the NRGR as showed in appendix 2.

Table 7 Summary of the 242 landrace cultivars from the locations where the aromatic wild species were identified.

Locations		Wild spp.	Landrace
District	Province		
Wang Thong	Phitsanulok	16	129
Meuang	Sukhothai	25	46
Tha Mai	Chanthaburi	1	20
Nonsoong	Nakhon Ratchasima	14	12
Khao Saming	Trat	1	32
Manorom	Chai Nat	5	3

Source: Thai National Rice Seed Storage Laboratory for Genetic Resources

1.3 International wild rice accessions

All 101 accessions of 18 wild rice species were obtained from the NRGR. The list of number and species was showed below in Table 8.

Table 8 Summary of 101 accessions and countries of origin of the 18 wild rice species representing the international wild rice accessions used in this study.

Wild rice species	Genome	Locations	Accession
<i>Oryza alta</i>	CCDD	America	1
		Brazil	1
		India	2
		Philippines	1
		Surinam	1
<i>Oryza australiensis</i>	EE	America	6
		India	1
		Philippines	1
<i>Oryza barthii</i>	A ^g A ^g	Cameroon	1
		Chad	2
		Mali	1
		Philippines	1
		Sudan	1
		Zambia	1
<i>Oryza brachyantha</i>	FF	Mali	2
		Sierra Leone	3
<i>Oryza eichingeri</i>	CC	Ceylon	1
		Philippines	1
		Uganda	3
<i>Oryza glumaepatula</i>	A ^{sp} A ^{sp}	Brazil	7
		Cuba	1
		India	1
		Surinam	1
<i>Oryza granulata</i>	GG	Borneo	1
		Burma	1
		Ceylon	1
		India	3
		Japan	1
		Loas	1
		Philippines	1
		Costarica	1
<i>Oryza latifolia</i>	CCDD	Guatemala	1
		India	2
		India	1
		USA	1
		Africa	1
<i>Oryza longistaminata</i>	A ¹ A ¹	Indonesia	1
		Ivory Coast	1
		New Guinea	1
		Nigeria	1
		Australia	4
<i>Oryza meridionalis</i>	A ^m A ^m		

Table 8 (Continued)

Wild rice species	Genome	Locations	Accession
<i>Oryza minuta</i>	BBCC	Philippines	4
		Bangladesh	3
		India	3
		Laos	2
<i>Oryza officinalis</i>	CC	Philippines	1
		Bangladesh	1
		Brunai	1
		India	1
		Indonesia	1
		Malaysia	1
		Philippines	1
<i>Oryza perrieri</i>	unknown	Japan	2
<i>Oryza punctata</i>	BB, BBCC	Cameroon	1
		Ghana	1
		India	1
		Nigeria	2
		Tanzania	2
<i>Oryza ridleyi</i>	HHJJ	Malaysia	1
		Philippines	2
<i>Oryza rufipogon</i>	AA	Bangladesh	1
		Burma	1
		Indonesia	1
		Laos	1
		Philippines	1
		Taiwan	1

2. Methods

2.1 Characterization of wild species

Standard morpho-agronomic traits in the “Descriptors for wild rice” was used as a guideline and data were recorded on IRGC data sheet.

The traits observed at the early and late vegetative, reproductive and maturity stages were recorded in the field. Panicle and grain characteristics were recorded in the laboratory.

Descriptors used:

Table 9 Descriptors for wild rice.

Character No.	Descriptor stage and Meaning
1	G.S. No:
2	Species name: see Appendix:
3	Designation:
4	Location:
5	Height at 55 days: height measure in cm
6	Growth habit 1=erect 3=semi-erect 5=intermediate 7decumbent 9=prostrate
7	Culm diameter:measure midportion of the main culm in mm
8	Leaf sheath color: 1=green 2=dark green 3=light purple 4=purple
9	Leaf blade color: 1=green 2=dark green 3=purple at margin 4=purple line 5=all purple
10	Tillers: number of tiller per plant at full vegetative stage
11	Adventitious root: 1=present 2=absent
12	Ligule color: 1=colorless 2=purple
13	Ligule shape: 1=1 clip 2=2 clips 3=truncate
14	Ligule length (length from collar base to ligule tip measure in...mm
15	Auricle color: 1=colorless 2=purple
16	Flowering date (50 %)...or Maturity.....day
17	Number of leaves to flowering:count at flowering.....
18	Pubescence: 1=glabrous 2=intermediate 3=pubescent
19	Leaf blade length:measure length of the the topmost leaf in cm.....
20	Leaf blade width:measure widest portion of the topmost leaf in cm...
21	Flag leaf angle : 1=erect 3=intermediate 5=horizontal 7=droopy
22	Flag leaf length:measure in cm.....
23	Flag leaf width:measure widest portion in cm.....
24	Spikelet color: 1=straw 2=brown 3=yellow 4=red 5=black
25	Apiculus color : 1=colorless 2=brown 3=yellow 4=red 5=black
26	Anther length: 1=1/4 spikelet 2=1/2 spikelet 3=3/4 spikelet 4=full or equal to spikelet
27	Stigma color: 1=colorless 2=red 3=purple 4=black

Table 9 (Continued)

Character No.	Descriptor stage and Meaning
28	Stigma exertion: 1=enclose 2=exserte 3=well exerted
29	Stigma size: 1=big 2=small
30	Awne: 1=absent 2=present
31	Awn color: 1=colorless 2=yellow 3=red 4=black
32	Sterile lemma color: 1=colorless 2=brown 3=red 4=purple-black
33	Plant height: measure at harvesting time in cm.....
34	Bearing tillers: count panicles at harvesting time in cm.....
35	Panicle length: measure from base to panicle tip in cm.....
36	Panicle type: 1=compact 5=intermediate 9=open
37	Branching: 1=absent 2=some 3=intermediate 4=many
38	Fertility: 1=0% 2=0-50% 3=>50%
39	Shattering: 1=high 2=medium 3=low
40	Hull color: 1=straw 2=yellow 3=red 4=dark-brown 5=black
41	Grain pubescence: 1=glabrous 2=intermediate 3=pubescent
42	Panicle base length: measure from panicle base to first branching in cm.....
43	Grain length:measure in mm.....
44	Grain width:measure widest portion in mm.....
45	Grain thickness:measure in mm
46	Awn length:measure from apiculus tip to awn tip in cm.....
47	Sterile lemma length: 1=short 3=medium (<1/2spikel) 5=long (<1/2spikelet) 7=very long (longer than spikelet)
48	100 grain weight:weigh 100 well-developed grain in g.....
49	Pericarp color 1=white 2=red 3=black 4=waxy
50	Life span 1=annual (A) 2=perennial (P)
51	Root: 0=normal 1=rhizome 2=stolon
52	Water condition character no.
53	Shading character no
54	Latitude at North (converted from area code)
55	Longitude at East (converted from area code)

2.2 Screening of aromatic gene

Genomic DNA was isolated from leaves of seedlings pooled from each accession using DNA trap method following the product protocol (DNA Technology Laboratory, National Center for Genetic Engineering and Biotechnology, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom, Thailand). The primers used in this study were developed and provided by the Rice Gene Discovery (National Center for Genetic Engineering and Biotechnology, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom, Thailand) as shown in Table 10.

Table 10 Multiplex primer sequence and positions on the rice genome.

Primer name	Location	Pseudomolecule		Primer sequence
		start	end	
Aromarker	7th exon	20249866	20250193	F: TGCTCCTTTGTCATCACACC R: TTCCACCAAGTTCCAGTGA

The PCR analyses were performed in a total reaction volume of 20 μ l, consisting of 0.1 μ l *Taq* DNA polymerase, 2 μ l genomic DNA (50 ng/ μ l), 2 μ l of 10x buffer, 4 μ l dNTPs (5 mM each), and 2 μ l each primer (10 μ M). The PCR cycling was performed in a Thermal Cycler PTC 200 (MJ Research, Waltham, MA) and consisted of an initial denaturation at 94° C for 2 min, followed by 30 cycles of 30 sec at 94° C, 30 sec at 55° C, and 1 min at 72° C, and terminated with a final extension step for 10 min at 72° C. The amplicons were separated in 4.5% Polyacrylamide Gel Electrophoresis (PAGE) using 60 watt at 50° C for approximately 18 cm length and silver stained for visualization.

Analysis of 2-acetyl-1-pyrroline content and sensory analysis

Analysis of 2-acetyl-1-pyrroline (2AP) was accomplished by using gas chromatographic mass spectrophotometry (GC-MS) with headspace as described by Sriseadka *et al.* (2006). Either young leaves or grains were used for the analysis of 2AP. Aroma sensory for rice grain was tested using a chewing method.

RESULTS

Morphological characteristic of local wild species

The 244 accessions of Thai wild rice were characterized at PTRRC. Most accessions of *O.rufipogon* have spread tiller and photoperiod insensitive similar to most cultivated rice. The species reached the panicle initiation stage and flowered in June. Their seed awns are red or white color with compacted panicles. From visual observation, these rice species were usually more severely destroyed by rat rather than other species. That may indicates some special characteristics of this species. While *O.nivara* has moderately spread panicle and straw, colored seeds, long awns with red and white color but shorter than *O.rufipogon*. The results from all samples tested were concluded in Table 11.

Table 11 General characterizations of two local wild rice species for key morphological traits.

Trait	Species	
	<i>O. rufipogon</i>	<i>O. nivara</i>
Height (cm)	53.4	45.32
Tiller type	Spread	Intermediate
Leaf hair	some	Some
Leaf sheath color	Light purple	Light purple
Leaf color	Purple at edge	Purple at edge
Special Shoot/root	Yes	Yes
Awn	Yes	Yes
Flowering Date	July, 29	August, 6

Two hundred and forty four accessions of wild rice species from Thailand were used and planted at PTRRC. During the four-month experimental period, all observed morphological characteristic of wild rice from vegetative, reproduction to harvest stages were recorded for the *O. nivara*, and *O. rufipogon* collected from all geographical areas of Thailand. Two hundred and forty -four accessions were used in this study. The gene specific marker for aroma trait was used to survey the presents of aroma gene in the wild rice genome.

Table 12 Characterization of six Thai wild rice accessions identified as aromatic.

Traits	<i>O. rufipogon</i>					<i>O. nivara</i>
	GS. No. 6092	GS. No. 9351	GS. No. 10561	GS. No. 10563	GS. No. 10592	GS. No. 18341
Height	57.54	75.69	81.36	74.29	110.62	71.44
Culm	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Diameter	1.05	1.19	1.70	0.93	1.40	1.16
Leaf sheath color	Light purple	Green	Green, Light purple	Green	Green, Purple, Light purple	Green
Leaf blade color	Purple	Green	Green, Dark green	Green	Dark Green, Green, Purple	Green
Tiller number	14.43	11.59	10.27	10.55	22.36	10.36
Adventitious root	Present	Present	Absent, Present	Present	Present, Absent	Present
Ligule color	Purple	Colorless	Colorless, Purple	Colorless	Colorless, Purple	Purple, Colorless
Ligule shape	Prumcate	Prumcate	Prumcate	Prumcate	Prumcate	Prumcate
Ligule length	2.48	2.21	1.68	1.46	2.38	2.73

Table 12 (Continued)

Traits	<i>O. rufipogon</i>					<i>O. nivara</i>
	GS. No. 6092	GS. No. 9351	GS. No. 10561	GS. No. 10563	GS. No. 10592	GS. No. 18341
Auricle color	Purple	Colorless	Colorless, Purple	Colorless	Colorless, Purple	Purple, Colorless
Flowering date	96.00	98.00	98.00	95.00	101.00	115
Number of leaves	5.25	6.00	4.36	7.00	6.67	6
Pubescence	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
Leaf blade length	44.91	45.51	67.17	47.21	60.63	52.25
Leaf blade width	0.88	2.08	1.17	1.43	1.33	1.2
Flag leaf angle	Intermediate	Intermediate, Horizontal	Intermediate	Intermediate	Intermediate	Intermediate
Flag leaf length	37.81	44.44	44.97	31.63	38.28	36.79
Flag leaf width	1.11	1.31	1.46	1.40	1.48	1.39
Spikelet color	Yellow	Straw	Straw	Straw, Black	Black, Yellow, Straw	Black, Yellow

Table 12 (Continued)

Traits	<i>O. rufipogon</i>					<i>O. nivara</i>
	GS. No. 6092	GS. No. 9351	GS. No. 10561	GS. No. 10563	GS. No. 10592	GS. No. 18341
Apiculus color	Red, Dark purple	Colorless	Colorless, Red	Colorless	Colorless, Red	Red, Colorless
Anther length	3/4-full Spikelet	Full spikelet	1/2-full Spikelet	3/4-full spikelet	1/2-full spikelet	1/2-3/4 spikelet
Stigma color	Black	Colorless	Colorless, Black	Colorless	Black, Colorless	Black, Yellow, Colorless
Stigma exertion	Well exerted	Well exerted	Well exerted	Well exerted	Well exerted	Well exerted
Stigma size	Small	Small	Small	Small	Small, Large	Small
Awned	Present	Present	Present	Absent, Present	Absent, Present	Present
Awn color	Colorless, Red	Colorless	Colorless, Red	Colorless	Colorless, Red	Red, Colorless
Sterile lemma	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
Plant height	123.00	107.12	148.82	129.88	163.42	126.25
Bearing tillers	30.88	25.34	20.82	30.63	29.67	27.00

Table 12 (Continued)

Traits	<i>O. rufipogon</i>					<i>O. nivara</i>
	GS. No. 6092	GS. No. 9351	GS. No. 10561	GS. No. 10563	GS. No. 10592	GS. No. 18341
Panicle length	28.03	24.63	31.47	25.13	31.55	24.88
Panicle type	Intermediate	Intermediate	Intermediate, Open	Intermediate, Open	Compact, Open, Intermediate	Open, Intermediate, Compact
Branching	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Some
Fertility	Intermediate	High	Intermediate	Intermediate, High	Sterility, Low, Intermediate	High
Shattering	High	High	Intermediate, High	High	High, Intermediate	High
Hull color	Yellow	Straw	Straw	Straw, Black, Yellow	Straw, Yellow, Black	Black, Yellow
Grain pubescence	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
Panicle base length	17.03	11.09	12.73	10.05	10.61	7.81
Grain length	10.11	9.18	8.50	8.34	9.11	9.58
Grain width	2.59	2.67	2.52	2.62	2.58	2.70

Table 12 (Continued)

Traits	<i>O. rufipogon</i>					<i>O. nivara</i>
	GS. No. 6092	GS. No. 9351	GS. No. 10561	GS. No. 10563	GS. No. 10592	GS. No. 18341
Grain thickness	1.92	1.84	1.76	1.81	1.87	1.85
Awn length	5.07	3.88	2.25	2.00	3.32	3.32
Sterile lemma length	Short	Short	Short	Short	Short	Short
100 Grain weight	2.79	2.33	1.84	2.03	2.55	2.86
Pericarp color	White, Red	Red	Red	Red	white	white
Life span	147.00	134.00	160.50	160.00	180.00	155.50
Root	Rhizome	Rhizome	Rhizome	Rhizome	Rhizome	Rhizome
Scent	Aroma	Aroma	Aroma	Aroma	Aroma	Aroma

Survey of aromatic gene in local wild species

Local wild species genotyping

Molecular study of wild rice by using gene-specific DNA marker of the aromatic gene; Aromarker and selection of wild rice lines containing 8 bp deletion in the exon 7 and determination of quantity of aromatic compound by using GC-MS for analysis base sequence of aromatic gene in wild rice species. We identified aromatic alleles in the wild rice collected from 6 provinces.

Table 13 Wild rice and aromatic gene found.

Entry	Accession	Variety	Province	Remark
1	6092	<i>O.rufipogon</i>	Phitsanulok	aromatic gene
2	9351	<i>O.rufipogon</i>	Sukhothai	aromatic gene
3	10561	<i>O.rufipogon</i>	Chanthaburi	aromatic gene
4	10563	<i>O.rufipogon</i>	Trat	aromatic gene
5	10592	<i>O.rufipogon</i>	Chai Nat	aromatic gene
6	18341	<i>O.nivara</i>	Nakhon Ratchasima	aromatic gene

Because of the heterozygosity of aromatic alleles in wild species, we decided to purify them in paddy field at Klong Luang Rice Research Center (KLRR) during 2006-2007 wet season. Six accessions have still maintained aromatic scent with robust growth in the field. Sensory testing of aromatic scent of rice grains found that accessions 6092 and 10592 have strongest aromatic scent.

Table 14 Genotyping of wild rice.

Thai wild rice	Accession	Genotype	
		A	B
<i>O. nivara</i>	60	1	59
<i>O. rufipogon</i>	184	5	179
Total	244	6	238

A = Aromatic allele, B = Non-aromatic allele

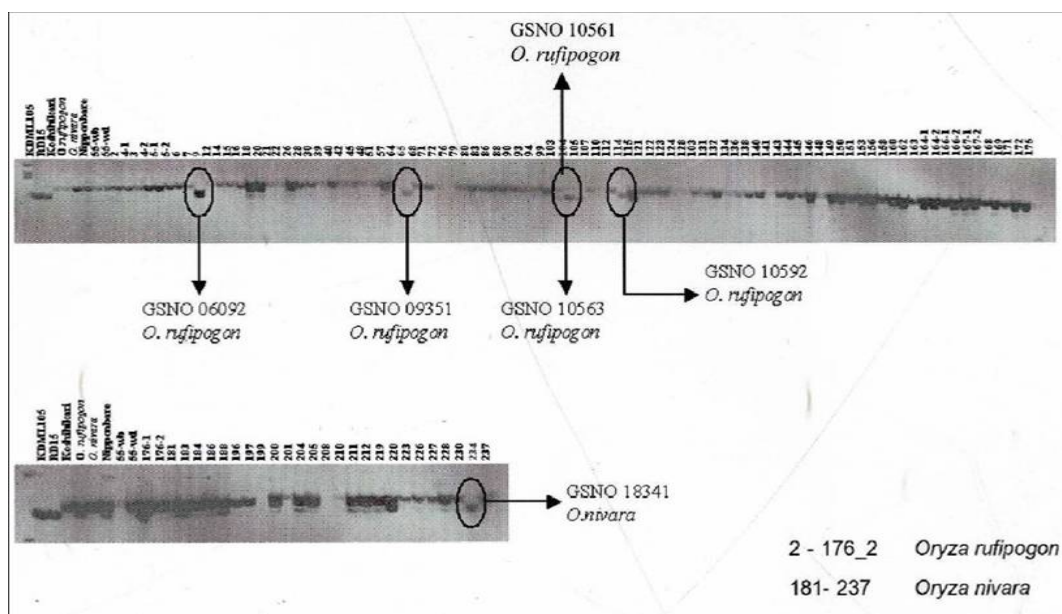


Figure 7 Genotyping of Thailand for Aromarker.

2-acetyl-1pyrroline (2AP) content analysis

The results of Aromarker screening showed that six samples of wild rice were aromatic rice (Figure 7). These aromatic wild spp. and the positive control, KDML105, and the negative control, JHN, were tested for 2AP content. The result shown, only accession that positive by Aromarker screening were present 2AP compound.

Table 15 Result of 2-acetyl-1pyrroline (2AP) analysis.

Name	Result in 4.5 % PAGE	Sample amount (g)	Concentration of 2AP in rice sample (ppm)
GSNO 06092 (9RU)	aromatic wild rice	4.313	0.35
GSNO 09351 (65RU)	aromatic wild rice	4.568	0.46
GSNO 10545 (103RU)	non-aromatic wild rice	3.969	0
GSNO 10563 (104RU)	aromatic wild rice	4.934	0.85
GSNO 10592 (114RU)	aromatic wild rice	5.031	0.82
Jao Hawm Nin (JHN)	aromatic cultivated rice (negative control)	5.081	0
Khao Dawk Mali 105 (KDML105)	non-aromatic cultivated rice (positive control)	5	1.41

The seed purification test from leaf pools

We tested the seed purification in each aromatic sample because there were many lines of wild rice grown in the same location. The purification test used pool leaf for extracted DNA in each sample.

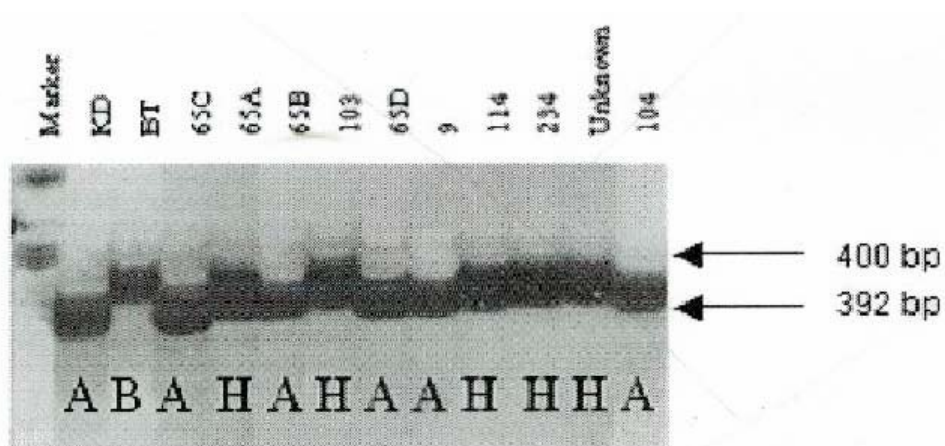


Figure 8 The result of purification test.

Allele A - homozygous aromatic

Allele B - homozygous non aromatic

Allele H - heterozygous

From the result 5 pool samples had heterozygous allele include

pool 65A (GS.No. 09351)

pool 103 (GS.No. 10545)

pool 114 (GS.No. 10592)

pool 234 (GS.No. 18341)

and unknown pool

Segregation of Aromarker allele

Since heterozygous was found in leaf pool from previous experiment, so in this experiment extraction DNA from single seed in each line was performed for investigation of heterozygous evident either natural heterozygous or contamination.

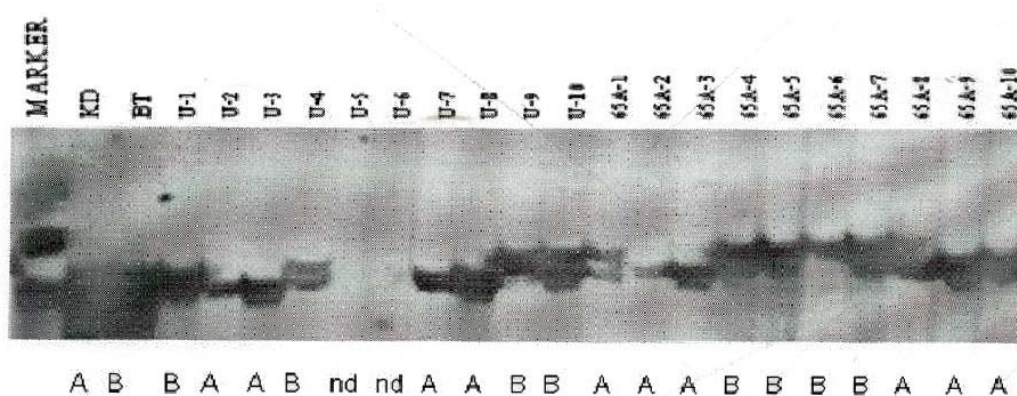


Figure 9 Shown distributions of samples (single seed extraction) in unknown and 65A pools by 4.5% denaturing PAGE. Aromatic allele is lower band and non-aromatic is upper band.

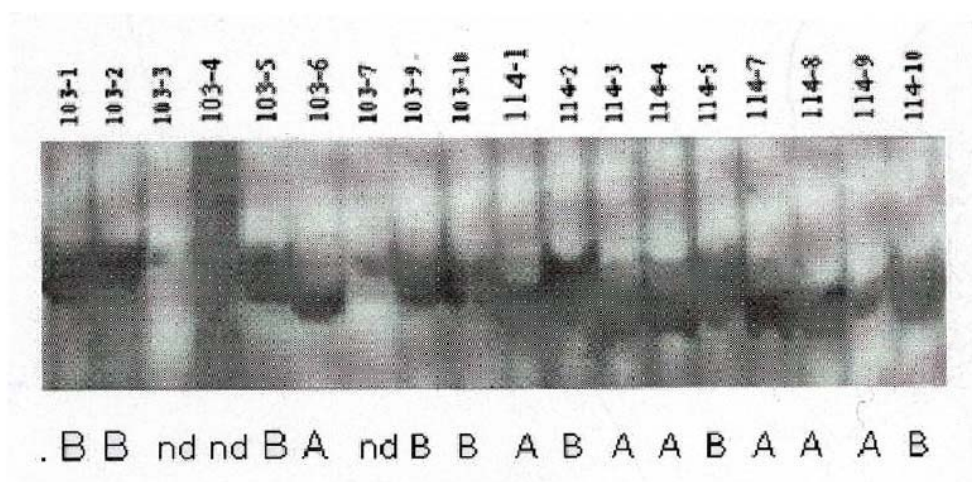


Figure 10 Shown distributions of samples (single seed extraction) in 103 (GS.No. 10545) and 114 (GS.No. 10592) pools by 4.5% denaturing PAGE. Aromatic allele is lower band and non-aromatic is upper band.

Characterization of the six aromatic Thai wild rice accessions

The morphological characterization of selected aromatic wild rice accessions in Thailand that observed during collection was summarized as follows:

1. *O. rufipogon* accession no. 6092: This accession was 57 cm tall and showed horizontal culm. Leaf sheath color was light purple with a purple leaf blade. The flowering date of this accession was 96 day after germination. Pubescences were found in intermediate level and had yellow spikelet. The flag leaf length and flag leaf width were 38 and 1 cm, respectively. Awns were either colorless or red color. The pericarp was white and red color.

2. *O. rufipogon* accession no. 9351: This accession was 75 cm tall with a horizontal culm. Their leaf sheath was light purple corresponding to the leaf blade color. The flowering date of this accession was 98 days. Leaf pubescence level was intermediate and flag leaf length and width were 44 and 1.3 cm, respectively. Seeds have awn with colorless and their pericarp was red color.

3. *O. rufipogon* accession no. 10561: This accession was 81 cm tall with a horizontal culm. Their leaf sheath was either green or light purple. Their leaf blades were either green or dark green. The flowering date was 98 days after seed germination. Their flag leaf length and width were 45 and 1.5 cm, respectively. The spikelet color was straw with red pericarp. Their awns were either colorless and red.

4. *O. rufipogon* accession no.10563: This accession was 74 cm high with horizontal culm. Both leaf sheath and leaf blade color are green with intermediate level of pubescence. Their flowering date was 95 days after germination. The flag leaf length and width were 32 and 1.4 cm, respectively. Their spikelet colors are either straw or black with either absent or present a colorless awn. Mature seeds were either straw, black or yellow with a red pericarp.

5. *O. rufipogon* accession no.10592: This accession was 111cm with a horizontal culm. Their leaf sheath was color in green, purple and light purple while the leaf blades were dark green and green purple. The flowering date is longer than other selected accession in 101 days after their grown. This accession shows a pubescence in an intermediate level. Their flag leaf length and a flag leaf blade were 38 and 1.5 cm, respectively. The mature seed was straw, yellow or black with the white pericarp.

6. *O. nivara* accession no. 18341: This was the only aromatic *O.nivara* species. This accession had a horizontal culm with 71 cm tall. Both leaf sheath and leaf blade colors are green. Pubescence was founded with intermediated level. The flowering date was 115 days, the longest among other selected aromatic wild rice found in this study. Their flag leaf length and flag leaf width were 37 and 1.4 cm, respectively. Their spikelet colors were either black or yellow with red or colorless awn. The mature seeds were either black or yellow color with white pericarp.

Survey of landrace in the selected provinces

In order to understand the significance of the aromatic allele in the two ancestors of cultivated rice, 194 accessions of landrace varieties selected from provinces where wild spp were discovered. The results found that 24 accessions were aromatic. The cultivated rice was collected comprise of 14 samples from Pitsanulok, 4 samples from Sokhothai, 2 samples from Trat, 5 samples from Nakon Rachasima 1 samples from Chanthaburi and 1 sample from Chainat.

Study of aromatic gene discovery of wild rice, we found in rice from 6 provinces. Therefore, this result leading us to collect local varieties in nearby district and province as well as the same district which found these aromatic wild rice for aromatic gene determination. Two hundred and forty one samples collected from Phitsanulok, Sukhothai, Chantaburi, Nakhonratchasima, Trat and Chai Nat province, we have found 29 samples carry aromatic gene.

Table 16 Aromarker genotyping of 242 accessions of landrace rice.

Landrace	Accession	Genotype		
		A	H	B
Phitsanulok	129	17	4	108
Sukhothai	46	4	-	42
Chantaburi	20	1	-	19
Nakhonratchasima	12	5	-	7
Trat	32	1	-	31
Chai Nat	1834	1	-	2
Total	242	29	-	209

A = Aromatic allele, B = Non-aromatic allele, H = Heterozygous allele

The local varieties which carry aromatic gene are the site specific local variety. Farmers in these areas used to grown these varieties long time ago. Hypothetically perhaps we can conclude that these local varieties obtain aromatic characteristic by transferring from wild rice, as we have found wild rice before cultivated rice.

Table 17 List of all 29 accessions of local landraces identified as aromatic by Aromarker.

No.	Acc.	Variety name	District	Province	Aromatic
1	1780	Daw Dam	Wang Thong	Phitsanulok	A
2	1782	Ngah Chang	Wang Thong	Phitsanulok	A
3	3535	Bang Gawk	Wang Thong	Phitsanulok	A
4	3536	Niaw Lampahng	Wang Thong	Phitsanulok	A
5	3538	Khiaw Paed	Wang Thong	Phitsanulok	A
6	3551	Khao Prajuab	Wang Thong	Phitsanulok	A
7	3552	Khao Maled Yao	Wang Thong	Phitsanulok	A
8	3554	Leuang Awn Bow	Wang Thong	Phitsanulok	A
9	6344	Pleuk Kai	Wang Thong	Phitsanulok	A
10	6345	Puang Tah Ni	Wang Thong	Phitsanulok	A
11	6346	Puang Tawng	Wang Thong	Phitsanulok	A
12	6364	Sahm Deuan	Wang Thong	Phitsanulok	A
13	6415	Lian Tawng	Wang Thong	Phitsanulok	A
14	17914	Leuang Tawng	Wang Thong	Phitsanulok	A
15	17920	Maled Yai	Wang Thong	Phitsanulok	A
16	17928	Khao'Lao	Wang Thong	Phitsanulok	A
17	17967	Supanburi	Wang Thong	Phitsanulok	A
18	4890	Ma khaek	Meuang	Sukhothai	A
19	4897	Hawm Krua	Meuang	Sukhothai	A
20	4914	Khao Dawk Mali	Meuang	Sukhothai	A
21	4915	Niaw Hawm	Meuang	Sukhothai	A
22	12281	Khao Yai Sai	Tha Mai	Chanthaburi	A
23	1625	Khao Dawk Mali	Nonsoong	Nakhon Ratchasima	A
24	5766	Sahm Deuan	Nonsoong	Nakhon Ratchasima	A
25	5770	Leuang Gluay	Nonsoong	Nakhon Ratchasima	A
26	21757	Khao Sawad	Nonsoong	Nakhon Ratchasima	A
27	21767	Te Haw	Nonsoong	Nakhon Ratchasima	A
28	21245	Khao Mali	Khao Saming	Trat	A
29	6522	Beu Nam	Manorom	Chai Nat	A

A = Aromatic allele


Survey of Aromatic Gene in *O. glaberrima* and other wild species

All 18 species of international wild rice were obtained from NRSSLGR and 101 accessions were screened for aromatic allelic types using the Aromarker. Extensive survey of 101 accessions of wild rice from 18 species were screened for the aromatic gene. We identified 14 accessions of 8 species were aromatic. These wild species rice genomes including BBCC, CCDD, CC, EE and FF genomes were aromatic while rice with genomes GG, HHJJ and HHKK were not aromatic. The 14 international wild rice accessions comprised of four samples from African group, three samples from India, three samples from Bangladesh, two samples from Australia, one sample from America and the Philippines.

Table 18 Aromarker allelic typing of the list of international wild rice species.

Genome	Wild speices	Country of origin	Aromaker allele	Aromaker allelic type
AA	<i>O. nivara</i>	Laos	1	Non aromatic
AA	<i>O. nivara</i>	Philippines	-	Absent band
AA	<i>O. nivara</i>	India	2	Aromatic
AA	<i>O. nivara</i>	Bangladesh	-	Absent band
AA	<i>O. nivara</i>	Bangladesh	1	Non aromatic
AA	<i>O. nivara</i>	Bangladesh	2	Aromatic
AA	<i>O. nivara</i>	India	1	Non aromatic
AA	<i>O. nivara</i>	Laos	-	Absent band
AA	<i>O. rufipogon</i>	nd	-	Absent band
AA	<i>O. rufipogon</i>	nd	1	Non aromatic
AA	<i>O. rufipogon</i>	nd	1	Non aromatic
AA	<i>O. rufipogon</i>	nd	-	Absent band
AA	<i>O. rufipogon</i>	nd	-	Absent band
AA	<i>O. rufipogon</i>	nd	2	Aromatic
AA	Spontanea form	nd	1	Non aromatic
AA	Spontanea form	nd	1	Non aromatic
AA	Spontanea form	nd	1	Non aromatic
A ^g A ^g	<i>O. barthii</i>	Mali	-	Absent band
A ^g A ^g	<i>O. barthii</i>	Chad	1	Non aromatic
A ^g A ^g	<i>O. glaberrima</i>	Sudan	2	Aromatic
A ¹ A ¹	<i>O. longistaminata</i>	Philippines	1	Non aromatic
A ¹ A ¹	<i>O. longistaminata</i>	Philippines	-	Absent band
A ^m A ^m	<i>O. meridionalis</i>	Australia	2	Aromatic
BB,BBCC	<i>O. punctata</i>	India	-	Absent band
BB,BBCC	<i>O. punctata</i>	Nigeria	1	Non aromatic
BB,BBCC	<i>O. punctata</i>	Nigeria	-	Absent band
BB,BBCC	<i>O. punctata</i>	Cameroon	2	Aromatic
BB,BBCC	<i>O. punctata</i>	Ghana	1	Non aromatic
BB,BBCC	<i>O. punctata</i>	Tanzania	-	Absent band
CC	<i>O. eichingeri</i>	Philippines	1	Non aromatic
CC	<i>O. eichingeri</i>	Uganda	1	Non aromatic
CC	<i>O. officinalis</i>	India	2	Aromatic
CC	<i>O. officinalis</i>	Philippines	2	Aromatic
CC	<i>O. officinalis</i>	Bangladesh	2	Aromatic
CCDD	<i>O. latifolia</i>	Costa Rica	2	Aromatic
CCDD	<i>O. latifolia</i>	India	2	Aromatic
CCDD	<i>O. latifolia</i>	India	1	Non aromatic
CCDD	<i>O. latifolia</i>	Guatemala	2	Aromatic
CCDD	<i>O. latifolia</i>	USA	2	Aromatic
CCDD	<i>O. latifolia</i>	Nicaragua	1	Non aromatic
EE	<i>O. australiensis</i>	Australia	-	Absent band
EE	<i>O. australiensis</i>	Australia	-	Absent band
EE	<i>O. australiensis</i>	Australia	2	Aromatic
FF	<i>O. brachyantha</i>	Siera Leone	2	Aromatic
FF	<i>O. brachyantha</i>	Siera Leone	1	Non aromatic
HHJJ	<i>O. ridleyi</i>	nd	-	Absent band

Aromatic allele: 8 bp deletion, Non aromatic allele: non-deletion, nd: no data



No.	VARNIM	FORI	ARO	IND	SSR	NOTE
1	W5	China	-	2	1	Absent band
2	O.longistaminata	Philippines	1	1	1	Non aromatic
3	O.nivara	Philippines	-	2	3	Absent band
4	O.longistaminata	Philippines	-	2	4	Absent band
5	O.rufipogon		-	-	-	Absent band
6	O.spontanea		1	2	4	Non aromatic
7	O.spontanea		1	1	1	Non aromatic
8	14-1 O.spontanea		1	H	H	Non aromatic
9	O.rufipogon		1	2	4	Non aromatic
10	O.ridleyi		-	2	4	Absent band
11	O.rufipogon		1	H	H	Non aromatic
12	17-1 O.rufipogon		-	-	-	Absent band
13	O.rufipogon		-	1	1	Absent band
14	O.eichingeri	Philippines	1	1	1	Non aromatic
15	O.australiensis	Australia	-	-	-	Absent band
16	O.australiensis	Australia	-	1	1	Absent band
17	O.australiensis	Australia	2	2	-	Aromatic
18	O.barthii	Mali	-	3	-	Absent band
19	O.barthii	Chad	1	H	1	Non aromatic
20	O.brachyantha	Siera Leone	2	-	2	Aromatic
21	34-1 O.brachyantha	Siera Leone	1	2	4	Non aromatic
22	O.eichingeri	Uganda	1	H	1	Non aromatic
23	O.glaberrima	Sudan	2	-	-	Aromatic
24	O.latifolia	Costa Rica	2	3	-	Aromatic
25	43 O.latifolia	India	2	3	-	Aromatic
26	44 O.latifolia	India	1	1	1	Non aromatic
27	45 O.latifolia	Guatemala	2	2	-	Aromatic
28	46 O.latifolia	USA	2	3	-	Aromatic
29	48 O.latifolia	Nicaragua	1	1	1	Non aromatic
30	51 O.meridionalis	Australia	2	H2	-	Aromatic
31	O.nivara	India	2	3	-	Aromatic
32	O.nivara	Bangladesh	-	3	-	Absent band
33	57 O.nivara	Bangladesh	1	1	1	Non aromatic
34	58 O.nivara	Bangladesh	2	3	-	Aromatic
35	59 O.officialis	India	2	3	-	Aromatic
36	60 O.officialis	Philippines	2	2	-	Aromatic
37	61 O.officialis	Bangladesh	2	3	-	Aromatic
38	63 O.punctata	India	-	3	-	Absent band
39	65 O.punctata	Nigeria	1	1	1	Non aromatic
40	66 O.punctata	Nigeria	-	4	4	Absent band
41	67 O.punctata	Cameroon	2	5	-	Aromatic
42	69 O.punctata	Ghana	1	H3	1	Non aromatic
43	70 O.nivara	India	1	1	1	Non aromatic
44	71 O.punctata	Tanzania	-	-	-	Absent band
45	72 O.nivara	Laos	-	H3	2	Absent band
46	72-2		1	2	5	Non aromatic
47	73 O.rufipogon		2	5	2	Aromatic

Figure 11 Band detection of wild rice by polyacrylamide gel electrophoresis (PAGE).

DISCUSSION

Origin of aromatic rice

The center of diversity of aromatic rice

The center of origin of aromatic rice was proposed by Khush (2000). He proposed that aromatic rice from isozyme group V originated from the foothills of Himalayas, India.

Consideration of 4 samples from African group we perhaps conclude that African geographic is sandy and drought prone area similar to the northeast of Thailand. Drought condition provides aromatic scent therefore the aroma occurs mostly in these countries. For 2 samples from Australia we predicted from the result that rice from this country has various aromatic germplasm, probably due to Australia is a part of Africa when there was changing of landscape and separated Australia from Africa. There aromatic genetic therefore come from the same original area.

Two species, 244 accessions, of Thailand wild rice they were *O. nivara*, *O. rufipogon*, were obtained from The National Seed Storage Laboratory Genetic resources (Genebank). From morphological and molecular biology test, the results showed 6 samples wild rice of 2 species were aromatic 5 samples in *O. rufipogon* and 1 sample in *O. nivara*. Aromatic *O. rufipogon* was collected from Pisanulok, Sukhothai, Chinart, Trad and Chantaburi. The only one aromatic *O. nivara* was collected from Nakhon Rachasrima. After that 242 samples of local cultivated rice in the same province from National Rice Seed Storage Laboratory for Genetic Resources Pathum Thani Rice Research Centre were test by the same experiment.

The results showed that 29 samples were aromatic rice. Moreover, they process the same allele that found in 21 species of wild rice obtained from Genebank. The present of aroma allele were determined by using the same primer. Eight species, 14 accessions, of wild rice consisted of *O. australiansis*,

O. brachyantha, *O. latifolia*, *O. meridionalis*, *O. nivara*, *O. officinalis*, *O. punctata* and *O. rufipogon* were found to carry aroma allele.

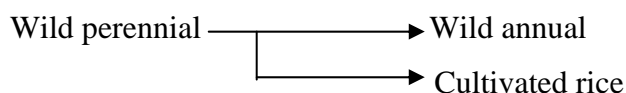
All of evidences indicated that aroma gene present in the cultivated rice today may originally come from wild rice ancestor.

Ecological Fitness of Aromatic Rice

Origin of rice

The first person reported about rice origin is Roschevicz in 1931 (Chang, 1976 a). He proposed that original center of plant in *Oryza* species is in Africa continent. Chang, the researcher of International Rice research Institute (IRRI) and Oka the researcher from Japanese National Institute of Genetic (NIG) have reported about origin and revolution of rice in several papers. They have similar idea for rice origin but in case of revolution of wild rice to cultivated rice slightly different though, the origin of rice is controversy (Oka, 1977). However, Oka pointed that the reports which show strong point of rice origin were 2 reports from Nayar and Sampath (1973).

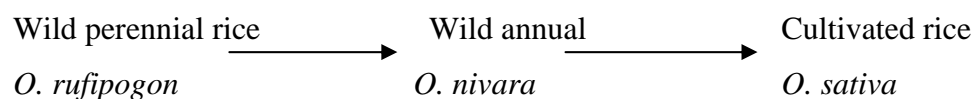
Oka (1974,1975) believe that perennial wild rice (*O.pernnis* = *O.rufipogon*) is direct ancestor of cultivated rice and due to perennial wild rice has higher genetic variation than annual wild rice (*O.nivara*) Oka (1977). He therefore proposed that perennial wild rice is the ancestor of annual wild rice and cultivated rice.



Nayar aim his research at Cytogenetics to generate his idea. While Sampath aim at relationship among rice types. Later on Chang (1979) reviewed papers carefully to discover the correct answer. Due to nowadays there are 2 types of rice, which is doubting whether these 2 types have same origin or not? From widely

exploration recently found that the distribution of *Oryza* species and related weed were found in humid tropical zone of Africa, south and northeast Asia, Australia, middle and south America. And report of Oka (1974) indicated possible tendency of same ancestor of rice render Chang (1979) confidential believed that *Oryza* species was originated in humid tropical zone of Gondwanaland continent before the earth discrimination and movement to different continents during 230-600 million years ago.

Chang (1976) created the hypothesis that cultivated rice come from *O.nivara* which has *O. rufipogon* as its ancestor this hypothesis similar to several scientists. Which Ng (1978) believed firmly because cultivated rice has grain character closer to *O. nivara* than *O. rufipogon* which is interested to human for food and finally this rice species was improved and developed. He has compared between character of Asian rice with the ancestor, the annual wild rice is able to grow well in the are where human has already grown rice which Hawkes (1967) believe that this is the important key for the original of crop.



Aside from the reports above, there is other evidence which can be used to discover the rice original as follows:

Etymology part: the word use to call “Rice” has already used as long time ago in Sanskrit (call rice as Vrihi) and Chinese language therefore they believe that rice has original in Asia.

Historical part: Ng (1978) reported that Chinese ancient legend has talked about rice cultivation in India before Arayan intrusion 2300 year before Christ.

Archaeology part: there is the oldest evidence in India about 2500 year before Christ for rice original. But evidence found rice seed in China which has about 3280 year before Christ (Chang, 1979). From the discovery of rice seed print at Non Nok

Ta in Thailand with the age of 3500 year before Christ (Bayard, 1970) leading some investigator accept that southeast Asia is the center of rice original as reported by Chang (1979).

However, these evidences provided the trend to consider only the rice origin but are not able to indicate time and certainly location. Therefore, Morishima *et al.* (1990) express the idea that in former time human lived by collecting for fruit, vegetable and hunting for meat. Wild rice has high variation render the difficulty for researcher to separate between wild rice and cultivated rice due to sometime rice seed has both wild and cultivated rice characters.

Domestication of Aromatic Rice

The original locations of landrace rice sample are the same area as wild rice in Thailand where we found aromatic gene. Thus, our assumption is aromatic gene in this local variety occur when the farmer grown their cultivated rice in the same area as wild rice which has this aromatic gene. Therefore the occurrence of domesticated aromatic rice cultivars is probably due to the transfer of aromatic gene from wild rice to cultivated rice grown in the same area.

Of necessity and must proceed immediately is to collect local rice variety and preserve in The National Rice Seed Storage Laboratory Genetic Resources in Pathum Thani Rice Research Center. This material is very useful for rice improvement since they compose of several resistant genes which could solve urgent problem such as flooding, disease and pest that can destroy all of rice genetic resource. As we known that Thailand is one importance area of the rice origin and also evolution of rice. Rice in Thailand has high variation which very as the region. There are several species of wild rice almost all of the area where growing cultivated rice. The location as rice genetic resource normally composed of several local rice or plants which has species close to rice. Therefore to conserve these genetic resources, the first important thing is to collect local and wild rice from every where of country. The national Rice Seed Storage Laboratory Genetic Resources has already collect about 17,000 samples of

local rice variety and this study has also used the rice samples which collected in nearby area of wild rice in Thailand in which these wild rice accessions have been found that carry aromatic gene.

Discovery of aromatic rice

Discovery of aromatic gene type found that 312 sample in 5 species of Thai wild rice, 101 samples in 22 species of out-country wild rice and 241 samples from 6 provinces have aromatic gene in 6, 14, and 29 samples respectively illustrated that:

1. This is the first aromatic gene has been found in the world because there is no study for this impact before.
2. Local varieties differ from wild rice in case that wild rice is ancestor of cultivated rice. Wild rice occur before cultivated rice. As the hypothesis found in various theory we therefore concluded that wild rice may transfer aromatic gene to cultivated rice grown in nearby area.
3. Local variety which obtain aromatic gene is the site specific variety which grown up in the same area as wild rice. This discovery has been found from the study using Aromarker 8 bp. Deletion.
4. Pathway of wild rice which moves site by site may be occurring by human or animal with unwillingly.
5. AA Genome group is much close link to cultivated rice with more than 90% aromatic scent.
6. For BBCC and other groups which carry aromatic gene probably comes from the same landscape as drought and sandy area.
7. The discovery of aromatic gene at 8bp.Delection indicated that this location has high potential which is consider being the basic for future discovery.

8. The discovery of aromatic gene in wild rice, we predicted that this has transferred to Khao Dawk Mali 105 which could not specify occur time but we could indicate that it is the same aromatic gene.

The diversity of genetic base for rice is never end. It must be continuing investigated. Local rice genetic base is important task which need further study. From this study, by collection and reservation of rice, if there is no one push out investigation, we expected that there will be a new discovery which very valuable for research with never end. Because this study is just hypothesis and the samples tested were only aromatic gene found in rice collected from 6 provinces. There still various province need to discover in the future.

CONCLUSIONS

From the experimental results and discussion of this study, the conclusion can be drawn as follow: The main outcome of this study was as follow

1 .Six accessions of wild rice in two species from Thailand were aroma was aromatic wild rice include 5 samples in *O. rufipogon* and 1 sample in *O. nivara* .Aromatic of *O. rufipogon* was collected fro Phitsanulok, Sukhothai, Chai Nat, Trat and Chanthaburi. The only one aromatic *O. nivara* was collected from Nakhon Ratchasima.

2. Samples of local cultivated rice in the same province as aromatic wild rice from Genebank were aromatic rice and they had the same allele that found in wild rice.

3. Eight species of International wild rice consisted of *O. australiansis*, *O. brachyantha* ,*O. latifolia*, *O. meridionalis*, *O. nivara*, *O. officinalis*, *O. punctata* and *O. rufipogon* were carried aroma allele 101 accessions of international wild rice from 8 species were aromatic rice.

4. One accession of *O. glaberrima* was aromatic rice.

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APPENDIX

Appendix Table 1 List the name of aromatic rice in Thailand which collected from different location of Thailand.

Entry	Acc. no	Variety	District	Province	Collected year
1	231	Hawm Turian	Sanpatong	Chiang Mai	1970
2	770	Hawm Gulahb	Koksamrong	Lop Buri	1970
3	799	Hawm Tang	Muang	Phra Nakhon Si Ayutthaya	1970
4	1379	Hawm	Muang	Lampang	1970
5	1682	Hawm Tang	Muang	Ang Thong	1970
6	1629	Hawm Tang	Muang	Ang Thong	1970
7	1641	Hawm Jampah	Muang	Songkhla	1970
8	1688	Hawm Hahng	Muang	Phra Nakhon Si Ayutthaya	1971
9	1765	Hawm Jan	Khaochaison	Phatthalung	1972
10	1784	Hawm Om	Wangthong	Phitsanulok	1972
11	1791	Hawm Dong	Wangthong	Phitsanulok	1972
12	1884	Hawm Maejo	Muang	Khon Kaen	1972
13	1887	Hawm Pae	Muang	Khon Kaen	1972
14	1891	Hawm	Muang	Khon Kaen	1972
15	1955	Hawm Jan	Kuan kanoon	Phatthalung	1972
16	2018	Hawm India	Muang	Chai Nat	1972
17	2088	Hawm Tung	Muang	Phra Nakhon Si Ayutthaya	1972
18	2477	Hawm	Muang	Khon Kaen	1974
19	2479	Hawm Niaw	Nonghan	Udon Thani	1974
20	2503	Hawm	Huayseeton	kalasin	1974
21	2555	Hawm Dawk	Putthaisong	Buri Rum	1975
22	2578	Hawm	Muang	Chiang Mai	1975
23	2747	Hawm Mali	Tapanhin	Phichit	1976
24	2749	Hawm Tang	Muang	Ang Thong	1976
25	2968	Hawm Setti	Muang	Phra Nakhon Si Ayutthaya	1977
26	2970	Hawm Om	Muang	Loei	1977
27	3005	Hawm Daeng Noi	Muang	Nakhon Ratchasima	1977
28	3008	Hawm Jan	Muang	Phitsanulok	1977
29	3011	Hawm Mah lai	Muang	Phitsanulok	1977
30	3016	Hawm Bang	Muang	Phitsanulok	1977
31	3029	Hawm Chahng	Muang	Suphan Buri	1977
32	3059	Hawm Hahng	Bang Rajan	Sing Buri	1977
33	3210	Hawm pamah	Wang Sapung	Loei	1978
34	3246	Hawm Meuang Luey	Tawat Buri	Roi Et	1978
35	3252	Hawm U-Dom	Nong Bua Lam Phu	Udon Thani	1978
36	3270	Hawm Nahng Nuan	Yang Tahlad	Kalasin	1978
37	3279	Hawm Tung	Muang	Kalasin	1978
38	3421	Hawm La-Aw	Muang	Sukhothai	1978
39	3448	Hawm Jan	Kong Krilad	Sukhothai	1978
40	3521	Hawm Mah Lah	Muang	Phitsanulok	1978
41	3545	Hawm Bang	Wang Tong	Phitsanulok	1978
42	3562	Hawm Dong	Bang Ragam	Phitsanulok	1978
43	3570	Hawm Mah Lai	Bang Ragam	Phitsanulok	1978
44	3725	Hawm Maled Lek	Bang Pamah	Suphan Buri	1979
45	3737	Hawm Maled Lek	Pangkon	Suphan Buri	1979

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
46	3775	Hawm La-Aw	Panom Tuan	Kanchanaburi	1979
47	3780	Hawm Pamah	Saiyok	Kanchanaburi	1979
48	3812	Hawm Mali	Panom Sakam	Chachoengsao	1979
49	4045	Hawm Prateep	Pangkon	Sakon Nakhon	1980
50	4068	Hawm Heuad	Pangkon	Sakon Nakhon	1980
51	4087	Hawm Kaset	Yang Tahlad	Kalasin	1980
52	4178	Hawm Jan	Kao Chison	Phatthalung	1980
53	4192	Hawm Jan	Kao Chison	Phatthalung	1980
54	4371	Hawm Jan	Tung Yai	Nakhon Si Thammarat	1980
55	4380	Hawm Mali	Muang	Prachin Buri	1980
56	4410	Hawm Om	Bang Khen	Krung Thep Maha Nakhon	1980
57	4422	Hawm Pai	Muang	Chiang Rai	1980
58	4423	Hawm	Muang	Chiang Rai	1980
59	4446	Hawm Maejo	Muang	Chiang Rai	1980
60	4561	Hawm Jan	Aou leak	Krabi	1980
61	4775	Hawm Dawk Jan	Gra Too	Phuket	1981
62	4778	Hawm Sawan	Gra Too	Phuket	1981
63	4779	Hawm Tung	Gra Too	Phuket	1981
64	4783	Hawm Nahng Nuan	Gra Too	Phuket	1981
65	4758	Hawm Mali	Gra Too	Phuket	1981
66	4786	Hawm Khi Kwai	Gra Too	Phuket	1981
67	4787	Hawm Udom Thai	Gra Too	Phuket	1981
68	4788	Hawm Dong	Gra Too	Phuket	1981
69	4789	Hawm Daeng Noi	Gra Too	Phuket	1981
70	4887	Hawm Mali	Muang	Sukhothai	1982
71	4895	Hawm Po	Muang	Sukhothai	1982
72	4897	Hawm Krua	Muang	Sukhothai	1982
73	4963	Hawm Jan	Kiri Mat	Sukhothai	1982
74	5007	Hawm Bang	Kiri Mat	Sukhothai	1982
75	5235	Hawm Krua	Srisam Rong	Sukhothai	1982
76	5149	Hawm Tawng	Song	Phrae	1982
77	5333	Hawm Pamah	Muang	Phitsanulok	1982
78	5459	Hawm Bai	Sam ngam	Phichit	1982
79	5624	Hawm Tung	Kheung Nai	Ubon Ratchathani	1982
80	5670	Hawm Tung	Pana	Ubon Ratchathani	1982
81	5745	Hawm Pae	Muang	Khon Kaen	1982
82	5751	Hawm Nai Pon	Muang	Nakhon Nayok	1982
83	5767	Hawm Jan	Non Soong	Nakhorn Ratchasima	1982
84	5787	Hawm Dong	Buayai	Nakhorn Ratchasima	1982
85	5819	Hawm Surin	Kon sawan	Chaiyaphum	1982
86	6023	Hawm Pamah	Muang	Chaing Rai	1982
87	6379	Hawm Gui	Chatragan	Phitsanulok	1983
88	6380	Hawm Jan	Muang	Phitsanulok	1983
89	6381	Hawm Po	Bang ragam	Phitsanulok	1983
90	6382	Hawm Bang	Wang Tong	Phitsanulok	1983

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
91	6383	Hawm Bang	Bang Gratum	Phitsanulok	1983
92	6384	Hawm Tung	Chatragarn	Phitsanulok	1983
93	6385	Hawm Pamah	Wang Tong	Phitsanulok	1983
94	6386	Hawm Pamah	Nern Maprang	Phitsanulok	1983
95	6426	Hawm Mali	Klong Long	Pathum Thani	1983
96	6684	Hawm Lao	Rawng Gwang	Phrae	1983
97	6724	Hawm Pamah	Bang Khen	Krung Thep Maha Nakhon	1983
98	6727	Hawm Mali	Bang Khen	Krung Thep Maha Nakhon	1983
99	6728	Hawm Daeng Noi	Bang Khen	Krung Thep Maha Nakhon	1983
100	6730	Hawm Lai	Bang Khen	Krung Thep Maha Nakhon	1983
101	6733	Hawm Lao	Bang Khen	Krung Thep Maha Nakhon	1983
102	6734	Hawm Dong	Bang Khen	Krung Thep Maha Nakhon	1983
103	6735	Hawm In Tok	Bang Khen	Krung Thep Maha Nakhon	1983
104	6737	Hawm Khi Kwai	Bang Khen	Krung Thep Maha Nakhon	1983
105	6738	Hawm Udom Thai	Bang Khen	Krung Thep Maha Nakhon	1983
106	6741	Hawm Mayom	Bang Khen	Krung Thep Maha Nakhon	1983
107	6797	Hawm Dawk	Bahn Na	Nakhon Nayok	1983
108	6823	Hawm Ta Wng	Muang	Nakhon Nayok	1983
109	6836	Hawm Nai Pon	Pak Pli	Nakhon Nayok	1983
110	6897	Hawm Tawng	Bang Pamah	Suphan Buri	1983
111	6902	Hawm Naled Lek	Bang Pamah	Suphan Buri	1983
112	6941	Hawm Mali	Dahn Chang	Suphan Buri	1983
113	6951	Biaw Dahng	Sanpah tong	Chaing Mai	1983
114	7009	Hawm Jan	Muang	Nakhon Si Thammarat	1983
115	7032	Hawm Jan	Ronpiboon	Nakhon Si Thammarat	1983
116	7065	Hawm Jan	Ronpiboon	Nakhon Si Thammarat	1983
117	7145	Hawm Mali	Rachasan	Chachoengsao	1983
118	7148	Hawm Nahng Mon	Plaeng Yao	Chachoengsao	1983
119	7209	Hawm Mali	Pahn Tong	Chon Buri	1983
120	7419	Hawm Jan	Kok Po	Pattani	1983
121	7425	Hawm Jan	Kok Po	Pattani	1983
122	7474	Hawm Jan	Jana	Songkhla	1983
123	7607	Hawm Dong	Kong	Nakhon Ratchasima	1984
124	7608	Hawm U-Dom	Nonsa-Ahd	Udon Thani	1984
125	7654	Hawm Dawk Mali	Gamalasai	Kalasin	1984
126	7655	Hawm Plah Sew	Huai Mek	Kalasin	1984
127	7672	Hawm Pae Palow	Huai Mek	Kalasin	1984
128	7686	Hawm Tung	Nawng grung Si	Kalasin	1984
129	7756	Hawm Nahng Nuan	Chun	Phayao	1984
130	7937	Hawm Mali	Pratai	Nakhon Ratchasima	1984
131	8113	Hawm Puang	Nawng Yah plawng	Phetchaburi	1984
132	8231	HawmMed Lek	Bang Sai	Phra Nakhon Si Ayutthaya	1984
133	8246	Hawm Jan	Muang	Uttaradit	1984
134	8258	Hawm Nahng Nuan	Muang	Uttaradit	1984
135	8266	Hawm Nahng Nuan	Muang	Uttaradit	1984

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
136	8347	Hawm Tawng	Tha plah	Uttaradit	1984
137	8349	Hawm Jan	Fahk Tha	Uttaradit	1984
138	8374	Hawm Tung	Nam Phad	Uttaradit	1984
139	8414	Hawm Gui	Tawng Saen Khan	Uttaradit	1984
140	8982	Hawm Jan	Pran Gratai	Kamphaeng Phet	1984
141	8992	Hawm Suan	Khanuworarak	Kamphaeng Phet	1984
142	8995	Hawm Mali	Khanuworarak	Kamphaeng Phet	1984
143	9041	Hawm Daw	Muang	Sakon Nakhon	1984
144	9042	Hawm Nahng Nuan	Muang	Sakon Nakhon	1984
145	9043	Hawm Huan	Muang	Sakon Nakhon	1984
146	9170	Hawm Mali	Nawng Bua	Nakhon Sawan	1984
147	9193	Hawm Tawmg	Si Nakon	Sukhothai	1984
148	9225	Hawm Dong	Si Nakon	Sukhothai	1984
149	9293	Hawm Pamah	Nam Yeun	Ubon Ratchathani	1984
150	9462	Hawm Mali	Muang	Trat	1984
151	9463	Hawm Mali	Muang	Trat	1984
152	9464	Hawm Mali	Muang	Trat	1984
153	9465	Hawm Mali	Lam Ngawb	Trat	1984
154	9600	Hawm Sadung	Thamaka	Kanchanaburi	1984
155	9605	Hawm Kamen	Thamaka	Kanchanaburi	1984
156	9694	Hawm Sak	Sichon	Nakhon Si Thammarat	1984
157	9703	Hawm	Kanawm	Nakhon Si Thammarat	1984
158	9745	Hawm Khao	Thasala	Nakhon Si Thammarat	1984
159	9751	Hawm Daeng	Thasala	Nakhon Si Thammarat	1984
160	9806	Hawm	Muang	Narathiwat	1984
161	9861	Hawm	Muang	Narathiwat	1984
162	9862	Hawm	Rangae	Narathiwat	1984
163	10093	Hawm	Kok Po	Pattani	1984
164	10124	Hawm Tung	Tha Li	Loei	1984
165	10125	Hawm U-Dom	Bahn Dung	Udon Thani	1984
166	10137	Hawm Dong	Kon Sawan	Chaiyaphum	1984
167	10221	HawmLook Khuey	Muang	Phatthalung	1984
168	10238	Hawm Jan	Muang	Phatthalung	1984
169	10275	HawmNah Khao	Kao Chison	Phatthalung	1984
170	10276	Hawm	Kao Chison	Phatthalung	1984
171	10382	Hawm Mali	Palian	Trang	1984
172	10473	Hawm Mane Jan	Muang	Chaing Mai	1984
173	10657	Hawm Surin	Bang Nampliaw	Chachoengsao	1985
174	10658	Hawm Mali 105	Ongka Rak	Nakhon Nayok	1985
175	10660	Hawm Mali 105	Nong seu	Pathum Thani	1985
176	10661	Hawm Surin	Thanya Buri	Pathum Thani	1985
177	10662	Hawm Si Nuan	Muang	Prachin Buri	1985
178	10663	Hawm Surin	Mean Buri	Krung Thep Maha Nakhon	1985
179	10665	Hawm Tung Daw	Kamcha-E	Mukdahan	1985
180	10672	Hawm Yung	Muang	Mukdahan	1985

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
181	10900	Hawm Mali	Sahm Ngam	Phichit	1985
182	10962	Hawm Mali	Nong Kae	Saraburi	1985
183	10967	Hawm Mali	Gaeng koi	Saraburi	1985
184	10969	Hawm Meuang Pet	Gaeng koi	Saraburi	1985
185	10982	Hawm Meuang Pet	Gaeng koi	Saraburi	1985
186	10984	Hawm Dawk Khah	Gaeng koi	Saraburi	1985
187	11018	Hawm Mali	Praputhabath	Saraburi	1985
188	11041	Hawm Chiang Mail	Muang	Kanchanaburi	1985
189	11058	Hawm Maled Yai	Muang	Kanchanaburi	1985
190	11071	Hawm Ruang	Sai Yok	Kanchanaburi	1985
191	11126	Hawm Hahng	Bang Rachan	Sing Buri	1985
192	11154	Hawm Jan	Tabpud	Phangnga	1985
193	11198	Hawm Jan	Tung Soong	Nakhon Si Thammarat	1985
194	11437	Hawm	Bahn Rai	Utthai Thani	1985
195	11467	Hawm Dong	Sri sawad	Kanchanaburi	1985
196	11477	Hawm Mali	Sri sawad	Kanchanaburi	1985
197	11510	Hawm	Sai Yok	Kanchanaburi	1985
198	11562	Hawm Fung	Tong phapoom	Kanchanaburi	1985
199	11572	Hawm	Sai Yok	Kanchanaburi	1985
200	11603	Hawm Daeng	Kao Ko	Phetchabun	1985
201	11607	Hawm Mali	Kao Ko	Phetchabun	1985
202	11612	Hawm	Nakorn Thai	Phetchabun	1985
203	11621	Hawm Dong	Kao Ko	Phetchabun	1985
204	11764	Hawm Yao	Sa	Nan	1985
205	11820	Hawm Jan	Pichai	Uttaradit	1985
206	11845	Hawm Nahng Nuan	Nam Pad	Nan	1985
207	11983	Hawm Nuan	Tung Chang	Nan	1985
208	12014	Hawm Pamah	Sa	Nan	1985
209	12034	Hawm Pamah	Na Noi	Nan	1985
210	12042	Hawm Jan	Na Meun	Nan	1985
211	12093	Hawm	Tha U Tain	Nakhon Phanom	1985
212	12113	Hawm Tung	Na Wah	Nakhon Phanom	1985
213	12138	Hawm Yai	Nah Gae	Nakhon Phanom	1985
214	12213	Hawm Jan	Muang	Rayong	1985
215	12230	Hawm Mali	Bahn Cahng	Rayong	1985
216	12231	Hawm Mali	Bahn Cahng	Rayong	1985
217	12298	Hawm Nai Pon	Laem Sing	Chanthaburi	1985
218	12334	Hawm Khing	Baw Rai	Trat	1985
219	12350	Hawm Rai	Kao Saming	Trat	1985
220	12454	Hawm Mali	Muang	Chon Buri	1985
221	12497	Hawm Jan	Bahn Taen	Chaiyaphum	1985
222	12512	Hawm U-Dom	Nawng Wua Saw	Udon Thani	1985
223	12565	Hawm Tung	Chaing Kan	Loei	1985
224	12566	Hawm Tung	Chaing Kan	Loei	1985
225	12571	Hawm Pamah	Nah Haew	Loei	1985

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
226	12573	Hawm Tung	Wang Sapung	Loei	1985
227	12604	Hawm Om	Gaeng Ko	Chaiyaphum	1985
228	12620	Hawm Lom Sak	Kon Sahn	Chaiyaphum	1985
229	12817	Hawm	Muang	Yala	1985
230	12947	Hawm Gaen Jan	Sanam Chai Ket	Chachoengsao	1985
231	12962	Hawm Tawng	Sanam Chai Ket	Chachoengsao	1985
232	12980	Hawm Dong	Sanam Chai Ket	Chachoengsao	1985
233	13252	Hawm Jan	Wap Pathu	Maha SaraKham	1985
234	13354	Hawm Nahng Nuan	Guchi Narai	Kalasin	1985
235	13368	Hawm Nahng Nuan	Muang	Sakon Nakhon	1985
236	13378	Hawm Tung	Tha U Tain	Nakhon Phanom	1985
237	13389	Hawm Nahng Nuan	Tha U Tain	Nakhon Phanom	1985
238	13396	Hawm Lai	Sri song Kram	Nakhon Phanom	1985
239	13405	Hawm Kaset	Panrana Nikom	Sakon Nakhon	1985
240	13456	Hawm Nak	Muaeng	Krabi	1985
241	13461	Hawm	Kao Panom	Krabi	1985
242	13498	Hawm Jan	Plai Prayah	Krabi	1985
243	13525	Hawm Jan	Tab Pud	Phangnga	1985
244	1373	Hawm Nuan	Gud Bak	Sakon Nakhon	1985
245	13734	Hawm Daw	Muang	Sakon Nakhon	1985
246	13739	Hawm Pamah	Gud Bak	Sakon Nakhon	1985
247	13740	Hawm Pan	Gud Bak	Sakon Nakhon	1985
248	13741	Hawm U-Dom	Gud Bak	Sakon Nakhon	1985
249	13880	Hawm Pamah	Mae Sai	Chaing Rai	1986
250	13911	Hawm	Tha U Tain	Nakhon Phanom	1986
251	13913	Hawm Tung	Tha U Tain	Nakhon Phanom	1986
252	13929	Hawm	Tha U Tain	Nakhon Phanom	1986
253	13932	Hawm Maled Lek	Tha U Tain	Mukdahan	1986
254	13974	Hawm Daw	Dong Luang	Mukdahan	1986
255	13989	Hawm Tung	Kam Cha-E	Khon Kaen	1986
256	14097	Hawm Lom	Chumpae	Chiang Mai	1986
257	14112	Hawm Maled Yao	Mae Rim	Ubon Ratchathani	1986
258	14149	Hawm Pakisatan	Muang	Ubon Ratchathani	1986
259	14150	Hawm Iran	Muang	Phatthalung	1986
260	14313	Hawm Mali	Muang	Nakhon Si Thammarat	1986
261	14442	Hawm Jan	Lahn Saka	Saraburi	1986
262	14457	Hawm Gahb Dam	Don Pud	Nakhon Phanom	1986
263	14508	Hawm Glahng	Plah Pahk	Nakhon Phanom	1986
264	14512	Hawm Nuan	Muang	Nakhon Phanom	1986
265	14518	Hawm Nahng Nuan	Nah khao	Nakhon Phanom	1986
266	14539	Hawm Dong	Bahn Paeng	Phichit	1986
267	14694	Hawm Rai	Sahm Ngam	Nan	1986
268	14805	Hawm Yao	Sa	Roi Et	1986
269	15263	Hawm Mali	Pon Sai	Si Sa Ket	1987
270	15264	Hawm Mali	Beung Boon	Surin	1987

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
271	15265	Hawm Mali	Sanom	Bui Rum	1987
272	15266	Hawm Mali	Prakonchai	Maha Sarakham	1987
273	15267	Hawm Mali	Payakumpisai	Phangnga	1987
274	15541	Hawm Mali	Tab Pud	Nakhon Si Thammarat	1987
275	15662	Hawm	Hua Sai	Phatthalung	1987
276	15695	Hawm Jan	Tamod	Phatthalung	1987
277	15721	Hawm Jan	Ranod	Narathiwat	1987
278	15787	Hawm	Tak Bai	Phitsanulok	1987
279	15831	Hawm Daeng	Wang Tong	Chaiyaphum	1987
280	15870	Hawm Meuang Luey	Bamnetnarong	Nong Khai	1987
281	16060	Hawm Tung	Sang Kom	Udon Thani	1987
282	16066	Hawm Pamah	Nong Hahn	Phatthalung	1987
283	16592	Hawm Lok Khuey	Muang	Phatthalung	1988
284	16601	Hawm	Kao Chai Son	Phatthalung	1988
285	16611	Hawm Dawk Ruam	Kuan Kanun	Phatthalung	1988
286	16616	Hawm Jan	Kuan Kanun	Songkhla	1988
287	16788	Hawm Jan	Muang	Phatthalung	1988
288	16798	Hawm Jan	Kao Chai Son	Krabi	1988
289	16814	Hawm Jan	Kao Panom	Songkhla	1988
290	16836	Hawm Jan	Ratapoom	Satun	1988
291	16852	Hawm Jan	Muang	Songkhla	1988
292	16858	Hawm Jan	Sating Pra	Songkhla	1988
293	16861	Hawm Jan	Ratapoom	Phuket	1988
294	16882	Hawm Jan	Muang	Songkhla	1988
295	16887	Hawm Jan	Ranod	Songkhla	1988
296	16923	Hawm Jan	Ranod	Songkhla	1988
297	17081	Hawm Bow	Ratapoom	Phatthalung	1988
298	17202	Hawm Jan	Ratapoom	Pattani	1988
299	17282	Hawm Jan	Muang	Phatthalung	1988
300	17288	Hawm Jan	Kok Po	Phatthalung	1988
301	17339	Hawm Look Khuey	Muang	Phatthalung	1988
302	17356	Hawm Jan	Muang	Trang	1988
303	17389	Hawm Nah Khao	Kao Chai Son	Trang	1988
304	17435	Hawm Sang	Muang	Trang	1988
305	17442	Hawm Sang Glai	Muang	Surin	1988
306	17443	Hawm Sang	Muang	Nakhon Ratchasima	1988
307	17682	Hawm Jan	Tha Toom	Songkhla	1988
308	17716	Hawm Jan	Soong Nern	Phitsanulok	1988
309	17756	Hawm Bow	Muang	Phitsanulok	1988
310	17930	Hawm Dong	Wang Tong	Phitsanulok	1988
311	17946	Hawm Jan	Muang	Sakon Nakhon	1988
312	17954	Hawm Bang	Wang Tong	Sakon Nakhon	1988
313	17983	Hawm Nahng Nuan	Panrana Nikom	Sakon Nakhon	1988
314	17988	Hawm Pon	Panrana Nikom	Sakon Nakhon	1988
315	17989	Hawm Lai	Panrana Nikom	Sakon Nakhon	1988

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
316	17990	Hawm Tung	Panrana Nikom	Sakon Nakhon	1988
317	18001	Hawm Daw	Panrana Nikom	Sakon Nakhon	1988
318	18412	Hawm Mali	Huai Mek	Kalasin	1989
319	18413	Hawm Mali	Prang Koo	Si Sa Ket	1989
320	18414	Hawm Mali	Muang	Roi Et	1989
321	18415	Hawm Mali	Muang	Ubon Ratchathani	1989
322	18416	Hawm Mali	Bawrabeu	Maha Sarakham	1989
323	18417	Hawm Mali	Kam Keun Gaew	Yasothon	1989
324	18418	Hawm Mali	Prakon Chai	Buri Rum	1989
325	18419	Hawm Mali	Lamprai Mat	Buri Rum	1989
326	18420	Hawm Mali	Pakam	Buri Rum	1989
327	18421	Hawm Mali	Muang Sahn Sib	Ubon Ratchathani	1989
328	18422	Hawm Mali	Kam Keun Gaew	Yasothon	1989
329	18423	Hawm Mali	Gud Chum	Yasothon	1989
330	18424	Hawm Mali	Trakan Peud Pon	Ubon Ratchathani	1989
331	18425	Hawm Mali	Kuchinarai	Kalasin	1989
332	18426	Hawm Mali	Ah-Gahd Amnuai	Sakon Nakhon	1989
333	18427	Hawm Mali	Beung Boon	Si Sa Ket	1989
334	18428	Hawm Mali	Sanom	Surin	1989
335	18992	Hawm Lao	Rawng Gwang	Phrae	1989
336	19040	Hawm Dawk Mali	Muang	Uttaradit	1989
337	19063	Hawm Tung	Tron	Uttaradit	1989
338	19070	Hawm Pamah	Tongsaen Kan	Uttaradit	1989
339	19082	Hawm Tung	Soong Men	Nan	1989
340	19128	Hawm Tawng	Wang Chin	Phrae	1989
341	19232	Hawm Luang Rahm	Muang	Phatthalung	1989
342	19303	Hawm Luang Rahm	Muang	Udon Thani	1989
343	19342	Hawm Mali	Bahn Dung	Udon Thani	1990
344	19343	Hawm Mali	Gumpawapi	Udon Thani	1990
345	19344	Hawm Mali	Non Sa Ahd	Udon Thani	1990
346	19345	Hawm Mali	Nong Hahn	Udon Thani	1990
347	19346	Hawm Mali	Muang	Udon Thani	1990
348	19347	Hawm Mali	Gumpawapi	Udon Thani	1990
349	19348	Hawm Mali	Wang Sahn Maw	Udon Thani	1990
350	19349	Hawm Mali	Muang	Udon Thani	1990
351	19350	Hawm Mali	Muang	Tak	1990
352	19351	Hawm Mali	Muang	Lampang	1990
353	19352	Hawm Mali	Muang	Lampang	1990
354	19353	Hawm Mali	Muang	Lampang	1990
355	19354	Hawm Mali	Muang	Si Sa Ket	1990
356	19355	Hawm Mali	Beung Boon	Si Sa Ket	1990
357	19356	Hawm Mali	Gantararom	Si Sa Ket	1990
358	19357	Hawm Mali	Beung Boon	Si Sa Ket	1990
359	19358	Hawm Mali	Muang	Si Sa Ket	1990
360	19359	Hawm Mali	Gantararom	Si Sa Ket	1990

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
361	19360	Hawm Mali	Rasisarai	Si Sa Ket	1990
362	19361	Hawm Mali	Rasisarai	Si Sa Ket	1990
363	19362	Hawm Mali	Beung Boon	Si Sa Ket	1990
364	19363	Hawm Mali	Doi Sa Ket	Chaing Mai	1990
365	19364	Hawm Mali	Saraphi	Chaing Mai	1990
366	19365	Hawm Mali	Prao	Chaing Mai	1990
367	19399	Hawm Mali	Sankampaeng	Chaing Mai	1990
368	19367	Hawm Mali	Hahng Dong	Chaing Mai	1990
369	19368	Hawm Mali	San Sai	Chaing Mai	1990
370	19369	Hawm Mali	Mae rim	Chaing Mai	1990
371	19370	Hawm Mali	Doi Sa Ket	Chaing Mai	1990
372	19371	Hawm Mali	Hahng Dong	Chaing Mai	1990
373	19372	Hawm Mali	Muang	Khon Kaen	1990
374	19373	Hawm Mali	Muang	Khon Kaen	1990
375	19374	Hawm Mali	Chonabot	Khon Kaen	1990
376	19375	Hawm Mali	Pon	Khon Kaen	1990
377	19376	Hawm Mali	Waeng Noi	Khon Kaen	1990
378	19377	Hawm Mali	Waeng Noi	Khon Kaen	1990
379	19378	Hawm Mali	Muang Sam Sib	Ubon Ratchathani	1990
380	19379	Hawm Mali	Sri Muang Mai	Ubon Ratchathani	1990
381	19380	Hawm Mali	Muang Sam Sib	Ubon Ratchathani	1990
382	19381	Hawm Mali	Gud Khao Pun	Ubon Ratchathani	1990
383	19382	Hawm Mali	Muang Sam Sib	Ubon Ratchathani	1990
384	19383	Hawm Mali	Muang Sam Sib	Ubon Ratchathani	1990
385	19384	Hawm Mali	Trakanpeud Pon	Ubon Ratchathani	1990
386	19385	Hawm Mali	Warin Chamrab	Ubon Ratchathani	1990
387	19386	Hawm Mali	Hua Tapahn	Ubon Ratchathani	1990
388	19387	Hawm Mali	Muang	Ubon Ratchathani	1990
389	19388	Hawm Mali	Tha Toom	Surin	1990
390	19389	Hawm Mali	Sa Nom	Surin	1990
391	19390	Hawm Mali	Sa Nom	Surin	1990
392	19391	Hawm Mali	Muang	Surin	1990
393	19392	Hawm Mali	Muang	Surin	1990
394	19393	Hawm Mali	Tha Toom	Surin	1990
395	19394	Hawm Mali	Tha Toom	Surin	1990
396	19395	Hawm Mali	Chumpon Buri	Surin	1990
397	19396	Hawm Mali	Prasat	Surin	1990
398	19397	Hawm Mali	Prasat	Surin	1990
399	19398	Hawm Mali	Prakon Chai	Buri Rum	1990
400	19399	Hawm Mali	Muang	Buri Rum	1990
401	19400	Hawm Mali	Nah po	Buri Rum	1990
402	19401	Hawm Mali	Nahng Rawng	Buri Rum	1990
403	19402	Hawm Mali	Prakon Chai	Buri Rum	1990
404	19403	Hawm Mali	Muang	Buri Rum	1990
405	19404	Hawm Mali	Lam Plai Mat	Buri Rum	1990

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
406	19405	Hawm Mali	Lam Plai Mat	Buri Rum	1990
407	19406	Hawm Mali	Lam Plai Mat	Buri Rum	1990
408	19407	Hawm Mali	Prakon Chai	Buri Rum	1990
409	19408	Hawm Mali	Kho wong	Kalasin	1990
410	19409	Hawm Mali	Kuchi Narai	Kalasin	1990
411	19410	Hawm Mali	Kamalasai	Kalasin	1990
412	19411	Hawm Mali	Sahat Khan	Kalasin	1990
413	19412	Hawm Mali	Kam Muang	Kalasin	1990
414	19413	Hawm Mali	Kamalasai	Kalasin	1990
415	19414	Hawm Mali	Kamalasai	Kalasin	1990
416	19415	Hawm Mali	Kuchi Narai	Kalasin	1990
417	19416	Hawm Mali	Yang Talahd	Kalasin	1990
418	19417	Hawm Mali	Beung Sam Pan	Kalasin	1990
419	19418	Hawm Mali	Lom Sak	Phetchabun	1990
420	19419	Hawm Mali	Lom Sak	Phetchabun	1990
421	19420	Hawm Mali	Lom Sak	Phetchabun	1990
422	19421	Hawm Mali	Lom Sak	Phetchabun	1990
423	19422	Hawm Mali	Lom Sak	Phetchabun	1990
424	19423	Hawm Mali	Lom Sak	Phetchabun	1990
425	19424	Hawm Mali	Lom Sak	Phetchabun	1990
426	19425	Hawm Mali	Lom Sak	Phetchabun	1990
427	19426	Hawm Mali	Lom Sak	Phetchabun	1990
428	19427	Hawm Mali	Muang	Roi Et	1990
429	19428	Hawm Mali	Muang	Roi Et	1990
430	19429	Hawm Mali	Muang	Roi Et	1990
431	19430	Hawm Mali	Muang	Roi Et	1990
432	19431	Hawm Mali	Muang	Roi Et	1990
433	19432	Hawm Mali	Muang	Roi Et	1990
434	19433	Hawm Mali	Muang	Roi Et	1990
435	19434	Hawm Mali	Muang	Roi Et	1990
436	19435	Hawm Mali	Muang	Roi Et	1990
437	19436	Hawm Mali	Muang	Roi Et	1990
438	19437	Hawm Mali	Gud Chab	Udon Thani	1990
439	19438	Hawm Mali	Gud Chab	Udon Thani	1990
440	19439	Hawm Mali	Non Sang	Udon Thani	1990
441	19440	Hawm Mali	Non Sang	Udon Thani	1990
442	19441	Hawm Mali	Non Sang	Udon Thani	1990
443	19442	Hawm Mali	Ko Wang	Yasothon	1990
444	19443	Hawm Mali	Sai moom	Yasothon	1990
445	19444	Hawm Mali	Gud Chum	Yasothon	1990
446	19445	Hawm Mali	Kamkeun Gaew	Yasothon	1990
447	19446	Hawm Mali	Lerng Nok Ta	Yasothon	1990
448	19447	Hawm Mali	Sai Moon	Yasothon	1990
449	19448	Hawm Mali	Lerng Nok Ta	Yasothon	1990
450	19449	Hawm Mali	Kamkeun Gaew	Yasothon	1990

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
451	19450	Hawm Mali	Kamkeun Gaew	Yasothon	1990
452	19451	Hawm Mali	Gud Chum	Yasothon	1990
453	19452	Hawm Mali	Wang Tong	Phitsanulok	1990
454	19453	Hawm Mali	Wang Tong	Phitsanulok	1990
455	19454	Hawm Mali	Wang Tong	Phitsanulok	1990
456	19455	Hawm Mali	Gusumal	Sakon Nakhon	1990
457	19456	Hawm Mali	Ah-Gahd Amnuai	Sakon Nakhon	1990
458	19457	Hawm Mali	Kam Tra Gla	Sakon Nakhon	1990
459	19458	Hawm Mali	Panrana Nikom	Sakon Nakhon	1990
460	19522	Hawm Jan	Muang	Krabi	1990
461	19594	Hawm Jan	Fahk Tha	Uttaradit	1990
462	19689	Hawm Tung	Nakorn Thai	Phitsanulok	1991
463	19843	Hawm Pamah	Klong Klung	Kamphaeng	1991
464	19844	Hawm Pamah	Klong Klung	Kamphaeng	1991
465	20575	Hawm Tawng	Bahn Sahng	Prachin Buri	1993
466	20811	Hawm Chaiya	Chaiya	Surat Thani	1995
467	20883	Hawm Mahng Nuan	Muang	Uttaradit	1996
468	20885	Hawm Mali	Muang	Uttaradit	1996
469	20973	Hawm Mahng Mon	Bahng Bahn	Phra Nakhon Si Ayuthdahaya	1996
470	20977	Hawm Deuan Sahn	Bahng Bahn	Phra Nakhon Si Ayuthdahaya	1996
471	20988	Hawm Tung	Tha wung	Lop Buri	1996
472	20989	Hawm Tung	Tha wung	Lop Buri	1996
473	20990	Hawm Tung	Muang	Sing Buri	1996
474	20999	Hawm Tawng	Kai Bang Rachan	Sing Buri	1996
475	21212	Hawm Dong	Krabin Buri	Prachin Buri	1996
476	21400	Hawm Dong	Baw ploi	Kanchanaburi	1996
477	21431	Hawm Tung	Chai Yo	Ang Thong	1996
478	21434	Hawm Pahn Tawng	Po Tong	Ang Thong	1996
479	21435	Hawm Tung	Po Tong	Ang Thong	1996
480	21681	Hawm Prae	Bahn Paeng	Nakhon Phanom	1996
481	21688	Hawm Pamah	Sri Wilai	Nong Khai	1996
482	21693	Hawm Pamah	Tah Khao	Loei	1996
483	21791	Hawm Grabang	Si Kiw	Nakhon Ratchasima	1996
484	21874	Hawm Mali	Um Pahng	Tak	1997
485	21875	Hawm Mong	Um Pahng	Tak	1997
486	22057	Hawm Dong	Bahn Na	Nakhon Nayok	1997
487	22084	Hawm Jan	Aranyapratet	Sa Kaeo	1997
488	22097	Hawm Jan	Gaeng Koi	Saraburi	1997
489	22174	Hawm Bahng Gaew	Kok Po	Pattani	1998
490	22218	Hawm Sangiam	Nah Wang	Nong Bua Lam Phu	1998
491	22382	Hawm Jan	Muang	Phrae	1998
492	22393	Hawm Mali	Muang	Phrae	1998
493	22404	Hawm Jan	Muang	Phrae	1998
494	22409	Hawm Mahng Nuan	Muang	Phrae	1998
495	22521	Hawm Tawng	Muang	Phrae	1998

Appendix Table 1 (Continued)

Entry	Acc. no	Variety	District	Province	Collected year
496	22741	Hawm Pae	Pra yeun	Khon Kaen	1999
497	22776	Hawm Nuan	Gud Chab	Udon Thani	1999
498	22856	Hawm Jan	Wang Nam Khiaw	Nakhon Ratchasima	1999
499	22866	Hawm Tawng	Nakon Thai	Phitsanulok	1999
500	22874	Hawm Mali Rai	Kao Ko	Phetchabun	1999
501	22885	Hawm Mong	Um Pahng	Tak	1999
502	22902	Hawm Mali Maled Yai	Bahn Rai	Utthai Thani	1999
503	22907	Hawm Daeng	Bahn Rai	Utthai Thani	1999
504	22908	Hawm Tood Dam	Bahn Rai	Utthai Thani	1999
505	22920	Hawm Mali	Bahn Rai	Utthai Thani	1999
506	23073	Hawm Mali Rai	Tong Pah Poom	Kanchanaburi	1999
507	23104	Hawm Sangaim	Pahk Chom	Loei	1999
508	23183	Hawm Yai	Tat Panom	Nakhon Phanom	1999

Appendix Table 2 Summary of the wild rice accessions used for for screening the aromatic allele.

No.	Gs. No.	Species and Code	Collection Province
1	6038	<i>O.rufipogon</i> (NNY 82-13)	Nakon Nayok
2	6047	<i>O.rufipogon</i> (PSL 82-22)	Phitsanulok
3	6049	<i>O.rufipogon</i> (SPR 82-24)	Suphan Buri
4	6053	<i>O.rufipogon</i> (SPR 82-28)	Suphan Buri
5	6055	<i>O.rufipogon</i> (SPR 82-30)	Suphan Buri
6	6060	<i>O.rufipogon</i> (AYY 82-35)	Phra Nakhon Si Ayutthaya
7	6073	<i>O.rufipogon</i> (PSL 82-48)	Phitsanulok
8	6083	<i>O.rufipogon</i> (PSL 82-85)	Phitsanulok
9	6092	<i>O.rufipogon</i> (PSL 82-67)	Phitsanulok
10	6094	<i>O.rufipogon</i> (PSL 82-69)	Phitsanulok
11	6110	<i>O.rufipogon</i> (PSL 82-85)	Phitsanulok
12	6114	<i>O.rufipogon</i> (PSL 82-89)	Phitsanulok
13	6115	<i>O.rufipogon</i> (PSL 82-90)	Phitsanulok
14	6116	<i>O.rufipogon</i> (PSL 82-91)	Phitsanulok
15	6117	<i>O.rufipogon</i> (PSL 82-92)	Phitsanulok
16	6118	<i>O.rufipogon</i> (PSL 82-93)	Phitsanulok
17	6120	<i>O.rufipogon</i> (PSL 82-95)	Phitsanulok
18	7865	<i>O.rufipogon</i> (SRB 83-114)	Saraburi
19	7866	<i>O.rufipogon</i> (SRB 83-115)	Saraburi
20	7867	<i>O.rufipogon</i> (SRB 83-116)	Saraburi
21	7868	<i>O.rufipogon</i> (SRB 83-117)	Saraburi
22	7869	<i>O.rufipogon</i> (SRB 83-118)	Saraburi
23	7870	<i>O.rufipogon</i> (SRB 83-119)	Saraburi
24	7871	<i>O.rufipogon</i> (SPR 83-120)	Suphan Buri
25	7872	<i>O.rufipogon</i> (SPR 83-120-2)	Suphan Buri
26	7875	<i>O.rufipogon</i> (UTD 83-128)	Uttaradit
27	7876	<i>O.rufipogon</i> (UTD 83-129)	Uttaradit
28	7877	<i>O.rufipogon</i> (UTD 83-130)	Uttaradit
29	7878	<i>O.rufipogon</i> (UTD 83-131)	Uttaradit
30	7879	<i>O.rufipogon</i> (UTD 83-132)	Uttaradit
31	7880	<i>O.rufipogon</i> (UTD 83-133)	Uttaradit
32	7884	<i>O.rufipogon</i> (PSL 83-137)	Phitsanulok
33	7885	<i>O.rufipogon</i> (NKS 83-138)	Nakhon Sawan
34	7888	<i>O.rufipogon</i> (SRB 83-141)	Saraburi
35	7889	<i>O.rufipogon</i> (SRB 83-142)	Saraburi
36	7890	<i>O.rufipogon</i> (SRB 83-143)	Saraburi
37	7891	<i>O.rufipogon</i> (SRB 83-144)	Saraburi
38	7896	<i>O.rufipogon</i> (NRM 83-150)	Nakhon Ratchasima
39	7902	<i>O.rufipogon</i> (KKN 83-156)	Khon Kaen
40	7905	<i>O.rufipogon</i> (UDT 83-159)	Udon Thani
41	7907	<i>O.rufipogon</i> (NGK 83-161)	Nong khai
42	7910	<i>O.rufipogon</i> (UDT 83-164)	Udon Thani
43	7914	<i>O.rufipogon</i> (MDH 83-169)	Mukdahan
44	7915	<i>O.rufipogon</i> (SSK 83-170)	Si Sa Ket
45	7916	<i>O.rufipogon</i> (SRN 83-171)	Surin

Appendix Table 2 (Continued)

No.	Gs. No.	Species and Code	Collection Province
46	7917	<i>O.rufipogon</i> (SRN 83-171-1)	Surin
47	7919	<i>O.rufipogon</i> (SRN 83-171-2)	Surin
48	7925	<i>O.rufipogon</i> (BRR 83-177)	Buri Rum
49	7926	<i>O.rufipogon</i> (SBR 83-179-1)	Saraburi
50	7929	<i>O.rufipogon</i> (SPR 83-182)	Suphan Buri
51	9315	<i>O.rufipogon</i> (SKT 84-210)	Sukhothai
52	9316	<i>O.rufipogon</i> (SKT 84-210)	Sukhothai
53	9317	<i>O.rufipogon</i> (PSL 84-212)	Sukhothai
54	9319	<i>O.rufipogon</i> (SKT 84-214)	Sukhothai
55	9321	<i>O.rufipogon</i> (PSL 84-216)	Suphan Buri
56	9323	<i>O.rufipogon</i> (SKT 84-218)	Sukhothai
57	9324	<i>O.rufipogon</i> (SKT 84-219)	Sukhothai
58	9327	<i>O.rufipogon</i> (SKT 84-222)	Sukhothai
59	9333	<i>O.rufipogon</i> (SKT 84-228)	Sukhothai
60	9334	<i>O.rufipogon</i> (SKT 84-229)	Sukhothai
61	9335	<i>O.rufipogon</i> (SKT 84-230)	Sukhothai
62	9336	<i>O.rufipogon</i> (SKT 84-231)	Sukhothai
63	9337	<i>O.rufipogon</i> (SKT 84-232)	Sukhothai
64	9338	<i>O.rufipogon</i> (SKT 84-233)	Sukhothai
65	9340	<i>O.rufipogon</i> (SKT 84-235)	Sukhothai
66	9342	<i>O.rufipogon</i> (SKT 84-237)	Sukhothai
67	9343	<i>O.rufipogon</i> (SKT 84-238)	Sukhothai
68	9345	<i>O.rufipogon</i> (SKT 84-240)	Sukhothai
69	9346	<i>O.rufipogon</i> (SKT 84-241)	Sukhothai
70	9347	<i>O.rufipogon</i> (SKT 84-242)	Sukhothai
71	9350	<i>O.rufipogon</i> (SKT 84-245)	Sukhothai
72	9351	<i>O.rufipogon</i> (SKT 84-246)	Sukhothai
73	9352	<i>O.rufipogon</i> (SKT 84-247)	Sukhothai
74	9354	<i>O.rufipogon</i> (SKT 84-249)	Sukhothai
75	9356	<i>O.rufipogon</i> (SKT 84-251)	Sukhothai
76	9762	<i>O.rufipogon</i> (SRB 83-101)	Saraburi
77	9763	<i>O.rufipogon</i> (NSR 83-102)	Nakhon Si Thammarat
78	9764	<i>O.rufipogon</i> (SBR 83-103)	Sing Buri
79	9765	<i>O.rufipogon</i> (RBR 83-104)	Ratchaburi
80	9768	<i>O.rufipogon</i> (RBR 83-108)	Ratchaburi
81	9769	<i>O.rufipogon</i> (RBR 83-109)	Ratchaburi
82	9770	<i>O.rufipogon</i> (RBR 83-110)	Ratchaburi
83	9771	<i>O.rufipogon</i> (RBR 83-111)	Ratchaburi
84	9772	<i>O.rufipogon</i> (AYY 83-124-1)	Phra Nakhon Si Ayutthaya
85	9774	<i>O.rufipogon</i> (AYY 83-125)	Phra Nakhon Si Ayutthaya
86	9775	<i>O.rufipogon</i> (PTT 83-126)	PathumThani
87	9776	<i>O.rufipogon</i> (PTT 83-127)	Pathum Thani
88	9789	<i>O.rufipogon</i> (NSR 84-193)	Nakhon Si Thammarat
89	9791	<i>O.rufipogon</i> (SRT 84-195)	Surat Thani
90	9792	<i>O.rufipogon</i> (SRT 84-196)	Surat Thani

Appendix Table 2 (Continued)

No.	Gs. No.	Species and Code	Collection Province
91	10535	<i>O.rufipogon</i> (SRB 84-252)	Saraburi
92	10536	<i>O.rufipogon</i> (RBR 84-253)	Ratchaburi
93	10537	<i>O.rufipogon</i> (RBR 84-254-1-)	Ratchaburi
94	10540	<i>O.rufipogon</i> (NKW 84-256)	Nakhon Sawan
95	10541	<i>O.rufipogon</i> (PJT 84-257)	Phichit
96	10542	<i>O.rufipogon</i> (PJT 84-258)	Phichit
97	10545	<i>O.rufipogon</i> (NKS 84-261)	Nakhon Sawan
98	10546	<i>O.rufipogon</i> (NKS 84-262)	Nakhon Sawan
99	10547	<i>O.rufipogon</i> (SRB 84-263)	Saraburi
100	10548	<i>O.rufipogon</i> (SRB 84-264)	Saraburi
101	10549	<i>O.rufipogon</i> (SRB 84-265)	Saraburi
102	10550	<i>O.rufipogon</i> (SRB 84-265-1)	Saraburi
103	10551	<i>O.rufipogon</i> (SRB 84-266)	Saraburi
104	10552	<i>O.rufipogon</i> (NKS 84-267)	Nakhon Sawan
105	10553	<i>O.rufipogon</i> (NKS 84-268)	Nakhon Sawan
106	10554	<i>O.rufipogon</i> (NKS 84-269)	Nakhon Sawan
107	10555	<i>O.rufipogon</i> (SRB 84-270)	Saraburi
108	10559	<i>O.rufipogon</i> (RYG 84-274)	Rayong
109	10560	<i>O.rufipogon</i> (RYG 84-275)	Rayong
110	10561	<i>O.rufipogon</i> (JBR 84-276)	Chanthaburi
111	10563	<i>O.rufipogon</i> (TRT 84-278)	Trat
112	10572	<i>O.rufipogon</i> (CPN 84-287)	Chumphum
113	10577	<i>O.rufipogon</i> (PBR 84-292)	Phetchaburi
114	10581	<i>O.rufipogon</i> (RBR 82-296)	Ratchaburi
115	10583	<i>O.rufipogon</i> (SPR 84-298)	Suphan Buri
116	10585	<i>O.rufipogon</i> (AGT 84-300)	Ang Thong
117	10587	<i>O.rufipogon</i> (SBR 84-302)	Sing Buri
118	10589	<i>O.rufipogon</i> (CNT 84-304)	Chai Nat
119	10590	<i>O.rufipogon</i> (CNT 84-305)	Chai Nat
120	10591	<i>O.rufipogon</i> (CNT 84-306)	Chai Nat
121	10592	<i>O.rufipogon</i> (CNT 84-307)	Chai Nat
122	10593	<i>O.rufipogon</i> (CNT 84-308)	Chai Nat
123	10594	<i>O.rufipogon</i> (NKW 84-309)	Nakhon Sawan
124	10595	<i>O.rufipogon</i> (UTN 84-310)	UtthaiThani
125	10596	<i>O.rufipogon</i> (UTN 84-311)	UtthaiThani
126	10598	<i>O.rufipogon</i> (UTN 84-313)	UtthaiThani
127	10603	<i>O.rufipogon</i> (NKW 84-318)	Nakhon Sawan
128	10604	<i>O.rufipogon</i> (SBR 84-319)	Sing Buri
129	10905	<i>O.rufipogon</i> (AGT 84-320)	Ang Thong
130	10606	<i>O.rufipogon</i> (AYY 84-321)	Phra Nakhon Si Ayutthaya
131	10607	<i>O.rufipogon</i> (AYY 84-322)	Phra Nakhon Si Ayutthaya
132	10609	<i>O.rufipogon</i> (AYY 84-324)	Phra Nakhon Si Ayutthaya
133	15136	<i>O.rufipogon</i>	Udon Thani
134	15151	<i>O.rufipogon</i>	Sakon Nakhon
135	15157	<i>O.rufipogon</i>	Surin

Appendix Table 2 (Continued)

No.	Gs. No.	Species and Code	Collection Province
136	15181	<i>O.rufipogon</i>	Sukhothai
137	15185	<i>O.rufipogon</i>	Kanchanaburi
138	15186	<i>O.rufipogon</i>	Kanchanaburi
139	15187	<i>O.rufipogon</i>	Ratchaburi
140	16115	<i>O.rufipogon</i>	Nakhon Nayok
141	16116	<i>O.rufipogon</i>	Nakhon Nayok
142	16126	<i>O.rufipogon</i>	Nakhon Nayok
143	16132	<i>O.rufipogon</i>	Phra Nakhon Si Ayutthaya
144	16154	<i>O.rufipogon</i>	Chiang Rai
145	16171	<i>O.rufipogon</i>	Chiang Mai
146	16172	<i>O.rufipogon</i>	Chiang Mai
147	16174	<i>O.rufipogon</i>	Lampang
148	16185	<i>O.rufipogon</i>	Kamphaeng Phet
149	16187	<i>O.rufipogon</i>	Kamphaeng Phet
150	16188	<i>O.rufipogon</i>	Nakhon Sawan
151	16191	<i>O.rufipogon</i>	Nakhon Sawan
152	16221	<i>O.rufipogon</i> (NRW 88-454)	Narathiwat
153	16122	<i>O.rufipogon</i> (NRW 88-455)	Narathiwat
154	16125	<i>O.rufipogon</i> (NRW 88-458)	Narathiwat
155	16126	<i>O.rufipogon</i> (NRW 88-459)	Narathiwat
156	16127	<i>O.rufipogon</i> (NRW 88-460)	Narathiwat
157	16128	<i>O.rufipogon</i> (PTN 88-461)	Pattani
158	16129	<i>O.rufipogon</i> (NRW 88-4562)	Narathiwat
159	16131	<i>O.rufipogon</i> (SKA 88-464)	Songkhla
160	18155	<i>O.rufipogon</i> (RBR 88-467)	Ratchaburi
161	18156	<i>O.rufipogon</i> (SBR 88-468)	Saraburi
162	18225	<i>O.rufipogon</i> (NRM 88-475)	Nakhon Ratchasima
163	18227	<i>O.rufipogon</i>	Nakhon Ratchasima
164	18235	<i>O.rufipogon</i>	Buri Rum
165	18246	<i>O.rufipogon</i> (SKN 88-496)	Sakon Nakhon
166	18282	<i>O.rufipogon</i> (SKN 88-532)	Sakon Nakhon
167	18283	<i>O.rufipogon</i> (SKN 88-533)	Sakon Nakhon
168	18295	<i>O.rufipogon</i> (UDT 88-545)	Udon Thani
169	18297	<i>O.rufipogon</i> (UDT 88-547)	Udon Thani
170	18298	<i>O.rufipogon</i> (UDT 88-548)	Udon Thani
171	18302	<i>O.rufipogon</i> (NGK 88-522)	Nong Khai
172	18311	<i>O.rufipogon</i> (UDT 88-561)	Udon Thani
173	18318	<i>O.rufipogon</i> (UDT 88-568)	Udon Thani
174	18322	<i>O.rufipogon</i> (KKN 88-572)	Khon Kaen
175	18337	<i>O.rufipogon</i> (NRM 88-578)	Nakhon Ratchasima
176	18338	<i>O.rufipogon</i> (NRM 88-588)	Nakhon Ratchasima
177	18343	<i>O.rufipogon</i> (NRM 88-593)	Nakhon Ratchasima
178	18383	<i>O.rufipogon</i> (AYY 89-604)	Phra Nakhon Si Ayutthaya
179	18384	<i>O.rufipogon</i> (AYY 89-605)	Phra Nakhon Si Ayutthaya
180	18385	<i>O.rufipogon</i> (AYY 89-606)	Phra Nakhon Si Ayutthaya

Appendix Table 2 (Continued)

No.	Gs. No.	Species and Code	Collection Province
181	18386	<i>O.rufipogon</i> (AYY 89-607)	Phra Nakhon Si Ayutthaya
182	18387	<i>O.rufipogon</i> (AYY 89-608)	Phra Nakhon Si Ayutthaya
183	20757	<i>O.rufipogon</i> (UDT 95-13)	Udon Thani
184	20774	<i>O.rufipogon</i> (CCH 95-29)	Chachoengsao
185	6039	<i>O.nivara</i>	Saraburi
186	6048	<i>O.nivara</i>	Suphan Buri
187	6080	<i>O.nivara</i>	Phitsanulok
188	6084	<i>O.nivara</i>	Phitsanulok
189	6105	<i>O.nivara</i>	Phitsanulok
190	16122	<i>O.nivara</i>	Prachin Buri
191	16150	<i>O.nivara</i>	Phayao
192	16168	<i>O.nivara</i>	Chiang Mai
193	16186	<i>O.nivara</i>	Kamphaeng Phet
194	16189	<i>O.nivara</i>	Nakhon Sawan
195	16190	<i>O.nivara</i>	Nakhon Sawan
196	16192	<i>O.nivara</i>	Nakhon Sawan
197	18200	<i>O.nivara</i>	Nakhon Ratchasima
198	18221	<i>O.nivara</i>	Nakhon Ratchasima
199	18222	<i>O.nivara</i>	Nakhon Ratchasima
200	18223	<i>O.nivara</i>	Nakhon Ratchasima
201	18230	<i>O.nivara</i>	Buri Rum
202	18233	<i>O.nivara</i>	Buri Rum
203	18234	<i>O.nivara</i>	Buri Rum
204	18237	<i>O.nivara</i> (BRR 88-487)	Buri Rum
205	18238	<i>O.nivara</i> (BRR 88-488)	Buri Rum
206	18239	<i>O.nivara</i> (BRR 88-489)	Buri Rum
207	18240	<i>O.nivara</i> (BRR 88-490)	Buri Rum
208	18241	<i>O.nivara</i> (BRR 88-491)	Buri Rum
209	18242	<i>O.nivara</i> (BRR 88-492)	Buri Rum
210	18243	<i>O.nivara</i> (SRN 88-493)	Surin
211	18249	<i>O.nivara</i> (SRN 88-499)	Surin
212	18250	<i>O.nivara</i> (SRN 88-500)	Surin
213	18253	<i>O.nivara</i> (SSK 88-503)	Si Sa Ket
214	18256	<i>O.nivara</i> (SSK 88-506)	Si Sa Ket
215	18258	<i>O.nivara</i> (SSK 88-508)	Si Sa Ket
216	18260	<i>O.nivara</i> (YST 88-510)	Yasothon
217	18261	<i>O.nivara</i> (YST 88-511)	Yasothon
218	18268	<i>O.nivara</i> (ROT 88-518)	Roi Et
219	18271	<i>O.nivara</i> (KLS 88-521)	Kalasin
220	18279	<i>O.nivara</i> (SKN 88-529)	Sakon Nakhon
221	18281	<i>O.nivara</i> (SKN 88-531)	Sakon Nakhon
222	18284	<i>O.nivara</i> (SKN 88-534)	Sakon Nakhon
223	18286	<i>O.nivara</i> (SKN 88-536)	Sakon Nakhon
224	18288	<i>O.nivara</i> (SKN 88-538)	Sakon Nakhon
225	18289	<i>O.nivara</i> (SKN 88-539)	Sakon Nakhon

Appendix Table 2 (Continued)

No.	Gs. No.	Species and Code	Collection Province
226	18290	<i>O.nivara</i> (SKN 88-540)	Sakon Nakhon
227	18291	<i>O.nivara</i> (SKN 88-541)	Sakon Nakhon
228	18303	<i>O.nivara</i> (NGK 88-553)	Nong Khai
229	18304	<i>O.nivara</i> (NGK 88-554)	Nong Khai
230	18305	<i>O.nivara</i> (NGK 88-555)	Nong Khai
231	18306	<i>O.nivara</i> (NGK 88-556)	Nong Khai
232	18313	<i>O.nivara</i> (UDT 88-563)	Udon Thani
233	18316	<i>O.nivara</i> (UDT 88-566)	Udon Thani
234	18320	<i>O.nivara</i> (UDT 88-570)	Udon Thani
235	18321	<i>O.nivara</i> (UDT 88-571)	Udon Thani
236	18327	<i>O.nivara</i> (CYP 88-577)	Chaiyaphum
237	18333	<i>O.nivara</i> (NRM 88-583)	Nakhon Ratchasima
238	18334	<i>O.nivara</i> (NRM 88-584)	Nakhon Ratchasima
239	18335	<i>O.nivara</i> (NRM 88-585)	Nakhon Ratchasima
240	18341	<i>O.nivara</i> (NRM 88-591)	Nakhon Ratchasima
241	18346	<i>O.nivara</i> (LBR 88-596)	Lop Buri
242	18347	<i>O.nivara</i> (LBR 88-597)	Lop Buri
243	18348	<i>O.nivara</i> (LBR 88-598)	Lop Buri
244	18351	<i>O.nivara</i> (SRB 88-601)	Saraburi

Appendix Table 3 Summary of the landrace cultivars from the locations where aromatic wild spp. were identified.

Entry	Acc.	Variety name	District	Province
1	1780	Daw Dam	Wang Thong	Phitsanulok
2	1781	Leuang Fun	Wang Thong	Phitsanulok
3	1782	Ngah Chang	Wang Thong	Phitsanulok
4	1783	Jao Khao	Wang Thong	Phitsanulok
5	1786	Khao Nuan	Wang Thong	Phitsanulok
6	1787	Leuang Fun	Wang Thong	Phitsanulok
7	1789	Mai Krai	Wang Thong	Phitsanulok
8	1790	Dawk Ma Kheu	Wang Thong	Phitsanulok
9	1862	Gahb Hok	Wang Thong	Phitsanulok
10	1864	Khao Nam Khang	Wang Thong	Phitsanulok
11	3527	Hahng Chang	Wang Thong	Phitsanulok
12	3528	Puang Tawng	Wang Thong	Phitsanulok
13	3530	Ton Soong	Wang Thong	Phitsanulok
14	3531	Pluk Rad	Wang Thong	Phitsanulok
15	3532	Puang Malai	Wang Thong	Phitsanulok
16	3534	Khao Lom	Wang Thong	Phitsanulok
17	3535	Bang Gawk	Wang Thong	Phitsanulok
18	3536	Niaw Lampahng	Wang Thong	Phitsanulok
19	3537	Khiaw Bow	Wang Thong	Phitsanulok
20	3538	Khiaw Paed	Wang Thong	Phitsanulok
21	3539	Bun Mi	Wang Thong	Phitsanulok
22	3540	Leuang Prae	Wang Thong	Phitsanulok
23	3541	Puang Chalawng	Wang Thong	Phitsanulok
24	3542	Leuang Jampah	Wang Thong	Phitsanulok
25	3543	Puang Tani	Wang Thong	Phitsanulok
26	3544	Long Mah	Wang Thong	Phitsanulok
27	3545	Hawm Bang	Wang Thong	Phitsanulok
28	3546	Bun Mah	Wang Thong	Phitsanulok
29	3547	Salaeng Bow	Wang Thong	Phitsanulok
30	3548	Bai Si	Wang Thong	Phitsanulok
31	3549	Payah Chom	Wang Thong	Phitsanulok
32	3550	Puang Wai	Wang Thong	Phitsanulok
33	3551	Khao Prajuab	Wang Thong	Phitsanulok
34	3552	Khao Maled Yao	Wang Thong	Phitsanulok
35	3553	Daeng Noi	Wang Thong	Phitsanulok
36	3554	Leuang Awn Bow	Wang Thong	Phitsanulok
37	3555	Khao Pleuak Kai	Wang Thong	Phitsanulok
38	3556	Ruang Yao	Wang Thong	Phitsanulok
39	3557	Ma Eng	Wang Thong	Phitsanulok
40	3558	Leuang Laeng	Wang Thong	Phitsanulok
41	3559	Mae Jaem	Wang Thong	Phitsanulok
42	3560	Koi Look Keuy	Wang Thong	Phitsanulok
43	3561	Wang Gra Dath	Wang Thong	Phitsanulok
44	6244	Gon Jud	Wang Thong	Phitsanulok

Appendix Table 3 (Continued)

Entry	Acc.	Variety name	District	Province
45	6252	Khao'Daw	Wang Thong	Phitsanulok
46	6259	Khao Gaw	Wang Thong	Phitsanulok
47	6262	Khao Gaw Diaw	Wang Thong	Phitsanulok
48	6263	Khao Gaw Diaw	Wang Thong	Phitsanulok
49	6278	Nahng Dam	Wang Thong	Phitsanulok
50	6290	Khao Loi	Wang Thong	Phitsanulok
51	6297	Khi Tom	Wang Thong	Phitsanulok
52	6309	Dawk Gaew	Wang Thong	Phitsanulok
53	6310	Dawk Doo	Wang Thong	Phitsanulok
54	6316	Dong Khui	Wang Thong	Phitsanulok
55	6319	Tah Bahn	Wang Thong	Phitsanulok
56	6323	Tawng Muan	Wang Thong	Phitsanulok
57	6326	Nahng Kam pai	Wang Thong	Phitsanulok
58	6328	Nahng Jaem	Wang Thong	Phitsanulok
59	6332	Bai Si	Wang Thong	Phitsanulok
60	6340	Bun Mah	Wang Thong	Phitsanulok
61	6344	Pleuk Kai	Wang Thong	Phitsanulok
62	6345	Puang Tah Ni	Wang Thong	Phitsanulok
63	6346	Puang Tawng	Wang Thong	Phitsanulok
64	6347	Puang Tawng	Wang Thong	Phitsanulok
65	6364	Sahm Deuan	Wang Thong	Phitsanulok
66	6368	Sao Gord	Wang Thong	Phitsanulok
67	6399	Leuang Tawng	Wang Thong	Phitsanulok
68	6415	Lian Tawng	Wang Thong	Phitsanulok
69	6417	E-Paed	Wang Thong	Phitsanulok
70	15815	Biaw Tao Ra	Wang Thong	Phitsanulok
71	15817	Khao Hawm	Wang Thong	Phitsanulok
72	15831	Hawm Daeng	Wang Thong	Phitsanulok
73	15832	Maew	Wang Thong	Phitsanulok
74	15833	Nam Sagui 19	Wang Thong	Phitsanulok
75	15835	Pahng	Wang Thong	Phitsanulok
76	15836	E-Khawai	Wang Thong	Phitsanulok
77	15840	Bahn Mai	Wang Thong	Phitsanulok
78	15841	Leuang noi	Wang Thong	Phitsanulok
79	15842	Rahk Haeng	Wang Thong	Phitsanulok
80	15843	Khao Yai	Wang Thong	Phitsanulok
81	15844	Maew	Wang Thong	Phitsanulok
82	16233	Phitsanulok60-1	Wang Thong	Phitsanulok
83	16234	Phitsanulok60-2	Wang Thong	Phitsanulok
84	17914	Leuang Tawng	Wang Thong	Phitsanulok
85	17916	Puang Tah Ni	Wang Thong	Phitsanulok
86	17917	Gawn Gaew	Wang Thong	Phitsanulok
87	17918	Puang Malai	Wang Thong	Phitsanulok
88	17919	Nahn Gui	Wang Thong	Phitsanulok
89	17920	Maled Yai	Wang Thong	Phitsanulok
90	17921	Dawk Pud	Wang Thong	Phitsanulok

Appendix Table 3 (Continued)

Entry	Acc.	Variety name	District	Province
91	17922	Khao Tah chong	Wang Thong	Phitsanulok
92	17925	Ruang Tawng	Wang Thong	Phitsanulok
93	17927	Leuang Tah Gaew	Wang Thong	Phitsanulok
94	17928	Khao'Lao	Wang Thong	Phitsanulok
95	17929	Jong Gon	Wang Thong	Phitsanulok
96	17930	Hawm Dong	Wang Thong	Phitsanulok
97	17931	Leuang Samer	Wang Thong	Phitsanulok
98	17932	Nahng Tah Ni	Wang Thong	Phitsanulok
99	17933	Gaeng Dao	Wang Thong	Phitsanulok
100	17934	Meuang Khaek	Wang Thong	Phitsanulok
101	17935	Pad Moon	Wang Thong	Phitsanulok
102	17936	Jed Soon	Wang Thong	Phitsanulok
103	17937	Gaen Jan	Wang Thong	Phitsanulok
104	17938	Bow Don Meuang	Wang Thong	Phitsanulok
105	17939	Mae Mai Kahnhak	Wang Thong	Phitsanulok
106	17942	Dong Kui1	Wang Thong	Phitsanulok
107	17944	Leuang Bai Lek	Wang Thong	Phitsanulok
108	17945	Khao Pramong	Wang Thong	Phitsanulok
109	17953	Khao' Rahaeng	Wang Thong	Phitsanulok
110	17954	Hawm Bahng	Wang Thong	Phitsanulok
111	17955	Mali Leuay	Wang Thong	Phitsanulok
112	17960	Rahk Haeng	Wang Thong	Phitsanulok
113	17961	Khiaw	Wang Thong	Phitsanulok
114	17962	Pra Yah Chom	Wang Thong	Phitsanulok
115	17963	Khao Yai	Wang Thong	Phitsanulok
116	17966	Leuang Yai	Wang Thong	Phitsanulok
117	17967	Supanburi	Wang Thong	Phitsanulok
118	17968	Awn Si	Wang Thong	Phitsanulok
119	17969	Mae Paed Nahprung	Wang Thong	Phitsanulok
120	17970	No name	Wang Thong	Phitsanulok
121	17972	Sagun Lai 2	Wang Thong	Phitsanulok
122	17974	Beu Trae	Wang Thong	Phitsanulok
123	17975	Leuang Sahm Ahang	Wang Thong	Phitsanulok
124	17976	Gaew	Wang Thong	Phitsanulok
125	17977	Bun Mah Khao	Wang Thong	Phitsanulok
126	17978	Nahng Nui	Wang Thong	Phitsanulok
127	19452	Hawm Mali	Wang Thong	Phitsanulok
128	19453	Hawm Mali	Wang Thong	Phitsanulok
129	19454	Hawm Mali	Wang Thong	Phitsanulok
130	3408	Tah Nod	Meuang	Sukhothai
131	3409	Soi Dao	Meuang	Sukhothai
132	3410	Leuang Chawahng	Meuang	Sukhothai
133	3411	Khao Loi	Meuang	Sukhothai
134	3412	Ma Khaek	Meuang	Sukhothai
135	3413	Niaw Daeng	Meuang	Sukhothai

Appendix Table 3 (Continued)

Entry	Acc.	Variety name	District	Province
136	3414	Puang Chalawm	Meuang	Sukhothai
137	3416	Tah Khui	Meuang	Sukhothai
138	3417	Leuang Tawng Yoi	Meuang	Sukhothai
139	3418	Niaw Dam	Meuang	Sukhothai
140	3419	Tawng Mah Eng	Meuang	Sukhothai
141	3422	Mali Leuay	Meuang	Sukhothai
142	3423	Meuang Krung	Meuang	Sukhothai
143	3424	Leuang Noi	Meuang	Sukhothai
144	3425	Look Plah	Meuang	Sukhothai
145	3426	Khao' Luang	Meuang	Sukhothai
146	3427	Jam Pah	Meuang	Sukhothai
147	3428	Leuang Tawng Yoi	Meuang	Sukhothai
148	4880	Khao Tah Haeng	Meuang	Sukhothai
149	4881	Leuang Nak	Meuang	Sukhothai
150	4883	Leuang Awn	Meuang	Sukhothai
151	4885	Khiaw Yai	Meuang	Sukhothai
152	4886	Khao Loi	Meuang	Sukhothai
153	4888	Soi Dao	Meuang	Sukhothai
154	4889	Leuang Awn	Meuang	Sukhothai
155	4890	Ma khaek	Meuang	Sukhothai
156	4897	Hawm Krua	Meuang	Sukhothai
157	4898	Ma khaek	Meuang	Sukhothai
158	4898	Ma khaek	Meuang	Sukhothai
159	4899	E-Paed	Meuang	Sukhothai
160	4902	Gaen Jan	Meuang	Sukhothai
161	4902	Gaen Jan	Meuang	Sukhothai
162	4903	E-Paed	Meuang	Sukhothai
163	4904	E-Paed	Meuang	Sukhothai
164	4905	Khiaw	Meuang	Sukhothai
165	4906	Tah -oo	Meuang	Sukhothai
166	4907	Lon Krok	Meuang	Sukhothai
167	4908	Tanod	Meuang	Sukhothai
168	4911	E-Paed	Meuang	Sukhothai
169	4912	Pin Gaew	Meuang	Sukhothai
170	4914	Khao Dawk Mali	Meuang	Sukhothai
171	4915	Niaw Hawm	Meuang	Sukhothai
172	4916	Leuang Awn	Meuang	Sukhothai
173	4917	Meuang Jeen	Meuang	Sukhothai
174	15180	Nahng Paed	Meuang	Sukhothai
175	19831	Puang Tawng	Meuang	Sukhothai
176	9412	Mahk Khaek	Tha Mai	Chanthaburi
177	9413	Mahk Khaek	Tha Mai	Chanthaburi
178	12279	Puang ngern	Tha Mai	Chanthaburi
179	12280	Puang Tawng	Tha Mai	Chanthaburi
180	12281	Khao Yai Sai	Tha Mai	Chanthaburi

Appendix Table 3 (Continued)

Entry	Acc.	Variety name	District	Province
181	12282	Khao Jeen	Tha Mai	Chanthaburi
182	12284	Nahng Mudcha	Tha Mai	Chanthaburi
183	12285	Khao Kad	Tha Mai	Chanthaburi
184	12286	Khao Choo Bai	Tha Mai	Chanthaburi
185	12287	Khao Choo Bai	Tha Mai	Chanthaburi
186	12288	Khao Pong Nak	Tha Mai	Chanthaburi
187	12289	Khao Pong Nak	Tha Mai	Chanthaburi
188	12290	Niaw Lai	Tha Mai	Chanthaburi
189	12292	Khao Tah Tua	Tha Mai	Chanthaburi
190	12293	Leuang Tawng	Tha Mai	Chanthaburi
191	22274	Maled Lek	Tha Mai	Chanthaburi
192	22275	Mahbun Krong	Tha Mai	Chanthaburi
193	22276	Nahng Khao	Tha Mai	Chanthaburi
194	22277	Nahng Khao	Tha Mai	Chanthaburi
195	22278	Khao Tha Tua	Tha Mai	Chanthaburi
196	1625	Khao Dawk Mali	Nonsoong	Nakhon Ratchasima
197	5765	Khao Jin	Nonsoong	Nakhon Ratchasima
198	5766	Sahm Deuan	Nonsoong	Nakhon Ratchasima
199	5769	Leuang	Nonsoong	Nakhon Ratchasima
200	5770	Leuang Gluay	Nonsoong	Nakhon Ratchasima
201	5771	Khao'Pae	Nonsoong	Nakhon Ratchasima
202	15864	No Name	Nonsoong	Nakhon Ratchasima
203	15865	Khao Jin	Nonsoong	Nakhon Ratchasima
204	15867	Niaw Bow	Nonsoong	Nakhon Ratchasima
205	15868	Niaw Dawk Jahn	Nonsoong	Nakhon Ratchasima
206	21757	Khao Sawad	Nonsoong	Nakhon Ratchasima
207	21767	Te Haw	Nonsoong	Nakhon Ratchasima
208	12335	Puang Ngern	Khao Saming	Trat
209	12337	Poo Khao	Khao Saming	Trat
210	12338	Taeng Din Saw	Khao Saming	Trat
211	12339	Khao Med Lek	Khao Saming	Trat
212	12340	Jek Cheuay	Khao Saming	Trat
213	12341	Ma Gawk	Khao Saming	Trat
214	12342	Khao Samed	Khao Saming	Trat
215	12343	Hin Sawn	Khao Saming	Trat
216	12344	Nahng Lai	Khao Saming	Trat
217	12345	Puang Ngern	Khao Saming	Trat
218	12346	Khao' Ber	Khao Saming	Trat
219	12347	Khao Med Lek	Khao Saming	Trat
220	12348	Khao Glin	Khao Saming	Trat
221	12349	Kaset Bow	Khao Saming	Trat
222	12350	Hawm Rai	Khao Saming	Trat
223	12353	Khao Kling	Khao Saming	Trat
224	21233	Puang Lamduan	Khao Saming	Trat
225	21234	Kahng Leuang	Khao Saming	Trat

Appendix Table 3 (Continued)

Entry	Acc.	Variety name	District	Province
226	21235	Khao Taeng Mo	Khao Saming	Trat
227	21236	Khao Hahng Mah	Khao Saming	Trat
228	21243	Niaw Teen Peung	Khao Saming	Trat
229	21244	Puang Ngern	Khao Saming	Trat
230	21245	Khao Mali	Khao Saming	Trat
231	21246	Khao Puang	Khao Saming	Trat
232	21247	Khao Med Lek	Khao Saming	Trat
233	21248	Khao'Leuang	Khao Saming	Trat
234	21249	Ruang Tawng	Khao Saming	Trat
235	21250	Khao'Med Lek	Khao Saming	Trat
236	21251	Puang Tawng	Khao Saming	Trat
237	21252	Nahng Leuang	Khao Saming	Trat
238	21254	Sao Leuam Wang	Khao Saming	Trat
239	21255	Khao'Med Lek	Khao Saming	Trat
240	3681	Nahng Ngahm	Manorom	Chai Nat
241	6522	Beu Nam	Manorom	Chai Nat
242	6523	Khao Sa-ahd	Manorom	Chai Nat

Appendix Table 4 Summary of 101 accessions derived from 18 wild species representing the International wild rice accessions used in this study.

No.	Gs. No.	Species	Collecting Location
1	16274	<i>O. alta</i>	Philippines
2	18727	<i>O. alta</i>	Brazil
3	18728	<i>O. alta</i>	India
4	18730	<i>O. alta</i>	Surinam
5	18731	<i>O. alta</i>	America
6	20117	<i>O. alta</i>	India
7	16273	<i>O.australiensis</i>	Philippines
8	18733	<i>O.australiensis</i>	India
9	18734	<i>O.australiensis</i>	Australia
10	18735	<i>O.australiensis</i>	America
11	18736	<i>O.australiensis</i>	Australia
12	18737	<i>O.australiensis</i>	Australia
13	18739	<i>O.australiensis</i>	Australia
14	18740	<i>O.australiensis</i>	Australia
15	18755	<i>O.brachyantha</i>	Sierra Leone
16	18756	<i>O.brachyantha</i>	Mali
17	18758	<i>O.brachyantha</i>	Sierra Leone
18	18759	<i>O.brachyantha</i>	Sierra Leone
19	20120	<i>O.brachyantha</i>	Mali
20	5497	<i>O.barthii</i>	Philippines
21	18741	<i>O.barthii</i>	Sudan
22	18743	<i>O.barthii</i>	Mali
23	18744	<i>O.barthii</i>	Chad
24	18749	<i>O.barthii</i>	Chad
25	18750	<i>O.barthii</i>	Cameroon
26	20135	<i>O.barthii</i>	Zambia
27	16272	<i>O.eichingeri</i>	Philippines
28	18760	<i>O.eichingeri</i>	Uganda
29	18764	<i>O.eichingeri</i>	Uganda
30	18766	<i>O.eichingeri</i>	Uganda
31	20132	<i>O.eichingeri</i>	Ceylon
32	18777	<i>O.glumaepatula</i>	Cuba
33	18778	<i>O.glumaepatula</i>	India
34	18780	<i>O.glumaepatula</i>	Surinam
35	18781	<i>O.glumaepatula</i>	Brazil
36	18784	<i>O.glumaepatula</i>	Brazil
37	18787	<i>O.grandiglumis</i>	Brazil
38	18790	<i>O.grandiglumis</i>	Brazil
39	18792	<i>O.grandiglumis</i>	Brazil
40	18793	<i>O.grandiglumis</i>	Brazil

Appendix Table 4 (Continued)

No.	Gs. No.	Species	Collecting Location
41	20122	<i>O.grandiglumis</i>	Brazil
42	10152	<i>O.granulata</i>	Japan
43	13698	<i>O.granulata</i>	Ceylon
44	16256	<i>O.granulata</i>	Philippines
45	18765	<i>O.granulata</i>	India
46	18796	<i>O.granulata</i>	India
47	18798	<i>O.granulata</i>	Burma
48	18799	<i>O.granulata</i>	Borneo
49	20127	<i>O.granulata</i>	India
50	20238	<i>O.granulata</i>	Loas
51	18802	<i>O.latifolia</i>	Costarica
52	18803	<i>O.latifolia</i>	India
53	18804	<i>O.latifolia</i>	India
54	18807	<i>O.latifolia</i>	Guatemala
55	18808	<i>O.latifolia</i>	USA
56	18815	<i>O.longistaminata</i>	Africa
57	18816	<i>O.longistaminata</i>	Nigerea
58	18818	<i>O.longistaminata</i>	Ivory Coast
59	18811	<i>O.longistaminata</i>	New Guinea
60	20134	<i>O.longistaminata</i>	Indonesia
61	5495	<i>O.minuta</i>	Philippines
62	16267	<i>O.minuta</i>	Philippines
63	18837	<i>O.minuta</i>	Philippines
64	18843	<i>O.minuta</i>	Philippines
65	18823	<i>O.meridionalis</i>	Australia
66	18825	<i>O.meridionalis</i>	Australia
67	18827	<i>O.meridionalis</i>	Australia
68	18830	<i>O.meridionalis</i>	Australia
69	5501	<i>O.nivara</i>	Philippines
70	18846	<i>O.nivara</i>	India
71	18852	<i>O.nivara</i>	Bangladesh
72	18853	<i>O.nivara</i>	Bangladesh
73	18855	<i>O.nivara</i>	Bangladesh
74	20125	<i>O.nivara</i>	India
75	20136	<i>O.nivara</i>	India
76	20239	<i>O.nivara</i>	Laos
77	20241	<i>O.nivara</i>	Laos
78	10798	<i>O.officinalis</i>	Indonesia
79	18856	<i>O.officinalis</i>	India
80	18857	<i>O.officinalis</i>	Philippines

Appendix Table 4 (Continued)

No.	Gs. No.	Species	Collecting Location
81	18860	<i>O.officinalis</i>	Bangladesh
82	18862	<i>O.officinalis</i>	Malaysia
83	18864	<i>O.officinalis</i>	Brunai
84	18866	<i>O.punctata</i>	India
85	18870	<i>O.punctata</i>	Nigeria
86	18874	<i>O.punctata</i>	Nigeria
87	18875	<i>O.punctata</i>	Cameroon
88	19657	<i>O.punctata</i>	Tanzania
89	20116	<i>O.punctata</i>	Ghana
90	20129	<i>O.punctata</i>	Tanzania
91	15070	<i>O.perrieri</i>	Japan
92	15073	<i>O.perrieri</i>	Japan
93	8425	<i>O.ridleyi</i>	Philippines
94	16266	<i>O.ridleyi</i>	Philippines
95	18879	<i>O.ridleyi</i>	Malaysia
96	5503	<i>O.rufipogon</i>	Philippines
97	10794	<i>O.rufipogon</i>	Indonesia
98	18881	<i>O.rufipogon</i>	Taiwan
99	18882	<i>O.rufipogon</i>	Burma
100	18885	<i>O.rufipogon</i>	Bangladesh
101	20242	<i>O.rufipogon</i>	Laos

Appendix Table 5 The collection of wild rice for passport data.

Entry	Character	Descriptor state and meaning
1	Collector mane :	Name of collectors or project
2	Vernacular name :	Local name for wild rice
3	Locality :	Name of district and province
4	Material :	1=seed, 2=plant, 3=seed+plant
5	Date of collection :	Date number in the year
6	Heterogeneity of sample :	1= homogeneous, 2=heterogeneous
7	Habitat :	1= deep water, 2=shallow, 3=swamp 4=pools in rocky, 5=dry
8	Shading :	1=open, 2=partial shade, 3=full shade
9	Growth habit :	1=erect, 3=semi-erect, 7=decumbent, 9=prostrate
10	Tillering :	1=very prolific, 3=good, 5=medium, 7=poor, 9=very poor
11	Tillers from higher nodes:	0=absent, 1=few, 2=many
12	Rhizome /stolon formation:	0=no, 1=rhizome, 2=stolon
13	Leaf pubescence :	1=glabrous, 2=intermediate, 3=pubescent
14	Panicle type :	1=compact, 5=intermediate, 7=open, 9=decending
15	Panicle exertion :	1=well exerted. 3=moderately well exerted, 5=just exerted, 7=partly exerted. 9=enclosed
16	Panicle axis :	1=straight, 2=droopy
17	Panicle shattering :	1=very low 3=well, 5=moderate, 7=loose, 9=high
18	Awning :	0=absent, 1=shot and partly awned, 2=awned, 3=fully awned
19	Lemma and palea color :	1=green, 2=straw, 3=green-striped gold, 4=brownish spots, 5=blackish brown furrows, 6=purple, 7=mottled patterns of purple, 8=black, 9=brown
20	Soil type :	1=loam, 2=acid sulphate, 3=sndy, 4=clay, 5=saline, 6=peat soil
21	Topography :	1=flat, 2=slope, 3=beach, 4=rock
22	Water condition	1=deep, 2=shallow, 3=swamp, 4=moist, 5=dry
23	Species name :	1= <i>O. rufipogon</i> , 2 = <i>O. nivara</i> , 3=spontanea forms, 4= <i>O. officinales</i> , 5= <i>O. ridleyi</i> , 6= <i>O. granulata</i> , 7=unclassified, 8= <i>O. minuta</i>

Note: 11 = variable in character

Appendix Table 6 The code for collection sites classified according to province in Thailand.

Region	Province	Area code	
Central	Phra Nakhon Si Ayuthaya	(AYY)	10100-10117
	Nonthaburi	(NBR)	10200-10206
	Pathum Thani	(PTT)	10300-10370
	Saraburi	(SRB)	10400-10411
	Lopburi	(LBR)	10500-10509
	Chainat	(CNT)	10600-10606
	Singburi	(SBR)	10700-10707
	Angthong	(ATG)	10800-10807
East	Chachoengsao	(CCS)	20110-20109
	Chonburi	(CBR)	20200-20210
	Rayong	(RYG)	20300-20306
	Chantaburi	(CTB)	20400-20406
	Trat	(TRT)	20500-20505
	Prachinburi	(PJR)	20600-20614
	Nakhon Nayok	(NNY)	20701-20704
	Samutprakan	(SMP)	20800-20805
Northeast I	Nakhonratchasima	(NRM)	30100-30126
	Buriram	(BRR)	30200-30214
	Surin	(SRN)	30300-30313
	Sisaket	(SSK)	30400-30415
	Ubonratchatani	(UBN)	30500-30522
	Chaiyaphum	(CYP)	30601-30612
	Yasothon	(YST)	30800-30808
	Northeast II	Udon Thani	(UDT)
Khonkaen		(KKK)	40200-40220
Maha Sarakham		(MSK)	40300-40310
Roi Et		(ROT)	40400-40415
Kalasin		(KLS)	40500-40514
Nakhon phanom		(NKP)	40600-40610
Sakon Nakhon		(SKN)	40700-40715
Nong Khai		(NGK)	40800-40811
Loei		(LOI)	40900-40912
Mukdahan		(MDH)	41000-41007

Appendix Table 6 (Continued)

Region	Province		Area code
North	Chiang Mai	(CMI)	50100-50121
	Mae Hong Son	(MHS)	50200-50207
	Lamphun	(LPN)	50300-50307
	Lampang	(LPG)	50400-50413
	Phrae	(PRE)	50500-50507
	Nan	(NAN)	50600-50611
	Chiang Rai	(CRI)	50700-50713
	Uttaradit	(UTD)	50800-50809
	Phayao	(PYO)	51000-51007
Lower North	Phitsanulok	(PSL)	60100-60109
	Sukhothai	(SKT)	60200-60209
	Tak	(TAK)	60300-60308
	Kamphaeng Phet	(KPP)	60400-60407
	Uthai Thani	(UTN)	60500-60508
	Nakhon Sawan	(NKS)	60600-60612
	Phichit	(PJT)	60700-60708
	Phetchabun	(PCB)	60800-60811
	West	Nakhon Pathom	(NPT)
Suphan Buri		(SPR)	70200-70211
Kanchanaburi		(KBR)	70300-70310
Ratchaburi		(RBR)	70400-70409
Phetchaburi		(PBR)	70500-70507
Prachuap Khiri Khan		(PJK)	70600-70607
Samut Sonkhram		(SMS)	70700-70703
Samut Sakhon		(SMK)	70800-70803
South I		Phuket	(PUK)
	Krabi	(KBI)	80200-80206
	Nakhon Si Thammarat	(NSR)	80300-80317
	Surat Thani	(SRT)	80400-80418
	Chumphon	(CPN)	80500-80508
	Ranong	(RNG)	80600-80604
	Phangnga	(PGA)	80700-80708
South I	Songkhla	(SKA)	90100-90114
	Phatthalung	(PTL)	90200-90209
	Trang	(TRG)	90300-90307
	Satun	(STL)	90400-90407
	Yala	(YLA)	90500-90506
	Narathiwat	(NRW)	90700-90612
	Pattani	(PTN)	90700-90711
Bangkok	Bangkok	(BKK)	100800-10824

Appendix Table 7 The country of origin of wild spp.

Entry	Country
1	China
2	America
3	Japan
4	Philippines
5	India
6	Brazil
7	Indonesia
8	Guatamala
9	Brunui
10	Costarica
11	Laos
12	Mexico
13	Nicaragua
14	Cameroon
15	Malaysia
16	Boneo
17	Chad
18	Ivory Coast
19	Mali
20	Cuba
21	Australia
22	Ceylon
23	Surinam
24	Sudan
25	Bangladesh
26	Siera leone
27	Uganda
28	Vietnam
29	Ghana
30	Africa
31	Guinea
32	Taiwan
33	Burma
34	Tanzania
35	New guinea
36	Zambia
37	Nigeria
38	Kambodia
39	Malaya

Appendix Table 8 Characterization and evaluation of wild rice sp. *O. nivara*

GS.NO.	06039	06048	06080	06084	06105
Species name	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>
Height	46	37	63	65	76
Culm	semi-erect	semi-erect	erect	erect	erect
Diameter	3	3	2	4	4
Leaf sheath color	-	green	light purple	light purple	dark green
Leaf blade color	green	green	green	green	green
Tiller number	134	225	108	59	51
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	15	15	20	26	27.2
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	3	3	3	4	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	24	23	35.5	43.8	62.8
Leaf blade width	1	0.9	0.7	1	1
Flag leaf angle	intermediate	horizontal	erect	droopy	erect
Flag leaf length	21	19	27	21.6	42
Flag leaf width	1	1	0.9	1.2	1.5
Spikelet color	black	straw	straw	brown	straw
Apiculus color	dark purple	red	red	colorless	colorless
Anther length	1/4 spikelet	1/4 spikelet	-	1/4 spikelet	1/4 spikelet
Stigma color	black	red	black	colorless	colorless
Stigma exertion	Well exerted	exerted	Well exerted	Well exerted	Well exerted
Stigma size	small	small	small	small	small
Awned	present	absent	present	present	present
Awn color	colorless	colorless	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	120	101	130	110	110
Bearing tillers	72	121	80	42	43
Panicle length	19.3	18.4	13	18	21.7
Panicle type	open	open	compact	open	intermediate
Branching	absent	absent	absent	absent	some
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	high	high	medium	high	high
Hull color	black	straw	straw	dark brown	straw
Grain pubescence	glabrous	intermediate	intermediate	glabrous	glabrous
Panicle base length	6.2	8.8	9.3	15.6	14.7
Grain length	7.4	8.1	6.5	9.7	9.9
Grain width	1.9	1.6	1.72	2.2	2.5
Grain thickness	1.67	1.52	1.44	1.84	1.84
Awn length	8.3	6	5	5.7	9.3
Sterile lemma length	short	short	short	short	short
100 Grain weight	21	1	2.3	2.3	2.6
Pericarp color	red	red	red	red	red
Life span	annual	annual	annual	annual	annual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	06039	06048	06080	06084	06105
Species name	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>	<i>O. nivara</i>
Height	46	37	63	65	76
Culm	semi-erect	semi-erect	erect	erect	erect
Diameter	3	3	2	4	4
Leaf sheat color	-	green	light purple	light purple	dark green
Leaf blade color	green	green	green	green	green
Tiller nimber	134	225	108	59	51
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	15	15	20	26	27.2
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	3	3	3	4	4
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	24	23	35.5	43.8	62.8
Leaf blade width	1	0.9	0.7	1	1
Flag leaf angle	intermediate	horizontal	erect	droopy	erect
Flag leaf length	21	19	27	21.6	42
Flag leaf width	1	1	0.9	1.2	1.5
Spikelet color	black	straw	straw	brown	straw
Apiculus color	dark purple	red	red	colorless	colorless
Anther length	1/4 spikelet	1/4 spikelet	-	1/4 spikelet	1/4 spikelet
Stigma color	black	red	black	colorless	colorless
Stigma exsertion	Well exserted	exserted	Well exserted	Well exserted	Well exserted
Stigma size	small	small	small	small	small
Awned	present	absent	present	present	present
Awn color	colorless	colorless	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	120	101	130	110	110
Bearing tillers	72	121	80	42	43
Panicle length	19.3	18.4	13	18	21.7
Panicle type	open	open	compact	open	intermediate
Branching	absent	absent	absent	absent	some
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	medium	hight	hight
Hull color	black	straw	straw	dark brown	straw
Grain pubesence	glabrous	intermediate	intermediate	glabrous	glabrous
Panicle base length	6.2	8.8	9.3	15.6	14.7
Grain length	7.4	8.1	6.5	9.7	9.9
Grain width	1.9	1.6	1.72	2.2	2.5
Grain thickness	1.67	1.52	1.44	1.84	1.84
Awn length	8.3	6	5	5.7	9.3
Sterile lemma length	short	short	short	short	short
100 Grain weigth	21	1	2.3	2.3	2.6
Pericarp color	red	red	red	red	red
Life span	annual	annual	annual	annual	annual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	16122	18200	18221	18222	18223
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	103	57	29	52	48
Culm	erect	decumbent	decumbent	semi-erect	decumbent
Diameter	6	4	3	5	4
Leaf sheat color	purple	green	green	light purple	green
Leaf blade color	purple at magin	purple at magin	purple at magin	green	purple at magin
Tiller nimber	19	43	35	95	38
Adventitious root	absent	absent	absent	present	absent
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	20	17	12	10	20
Auricle color	colorless	colorless	colorless	colorless	purple
Number of leaves	6	3	3	3	7
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	37	36	29	23	37
Leaf blade width	0.9	0.7	0.6	0.7	0.5
Flag leaf angle	intermediate	intermediate	intermediate	horizontal	intermediate
Flag leaf length	22	25	20	16	19
Flag leaf width	1	0.8	0.7	0.8	0.8
Spikelet color	brown	straw	straw	straw	brown
Apiculus color	red	red	red	red	red
Anther length	1/2 spikelet	full	1/2 spikelet	1/4 spikelet	1/2 spikelet
Stigma color	black	black	purple	black	purple
Stigma exsertion	exserted	enclosed	enclosed	exserted	enclosed
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	red	colorless	colorless	colorless	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	155	145	95	66	97
Bearing tillers	15	38	30	54	38
Panicle length	27	23	26	15	26
Panicle type	intermediate	intermediate	intermediate	intermediate	intermediate
Branching	intermediate	intermediate	intermediate	some	intermediate
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	medium	hight	hight	hight	hight
Hull color	dark brown	dark brown	dark brown	black	dark brown
Grain pubesence	glabrous	glabrous	glabrous	glabrous	glabrous
Panicle base length	13.4	10.6	6.5	3.5	3.6
Grain length	9.8	9.9	9.22	9.43	9.34
Grain width	2.6	2.4	2.77	2.37	2.79
Grain thickness	1.81	1.79	2.01	1.99	1.98
Awn length	12	8.2	10.5	8	10.1
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.4	2.1	2.3	2.4	2.1
Pericarp color	red	red	red	red	red
Life span	annual	annual	annual	annual	annual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18230	18233	18234	18237	18238
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	34	47	54	50	62
Culm	decumbent	decumbent	decumbent	decumbent	semi-erect
Diameter	3	5	3	6	4
Leaf sheat color	light purple	green	green	green	light purple
Leaf blade color	purple at magin	green	green	green	green
Tiller nimber	40	45	38	127	37
Adventitious root	absent	absent	absent	present	present
Ligule color	purple	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	12	15	12	10	17
Auricle color	purple	colorless	colorless	purple	purple
Number of leaves	4	5	6	3	4
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	20	29	29	31.5	25
Leaf blade width	0.8	0.7	0.5	0.7	1.1
Flag leaf angle	erect	intermediate	intermediate	horizontal	horizontal
Flag leaf length	15	21	19	16	13
Flag leaf width	0.8	0.9	0.8	0.9	1.2
Spikelet color	straw	straw	straw	straw	brown
Apiculus color	red	colorless	red	red	red
Anther length	3/4 spikelet	1/2 spikelet	1/2 spikelet	1/4 spikelet	3/4 spikelet
Stigma color	black	colorless	purple	black	black
Stigma exsertion	enclosed	enclosed	enclosed	exserted	exserted
Stigma size	small	small	small	small	small
Awned	-	present	present	present	present
Awn color	red	colorless	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	95	127	115	63	152
Bearing tillers	23	12	20	50	23
Panicle length	21	24	17.2	15	29
Panicle type	intermediate	intermediate	intermediate	intermediate	open
Branching	intermediate	intermediate	intermediate	some	absent
Fertility	0-50%	0-50%	>50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	brown	dark brown	dark brown	black	black
Grain pubesence	glabrous	intermediate	glabrous	glabrous	glabrous
Panicle base length	5	9.5	7.5	7.5	24
Grain length	8.97	9.75	9.31	9.1	8.89
Grain width	2.73	2.39	2.51	2.46	2.42
Grain thickness	1.97	1.8	1.78	1.82	1.83
Awn length	8.7	10.6	12	12.5	7.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.2	2.5	2.4	2.6	2.2
Pericarp color	red	red	red	red	red
Life span	annual	annual	annual	annual	annual
Root	rhizome	rhizome	rhizome	rhizome	stolon

Appendix Table 8 (Continued)

GS.NO.	18239	18240	18242	18243	18249
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	58	66	54	71	66
Culm	decumbent	semi-erect	decumbent	semi-erect	semi-erect
Diameter	4	6	4	4	7
Leaf sheat color	green	green	light purple	dark green	dark green
Leaf blade color	green	green	dark green	dark green	dark green
Tiller nimber	55	120	120	49	130
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	12	16	14	34	25
Auricle color	colorless	colorless	colorless	purple	colorless
Number of leaves	3	3	3	4	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	31	34.5	22	55	36
Leaf blade width	0.6	0.7	0.7	1.3	1
Flag leaf angle	horizontal	droopy	horizontal	horizontal	horizontal
Flag leaf length	18.5	22	17	8	25.5
Flag leaf width	0.8	0.8	0.9	1.8	1.1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/2 spikelet
Stigma color	black	black	black	black	purple
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	colorless	red	red	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	83	92	61	80	78
Bearing tillers	30	55	50	34	84
Panicle length	16	20	11	20	18.5
Panicle type	open	intermediate	intermediate	open	intermediate
Branching	some	some	absent	absent	absent
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	dark brown	dark brown	dark brown	dark brown
Grain pubesence	glabrous	glabrous	intermediate	intermediate	intermediate
Panicle base length	7	3.5	3.5	2.5	2.5
Grain length	8.7	6.92	7.82	8.4	8.4
Grain width	1.98	1.61	1.86	1.87	2.5
Grain thickness	1.79	1.51	1.36	1.24	1.61
Awn length	6.5	10.5	12	11	5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2	2	2.5	2.6	2
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	annual	perienial	perienial
Root	stolon	stolon	rhizome	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18250	18253	18256	18258	18260
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	53	55	96	100	68
Culm	decumbent	decumbent	semi-erect	semi-erect	semi-erect
Diameter	4	4	5	6	6
Leaf sheat color	dark green	dark green	dark green	purple	light purple
Leaf blade color	dark green	dark green	green	dark green	green
Tiller nimber	48	110	60	31	55
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	17	24	21	24	15
Auricle color	colorless	colorless	purple	purple	colorless
Number of leaves	3	3	5	4	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	44	35	52	57	28.5
Leaf blade width	0.6	0.6	0.9	1.1	0.7
Flag leaf angle	horizontal	horizontal	droopy	intermediate	intermediate
Flag leaf length	29.5	24	36.5	36.5	17
Flag leaf width	0.8	0.8	1.2	1.2	0.9
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	colorless	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	big	small
Awned	present	present	present	present	present
Awn color	colorless	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	55	67	62	96	95
Bearing tillers	35	95	17	9	30
Panicle length	15	18	27.5	22.5	18
Panicle type	open	open	open	open	intermediate
Branching	absent	absent	intermediate	absent	some
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	yellow	yellow	purple	dark brown	dark brown
Grain pubesence	intermediate	intermediate	intermediate	intermediate	glabrous
Panicle base length	7	3.5	2	2.5	4
Grain length	7.12	7.9	8.4	8.9	7.9
Grain width	2.4	2.4	1.2	2.7	2.6
Grain thickness	1.54	1.21	1.01	1.97	2.1
Awn length	9	3.5	11	8	8.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.5	1.5	2.2	2.1	2.1
Pericarp color	red	red	red	white	red
Life span	perienial	perienial	perienial	perienial	annual
Root	stolon	rhizome	rhizome	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18261	18268	18271	18279	18281
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	67	34	51	51	50
Culm	erect	erect	decumbent	decumbent	semi-erect
Diameter	4	3	-	6	5
Leaf sheat color	green	green	dark green	purple	light purple
Leaf blade color	green	green	dark green	dark green	purple line
Tiller nimber	33	13	95	110	170
Adventitious root	present	absent	present	present	present
Ligule color	colorless	colorless	colorless	purple	colorless
Ligule shape	clip	2 clip	clip	clip	clip
Ligule length	17	4	10	14	18
Auricle color	colorless	colorless	purple	colorless	colorless
Number of leaves	4	4	3	3	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	42.5	18	47	33.3	24.5
Leaf blade width	1.5	0.4	0.7	1	0.7
Flag leaf angle	horizontal	erect	horizontal	horizontal	horizontal
Flag leaf length	29.5	13.7	24	19.9	19
Flag leaf width	2	0.4	1	1.1	0.7
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	colorless	red	red	red	red
Anther length	1/4 spikelet	1/2 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	colorless	black	black	black	black
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	98	75	62	73	85
Bearing tillers	29	13	78	90	110
Panicle length	22.5	15.5	15	20	17
Panicle type	open	intermediate	intermediate	intermediate	intermediate
Branching	intermediate	intermediate	absent	intermediate	some
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	yellow	dark brown	purple	yellow	black
Grain pubesence	glabrous	intermediate	intermediate	intermediate	glabrous
Panicle base length	8	5.5	5.4	2.5	9.5
Grain length	9.92	8.82	6.51	6.92	7.01
Grain width	2.82	2.67	2.1	2.21	2.01
Grain thickness	2.03	2.01	1.56	1.48	1.32
Awn length	4.7	10.5	7	7	7.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2	2.01	1.6	1.9	1.7
Pericarp color	red	red	red	red	red
Life span	annual	annual	perienial	annual	annual
Root	rhizome	rhizome	stolon	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18284	18286	18288	18289	18290
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	53	57	65	26	48
Culm	decumbent	decumbent	semi-erect	semi-erect	decumbent
Diameter	4	4	5	3	6
Leaf sheat color	dark green	dark green	light purple	light purple	dark green
Leaf blade color	dark green	dark green	purple at magin	purple at magin	dark green
Tiller nimber	98	92	136	5	80
Adventitious root	present	present	present	absent	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	2 clip	clip
Ligule length	12	10	22	7	18
Auricle color	colorless	colorless	colorless	colorless	purple
Number of leaves	4	3	3	3	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	30.5	42.7	31.5	25.5	38
Leaf blade width	0.9	0.7	0.7	0.5	1.1
Flag leaf angle	horizontal	droopy	horizontal	intermediate	intermediate
Flag leaf length	23.4	29	14.5	16.9	26
Flag leaf width	1	0.9	0.6	0.6	1.1
Spikelet color	brown	straw	straw	yellow	straw
Apiculus color	dark purple	red	red	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	exserted	exserted	exserted	Well exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	red	colorless	colorless	colorless	red
Sterile lemma	red	colorless	colorless	colorless	colorless
Plant height	60	86	80	70	113
Bearing tillers	56	48	69	12	41
Panicle length	16	17	16	17	21
Panicle type	intermediate	intermediate	open	intermediate	intermediate
Branching	intermediate	absent	some	some	intermediate
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	dark brown	dark brown	dark brown	dark brown	dark brown
Grain pubesence	intermediate	intermediate	glabrous	intermediate	intermediate
Panicle base length	8	15	10.02	15	7.5
Grain length	7	9.23	9.14	9.28	9.4
Grain width	1.97	2.36	2.38	2.41	2.4
Grain thickness	1.91	1.82	1.81	1.79	1.81
Awn length	7.5	8.5	8.5	6	7
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.2	1.8	1.4	1.8	2.2
Pericarp color	red	red	red	red	red
Life span	annual	annual	annual	annual	annual
Root	rhizome	rhizome	rhizome	rhizome	stolon

Appendix Table 8 (Continued)

GS.NO.	18291	18316	18320	18321	18327
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	63	45	55	25	48
Culm	decumbent	decumbent	semi-erect	semi-erect	decumbent
Diameter	5	4	5	4	3
Leaf sheat color	dark green	light purple	green	light purple	dark green
Leaf blade color	dark green	dark green	green	purple at magin	dark green
Tiller nimber	76	130	82	5	39
Adventitious root	present	present	present	absent	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	2 clip	clip
Ligule length	11	10	15	11	12
Auricle color	colorless	purple	colorless	colorless	colorless
Number of leaves	3	3	3	4	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	29	40	43.5	25.5	38
Leaf blade width	0.5	0.9	0.9	0.6	0.8
Flag leaf angle	erect	intermediate	droopy	erect	erect
Flag leaf length	17	24	33	13.5	37
Flag leaf width	0.7	12	1.2	0.8	0.8
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	dark purple	colorless	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	colorless	black	black
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	red	red	colorless	red	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	97	71	95	51	91
Bearing tillers	47	61	61	6	35
Panicle length	20	17	18	9	18
Panicle type	intermediate	intermediate	intermediate	intermediate	open
Branching	intermediate	absent	some	some	intermediate
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	dark brown	dark brown	dark brown	dark brown	dark brown
Grain pubesence	intermediate	intermediate	glabrous	intermediate	intermediate
Panicle base length	6.5	13	13.5	13	10.7
Grain length	7.65	9.26	9.56	8.49	9.55
Grain width	1.62	1.92	1.9	2.41	2.62
Grain thickness	1.5	1.12	1.69	1.82	1.68
Awn length	8	9	4.5	8	9.2
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.7	2.1	2.2	2.4	2.3
Pericarp color	red	red	red	red	red
Life span	annual	annual	perienial	annual	annual
Root	rhizome	rhizome	stolon	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18334	18335	18341	18347	18348
Species name	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>	<i>O.nivara</i>
Height	60	57	57	64	65
Culm	semi-erect	semi-erect	decumbent	semi-erect	semi-erect
Diameter	6	4	6	6	5
Leaf sheat color	dark green	green	green	green	green
Leaf blade color	green	green	green	green	green
Tiller nimber	27	86	78	130	119
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	truncate	truncate	clip
Ligule length	19	13	7	8	13
Auricle color	colorless	colorless	purple	colorless	colorless
Number of leaves	3	3	3	3	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	44.5	31.5	35.5	40.5	37.3
Leaf blade width	0.9	0.7	0.7	0.6	0.9
Flag leaf angle	erect	horizontal	erect	erect	horizontal
Flag leaf length	27	16.5	25.5	19	26
Flag leaf width	1.1	0.8	1	0.6	1.1
Spikelet color	straw	straw	brown	brown	straw
Apiculus color	red	red	dark purple	red	colorless
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	colorless
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	83	98	88	115	98
Bearing tillers	26	62	36	52	79
Panicle length	12	18	23	21	17
Panicle type	open	open	open	intermediate	intermediate
Branching	absent	intermediate	some	some	some
Fertility	0-50%	0-50%	0-50%	0-50%	0-50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	dark brown	dark brown	dark brown	dark brown
Grain pubesence	intermediate	glabrous	glabrous	glabrous	glabrous
Panicle base length	9	3	2.5	10.5	9
Grain length	8.41	8.4	9.9	8.9	7.76
Grain width	2.81	2.4	2.8	2.6	2.42
Grain thickness	1.91	1.86	1.97	1.8	1.65
Awn length	7	8.5	8	8	9.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.3	2	2.5	2	2.5
Pericarp color	red	red	red	red	red
Life span	perienial	annual	perienial	annual	annual
Root	rhizome	rhizome	stolon	rhizome	rhizome

Appendix Table 8 (Continued)

GS.NO.	18351	22693
Species name	<i>O.nivara</i>	<i>O.nivara</i>
Height	47	87
Culm	decumbent	erect
Diameter	5	5
Leaf sheat color	green	green
Leaf blade color	green	green
Tiller nimber	123	14
Adventitious root	present	present
Ligule color	colorless	colorless
Ligule shape	truncate	clip
Ligule length	8	21
Auricle color	purple	colorless
Number of leaves	3	7
Pubesence	intermediate	intermediate
Leaf blade length	26.5	35
Leaf blade width	0.8	1
Flag leaf angle	erect	erect
Flag leaf length	17	18
Flag leaf width	1	1
Spikelet color	straw	straw
Apiculus color	red	colorless
Anther length	1/4 spikelet	1/2 spikelet
Stigma color	black	colorless
Stigma exsertion	exserted	exserted
Stigma size	small	small
Awned	present	present
Awn color	colorless	colorless
Sterile lemma	colorless	colorless
Plant height	92	163
Bearing tillers	53	12
Panicle length	16	26.2
Panicle type	intermediate	intermediate
Branching	some	intermediate
Fertility	0-50%	0-50%
Shattering	hight	hight
Hull color	black	dark brown
Grain pubesence	glabrous	glabrous
Panicle base length	9.5	11.5
Grain length	7.91	7.84
Grain width	1.92	1.98
Grain thickness	1.61	1.64
Awn length	8.5	7.3
Sterile lemma length	short	short
100 Grain weigth	1.8	1.5
Pericarp color	red	red
Life span	perienial	annual
Root	stolon	rhizome

Appendix Table 9 Characterization and evaluation of wild rice sp. *O. rufipogon*.

GS.NO.	6047	6049	6053	6055	6060
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	44	61	60	82	61
Culm	decumbent	decumbent	seminderect	decumbent	decucbent
Diameter	3	3	3	3	3
Leaf sheat color	green	green	green	purple	green
Leaf blade color	green	green	green	green	green
Tiller namber	92	69	58	116	82
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	14	10	18	50	16
Auricle color	purple	colorless	colorless	colorless	colorless
Number of leaves	3	3	3	4	3
Pubescence	intermediste	intermediate	intermediate	intermediate	intermediate
Leaf blade length	27.5	31.2	50	59.9	29.7
Leaf blade width	0.9	0.5	1.3	1.4	1.4
Flag leaf angle	intermediste	intermediate	horizontal	intermediate	droopy
Flag leaf length	19.5	16.4	22.6	39	20.4
Flag leaf width	1	0.7	1.2	1.5	1.4
Spikelet color	straw	straw	straw	red	straw
Apiculus color	purple	purple black	red	purple black	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	full	3/4 spikelet
Stigma color	black	black	colorless	black	black
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	big	big	small	big
Awned	present	present	present	present	present
Awn color	colorless	colorless	red	red	colorless
Sterile lemma	colorless	colorless	red	red	colorless
Plant height	135	72	175	111	115
Bearing tillers	80	30	47	15	23
Panicle length	24	15.5	23.4	22.5	19
Panicle type	open	open	open	open	open
Branching	absent	some	some	absent	absent
Fertility	0nd50%	0nd50%	0nd50%	0%	0nd50%
Shattering	high	high	high	high	high
Hull color	black	black	black	black	black
Grain pubescence	glabrous	glabrous	intermediate	glabrous	intermediate
Panicle base length	5.8	6.3	15.6	9.3	5
Grain length	7.8	8.36	9.2	9.4	7.9
Grain width	1.1	2.21	1.98	2.1	1.9
Grain thickness	1.38	1.66	1.9	1.6	2.1
Awn length	8.8	4.7	8.2	3.7	3
Sterile lemma length	short	short	short	medium	short
100 Grain weigth	2.3	2.3	1.5	2.8	1.9
Pericarp color	red	red	red	white	red
Life span	perienial	perienial	annual	perienial	perienial
Root	stolon	stolon	rhizome	rhizome	stolon

Appendix Table 9 (Continued)

GS.NO.	6073	6083	6092	6094	6110
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	65	72	73	52	86
Culm	erect	erect	seminderect	decumbent	seminderect
Diameter	3	4	4	3	5
Leaf sheat color	dark green	purple	purple	green	light purple
Leaf blade color	green	dark green	purple at magin	green	green
Tiller namber	113	48	26	111	4
Adventitious root	present	present	absent	present	present
Ligule color	colorless	purple	colorless	colorless	colorless
Ligule shape	clip	clip	2 clip	clip	2 clip
Ligule length	26	17	15	12	15
Auricle color	purple dark	purple	purple	colorless	colorless
Number of leaves	4	3	4	4	5
Pubesence	intermediste	intermediate	intermediate	intermediate	intermediate
Leaf blade length	45	48	49.2	24.7	30.4
Leaf blade width	0.9	1.2	1	0.8	1.2
Flag leaf angle	horizontal	erect	erect	droopy	intermediate
Flag leaf length	24	35	39.2	20	28
Flag leaf width	1.1	1.6	1.1	0.9	1.4
Spikelet color	red	straw	straw	straw	straw
Apiculus color	red	red	red	purple black	colorless
Anther length	1/4 spikelet	1/4 spikelet	1/2 spikelet	1/2 spikelet	1/2 spikelet
Stigma color	black	black	black	black	colorless
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	absent	present	present	present
Awn color	red	nd	red	colorless	colorless
Sterile lemma	red	colorless	colorless	colorless	colorless
Plant height	125	71	122	112	111
Bearing tillers	69	39	18	48	15
Panicle length	24.5	10	25.5	20.2	22.5
Panicle type	open	intermediate	intermediate	open	open
Branching	some	some	intermediate	absent	intermediate
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	straw	darknDbrown	straw	black	black
Grain pubesence	glabrous	glabrous	intermediate	glabrous	intermediate
Panicle base length	4.8	10.2	4.2	4	2.8
Grain length	8.6	9.7	10.06	5.9	6.7
Grain width	2.2	2.01	2.5	2.1	1.9
Grain thickness	1.8	1.4	1.92	1.5	1.2
Awn length	1.3	6.5	4.5	10	7.2
Sterile lemma length	short	short	short	short	short
100 Grain weigth	3.3	2.4	2.79	1	2.1
Pericarp color	red	red	red	9	red
Life span	perienial	annual	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	6114	6115	6116	6117	6118
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	92	93	75	92	95
Culm	erect	seminderect	erect	erect	seminderect
Diameter	4	5	4	6	5
Leaf sheat color	green	green	green	green	green
Leaf blade color	green	green	green	green	green
Tiller number	24	48	21	17	22
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	18	26	23	16	45
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	5	5	4	4	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	56.3	45	55	41	71
Leaf blade width	1.5	1.3	1.2	1.2	1.1
Flag leaf angle	erect	intermediate	erect	intermediate	intermediate
Flag leaf length	39	32	32	29	38.2
Flag leaf width	1.6	1.5	1.4	1.2	1.3
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	colorless	red	red	colorless	colorless
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	3/4 spikelet
Stigma color	colorless	black	black	colorless	colorless
Stigma exertion	exserted	exserted	exserted	exserted	well exerted
Stigma size	small	small	small	small	small
Awned	present	present	absent	present	present
Awn color	colorless	colorless	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	192	159	163	150	190
Bearing tillers	25	19	19	15	18
Panicle length	30.5	24	26	28	33
Panicle type	intermediate	open	intermediate	intermediate	open
Branching	some	intermediate	some	some	intermediate
Fertility	0nd50%	0%	0nd50%	0nd50%	0nd50%
Shattering	high	high	medium	high	high
Hull color	black	black	straw	straw	brown black
Grain pubescence	intermediate	glabrous	intermediate	intermediate	intermediate
Panicle base length	1.7	3.5	10.7	9.5	13.5
Grain length	6.5	7.95	8.2	7.9	9.6
Grain width	2.2	2.48	2.5	2.4	1.98
Grain thickness	1.6	1.77	1.4	1.9	1.82
Awn length	6.5	2.5	2.1	0.7	2.5
Sterile lemma length	short	short	short	short	short
100 Grain weight	2.3	2	2	2	2.2
Pericarp color	red	red	red	red	red
Life span	perennial	perennial	annual	perennial	annual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	6120	7865	7866	7868	7869
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	72	37	62	60	60
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	4	3	4	3	3
Leaf sheat color	green	purple	dark green	light purple	dark green
Leaf blade color	green	purple at magin	green	green	purple at magin
Tiller namber	33	113	173	182	82
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	46	11	15	12	18
Auricle color	colorless	purple	purple	colorless	colorless
Number of leaves	3	3	5	5	6
Pubesence	glabrous	intermediate	intermediate	intermediate	intermediate
Leaf blade length	73.5	28	46	12	36.2
Leaf blade width	1.1	0.8	1	0.8	0.6
Flag leaf angle	droopy	erect	intermediate	intermediate	erect
Flag leaf length	4.6	17.6	44.5	39.9	19.4
Flag leaf width	1.3	1	1.5	1.3	1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	red	dark purple
Anther length	1/4 spikelet	nd	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	well exserted	well exserted	exserted	exserted
Stigma size	big	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	175	76	101	108	107
Bearing tillers	30	71	30	17	34
Panicle length	17.2	13.2	19	11	22
Panicle type	intermediate	intermediate	open	open	intermediate
Branching	some	absent	some	absent	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	black	dark brown	black	black	black
Grain pubesence	intermediate	glabrous	glabrous	glabrous	glabrous
Panicle base length	10	5.6	5.5	13.5	7
Grain length	9.4	7.9	8.79	8.24	7.53
Grain width	2.1	2.1	2.90	2.28	2.47
Grain thickness	1.8	1.8	1.87	1.70	1.72
Awn length	2.5	3.3	4	5.5	13
Sterile lemma length	short	short	short	short	medium
100 Grain weigth	2.3	2.3	2.2	1.8	2.1
Pericarp color	red	red	red	red	red
Life span	annual	anual	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	7871	7872	7875	7879	7880
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	42	53	73	89	84
Culm	decumbent	decumbent	erect	erect	seminderect
Diameter	4	12	5	10	4
Leaf sheat color	dark green	green	green	green	green
Leaf blade color	purple at magin	green	green	green	green
Tiller namber	27	28	28	47	18
Adventitious root	absent	present	present	present	present
Ligule color	purple	colorless	colorless	colorless	colorless
Ligule shape	2 clip	clip	clip	clip	clip
Ligule length	13	10	27	13	18
Auricle color	purple	colorless	colorless	colorless	colorless
Number of leaves	3	3	4	4	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	26.5	59	63.3	52	43.7
Leaf blade width	0.7	0.9	1	1.7	1.1
Flag leaf angle	intermediate	intermediate	intermediate	droopy	erect
Flag leaf length	22.3	57	43.5	32	25
Flag leaf width	0.8	1.4	1.4	1.5	1.2
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	colorless	colorless
Anther length	3/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	colorless	colorless
Stigma exsertion	exserted	exserted	exserted	exserted	well exserted
Stigma size	small	small	small	big	small
Awned	present	present	absent	absent	absent
Awn color	colorless	colorless	nd	nd	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	83	115	144	143	162
Bearing tillers	17	67	14	39	19
Panicle length	15.3	26	34	27	28
Panicle type	intermediate	open	intermediate	intermediate	compact
Branching	intermediate	some	some	some	intermediate
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	medium	medium
Hull color	black	dark brown	straw	yellow	yellow
Grain pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Panicle base length	3	3.5	16.5	4.5	15.5
Grain length	9.8	10.2	9.7	8.4	7.8
Grain width	2.4	2.3	2.3	1.6	2.4
Grain thickness	1.6	1.72	1.91	1.8	1.9
Awn length	2.4	2.3	1.8	1.9	2.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.1	1.4	2.1	2.7	2.1
Pericarp color	white	white	white	white	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	7884	7886	7890	7891	7902
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	41	49	54	58	60
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	3	4	4	4	6
Leaf sheat color	dark green	dark green	green	light purple	purple
Leaf blade color	purple at magin	green	green	green	purple line
Tiller namber	78	23	70	98	36
Adventitious root	present	absent	present	present	present
Ligule color	nd	colorless	colorless	purple	purple
Ligule shape	clip	2 clip	clip	clip	clip
Ligule length	10	17	34	12	12
Auricle color	purple	colorless	colorless	purple	purple
Number of leaves	4	5	3	3	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	28.1	31	52.3	31	29
Leaf blade width	0.9	1.3	1.4	1	0.6
Flag leaf angle	horizontal	horizontal	horizontal	horizontal	horizontal
Flag leaf length	20.3	21	30.7	22.5	17.5
Flag leaf width	1.1	1.4	1.5	1.2	0.5
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	dark purple	red	red	red	red
Anther length	1/4 spikelet	3/4 spikelet	3/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	well exserted	well exserted	exserted	exserted
Stigma size	small	small	big	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	red	red	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	98	135	153	87	85
Bearing tillers	54	8	57	49	31
Panicle length	16.5	25	25.2	20	21
Panicle type	open	intermediate	open	open	open
Branching	some	intermediate	some	some	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	nd	black	straw	dark brown	dark brown
Grain pubescence	intermediate	glabrous	intermediate	intermediate	glabrous
Panicle base length	14.2	14	19.6	4.5	6
Grain length	8.1	6.7	9.2	9.4	8.7
Grain width	2.4	2.5	3.0	2.6	2.4
Grain thickness	1.8	1.67	1.82	1.8	1.72
Awn length	8.2	4	3.7	8.5	7.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.3	1.8	1.2	2.2	1.6
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	anual	anual
Root	rhizome	rhizome	stolon	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	7905	7907	7910	7914	7916
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	43	62	59	72	35
Culm	decumbent	seminderect	decumbent	erect	decumbent
Diameter	3	4	4	4	4
Leaf sheat color	purple	light purple	purple	green	light purple
Leaf blade color	purple at magin	purple at magin	purple at magin	green	purple at magin
Tiller nimer	88	75	107	75	13
Adventitious root	present	present	present	present	absent
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	2 clip
Ligule length	13	25	25	16	14
Auricle color	purple	purple	purple	colorless	colorless
Number of leaves	3	4	3	3	4
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	22.7	41	41.1	39.9	41
Leaf blade width	0.8	0.7	0.8	0.8	0.9
Flag leaf angle	horizontal	intermediate	horizontal	erect	intermediate
Flag leaf length	17	28.8	25.8	27.2	26.2
Flag leaf width	0.9	0.8	1	1	1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	exserted	exserted	well exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	red	colorless	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	69	71	78	78	72
Bearing tillers	74	62	69	52	61
Panicle length	11.7	12.2	17.6	11.8	11.9
Panicle type	compact	compact	intermediate	open	intermediate
Branching	absent	absent	absent	absent	absent
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	dark brown	straw	dark brown	dark brown	straw
Grain pubesence	glabrous	glabrous	glabrous	glabrous	glabrous
Panicle base length	8.6	7.8	55	8.8	7.8
Grain length	8.2	8.2	7.9	6.8	4.9
Grain width	2.6	1.9	2.0	1.85	1.49
Grain thickness	1.86	1.5	1.6	1.7	1.76
Awn length	5.5	3.5	7.6	4.5	6.2
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2	1.2	2	1.8	1.9
Pericarp color	red	red	red	red	red
Life span	annual	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	7917	7919	7925	7926	9315
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	82	78	78	92	76
Culm	erect	erect	decumbent	decumbent	seminderect
Diameter	3	4	4	3	12
Leaf sheat color	green	green	green	green	purple
Leaf blade color	green	green	green	dark green	purple at magin
Tiller namber	29	36	35	74	37
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	purple
Ligule shape	clip	clip	clip	clip	clip
Ligule length	20	30	29	33	16
Auricle color	colorless	colorless	colorless	colorless	purple
Number of leaves	4	4	4	5	4
Pubesence	intermediate	intermediate	glabrous	intermediate	intermediate
Leaf blade length	52.7	64.1	60.2	51.5	73
Leaf blade width	1.2	1	1	0.9	1.4
Flag leaf angle	erect	erect	droopy	intermediate	droopy
Flag leaf length	37.5	37	40.4	40	56
Flag leaf width	1.4	1.4	1.2	1.1	1.7
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	dark purple	red	dark purple
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	colorless	black
Stigma exsertion	exserted	well exserted	well exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	red	red	colorless	colorless	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	163	155	140	100	123
Bearing tillers	28	36	32	33	28
Panicle length	28.2	25	29.4	18.5	26
Panicle type	intermediate	intermediate	open	intermediate	intermediate
Branching	some	some	intermediate	absent	intermediate
Fertility	0nd50%	0nd50%	0nd50%	>50%	0nd50%
Shattering	high	high	high	high	high
Hull color	yellow	dark brown	straw	black	dark brown
Grain pubesence	intermediate	intermediate	glabrous	glabrous	intermediate
Panicle base length	2.8	2.5	8.2	6	5.5
Grain length	8.1	7.9	7.86	8.16	4.8
Grain width	2.4	1.9	2.0	2.33	1.8
Grain thickness	1.2	1.48	1.52	1.68	1.67
Awn length	6.8	7.4	4.5	6.2	2.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.1	1.9	2.6	1.9	1.7
Pericarp color	red	red	red	red	white
Life span	annual	perienial	perienial	perienial	anual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	9319	9321	9324	9327	9333
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	69	91	136	94	131
Culm	erect	erect	erect	erect	erect
Diameter	4	15	5	20	4
Leaf sheath color	green	purple	light purple	green	green
Leaf blade color	green	green	purple at margin	green	green
Tiller number	8	40	25	23	18
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	2 clip	clip	clip	clip	clip
Ligule length	20	20	32	19	22
Auricle color	colorless	colorless	colorless	purple	colorless
Number of leaves	3	3	3	3	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	27	74	64	72	75
Leaf blade width	0.9	1.1	1.3	1.4	1.4
Flag leaf angle	intermediate	intermediate	droopy	intermediate	intermediate
Flag leaf length	28	71	55	43	41
Flag leaf width	1	1.3	1.6	1.9	2
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	colorless	red	red	red	colorless
Anther length	1/4 spikelet	1/4 spikelet	1/2 spikelet	1/4 spikelet	3/4 spikelet
Stigma color	colorless	black	black	black	colorless
Stigma exertion	well exerted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	big
Awned	present	present	present	absent	absent
Awn color	colorless	red	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	123	131	140	62	136
Bearing tillers	12	31	20	18	4
Panicle length	26.5	28	28	23	25
Panicle type	intermediate	intermediate	intermediate	open	intermediate
Branching	some	some	intermediate	some	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	medium	high	medium
Hull color	straw	straw	yellow	straw	yellow
Grain pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Panicle base length	7	10	18	9	6
Grain length	5.2	5.8	8.86	8.38	9.14
Grain width	1.9	1.8	2.7	2.64	2.74
Grain thickness	1.2	1.25	1.93	1.79	1.91
Awn length	4	4.5	3	0.5	2.1
Sterile lemma length	short	short	short	short	short
100 Grain weight	1.8	1.9	2.4	2.2	2.3
Pericarp color	red	red	white	red	white
Life span	perennial	annual	perennial	annual	perennial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	9334	9335	9336	9337	9338
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	80	98	66	83	74
Culm	seminderect	erect	erect	erect	seminderect
Diameter	10	15	16	10	15
Leaf sheat color	green	green	purple	purple	green
Leaf blade color	green	green	purple at magin	purple at magin	green
Tiller nimber	40	18	19	22	47
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	purple	purple	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	7	11	7	12	23
Auricle color	colorless	colorless	purple	purple	colorless
Number of leaves	4	3	3	3	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	62	75	59.5	8.4	79
Leaf blade width	1.3	1.5	1.2	1.5	1.6
Flag leaf angle	intermediate	intermediate	intermediate	intermediate	erect
Flag leaf length	35	58	4.2	61	37
Flag leaf width	1.7	1.9	1.3	1.6	1.6
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	colorless	colorless	red	red	colorless
Anther length	1/2 spikelet	3/4 spikelet	1/4 spikelet	3/4 spikelet	1/2 spikelet
Stigma color	colorless	colorless	black	black	colorless
Stigma exsertion	exserted	well exserted	exserted	exserted	exserted
Stigma size	small	big	small	small	small
Awned	absent	present	present	present	present
Awn color	nd	colorless	red	red	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	149	147	145	155	166
Bearing tillers	28	12	27	18	38
Panicle length	26	31.5	17.5	26	29
Panicle type	intermediate	intermediate	intermediate	open	compact
Branching	intermediate	many	some	some	many
Fertility	0nd50%	>50%	0nd50%	0nd50%	>50%
Shattering	high	high	high	high	high
Hull color	straw	straw	dark brown	straw	dark brown
Grain pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Panicle base length	11.15	9.5	12.5	14.1	8.5
Grain length	9.23	7.85	8.9	7.3	4.2
Grain width	2.54	2.45	2.4	2.25	2.41
Grain thickness	1.94	1.89	1.98	1.68	1.83
Awn length	1.8	3	3.8	3.5	11.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.4	1.9	2.1	2.4	2
Pericarp color	red	white	red	white	red
Life span	perienial	annual	annual	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	9351	9762	9764	9765	9768
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	98	46	79	100	56
Culm	seminderect	decumbent	seminderect	erect	seminderect
Diameter	17	3	4	4	2
Leaf sheat color	green	purple	green	green	purple
Leaf blade color	green	purple at magin	green	green	green
Tiller namber	55	92	42	29	55
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	10	12	34	23	24
Auricle color	colorless	purple	colorless	colorless	colorless
Number of leaves	3	3	4	4	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	57.2	33.9	63.2	64.5	27.9
Leaf blade width	1.1	0.9	1.2	1.2	0.6
Flag leaf angle	intermediate	erect	horizontal	intermediate	erect
Flag leaf length	3.8	19.3	28	40.5	16.7
Flag leaf width	1.11	1.1	1.5	1.5	0.6
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	colorless	red	red	colorless	red
Anther length	1/4 spikelet	1/4 spikelet	3/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	colorless	black	black	colorless	black
Stigma exsertion	exserted	exserted	well exserted	well exserted	well exserted
Stigma size	small	small	small	small	big
Awned	present	present	present	present	present
Awn color	colorless	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	150	96	168	184	74
Bearing tillers	32	78	35	27	29
Panicle length	27	17.8	23.2	32.5	17
Panicle type	intermediate	open	open	intermediate	intermediate
Branching	intermediate	absent	some	some	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	straw	yellow	black	straw	black
Grain pubescence	intermediate	intermediate	intermediate	intermediate	glabrous
Panicle base length	3.7	9	10	4.7	6.7
Grain length	9.11	8.5	9.1	8.2	9.39
Grain width	2.76	2.58	2.6	1.92	2.52
Grain thickness	1.96	1.87	1.85	1.7	1.8
Awn length	3.9	9.6	6	5.9	4.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.3	2	1.9	2.3	2.6
Pericarp color	red	red	red	red	red
Life span	perienial	annual	perienial	annual	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	9769	9770	9771	9772	9776
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	63	51	46	108	72
Culm	decumbent	decumbent	seminderect	erect	decumbent
Diameter	3	2	4	18	4
Leaf sheat color	purple	green	green	green	purple
Leaf blade color	green	green	green	green	green
Tiller nimber	198	101	131	35	126
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	25	8	22	10	25
Auricle color	purple	colorless	colorless	colorless	colorless
Number of leaves	10	4	5	4	6
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	42.5	26.1	40.5	60	58
Leaf blade width	0.7	0.6	0.7	1.2	0.8
Flag leaf angle	intermediate	droopy	intermediate	intermediate	horizontal
Flag leaf length	32	17.8	35.5	44	56
Flag leaf width	0.9	0.7	1.2	1.3	1.4
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	colorless	red
Anther length	1/2 spikelet	nd	1/2 spikelet	1/2 spikelet	1/4 spikelet
Stigma color	black	black	black	colorless	black
Stigma exsertion	well exserted	well exserted	exserted	exserted	well exserted
Stigma size	big	small	small	small	big
Awned	present	present	present	absent	present
Awn color	colorless	red	red	nd	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	86	71	86	209	110
Bearing tillers	31	69	77	27	97
Panicle length	19.5	12	19	27	24
Panicle type	open	open	open	intermediate	open
Branching	some	absent	some	intermediate	absent
Fertility	0nd50%	0nd50%	0nd50%	>50%	>50%
Shattering	high	high	high	high	high
Hull color	black	straw	yellow	yellow	dark brown
Grain pubescence	glabrous	intermediate	intermediate	intermediate	pubescent
Panicle base length	10	3.5	9.1	8	11.5
Grain length	8.95	8.12	8.18	7.9	9.04
Grain width	2.43	2.14	2.2	2.14	2.29
Grain thickness	1.76	1.9	1.55	1.67	1.76
Awn length	3.2	6.7	7.2	4.2	3.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.9	1.6	1.7	2.2	1.6
Pericarp color	white	white	red	white	white
Life span	perienial	perienial	perienial	annual	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	9792	10535	10536	10537	10540
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	108	55	61	70	64
Culm	seminderect	decumbent	decumbent	decumbent	decumbent
Diameter	5	3	3	3	5
Leaf sheat color	light purple	purple	purple	purple	light purple
Leaf blade color	green	purple at magin	dark green	green	green
Tiller nimer	67	79	95	71	130
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	34	15	17	29	17
Auricle color	colorless	purple	colorless	colorless	purple
Number of leaves	5	3	4	4	5
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	59	33.8	37	53.2	37.2
Leaf blade width	1.6	0.9	0.7	0.7	0.9
Flag leaf angle	intermediate	horizontal	erect	horizontal	intermediate
Flag leaf length	32.5	22.6	25	26.9	25.4
Flag leaf width	1.6	1.1	0.7	0.9	1.1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	dark purple	red	red	dark purple	red
Anther length	1/2 spikelet	nd	1/4 spikelet	nd	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	well exserted	well exserted	well exserted	well exserted
Stigma size	big	small	small	small	big
Awned	present	present	present	present	present
Awn color	red	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	153	78	107	121	110
Bearing tillers	30	42	72	55	98
Panicle length	30.5	12.4	13.6	24.3	20
Panicle type	open	open	open	open	open
Branching	apsent	apsent	some	many	intermediate
Fertility	0%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	dark brown	dark brown	dark brown	black	black
Grain pubescence	intermediate	glabrous	glabrous	glabrous	glabrous
Panicle base length	15.6	12.3	10.1	8.3	nd
Grain length	8.45	8.2	7.9	8.12	9.19
Grain width	2.41	2.32	2.2	2.44	2.76
Grain thickness	1.77	1.62	1.48	2.01	1.88
Awn length	9.7	11.1	5.7	7.8	6
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.1	2.1	1.9	2.4	nd
Pericarp color	white	white	red	red	red
Life span	perienial	annual	annual	perienial	annual
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	10541	10542	10545	10546	10547
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	89	74	53	48	53
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	4	3	2	3	3
Leaf sheat color	green	purple	green	light purple	dark green
Leaf blade color	green	dark green	green	green	green
Tiller number	35	108	129	68	137
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	23	20	15	25	16
Auricle color	purple	colorless	colorless	colorless	colorless
Number of leaves	4	4	5	5	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	47.5	39	23.1	28.4	34
Leaf blade width	0.8	0.5	0.6	0.6	0.7
Flag leaf angle	intermediate	intermediate	intermediate	intermediate	intermediate
Flag leaf length	27.7	27.5	20.9	14.8	27
Flag leaf width	1.1	1.8	0.8	0.9	1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	dark purple	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	colorless
Stigma exertion	well exerted	well exerted	well exerted	well exerted	exerted
Stigma size	big	big	big	big	big
Awned	present	present	present	present	present
Awn color	colorless	colorless	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	129	96	77	79	81
Bearing tillers	32	43	50	66	48
Panicle length	22.5	19	18	18	17.5
Panicle type	intermediate	intermediate	intermediate	open	open
Branching	many	some	absent	absent	absent
Fertility	0nd50%	0nd50%	0nd50%	>50%	0nd50%
Shattering	high	high	high	high	high
Hull color	black	dark brow	black	dark brown	yellow
Grain pubescence	glabrous	glabrous	glabrous	glabrous	glabrous
Panicle base length	6.5	1.5	5	6.5	9
Grain length	9	7.95	9.29	9.29	8.21
Grain width	2.79	2.76	2.5	2.57	2.51
Grain thickness	1.78	1.55	2.71	1.81	1.5
Awn length	6	5.6	8.5	9.5	7.5
Sterile lemma length	medium	short	short	short	short
100 Grain weight	2.3	1.5	2	2.3	1.3
Pericarp color	red	red	red	red	red
Life span	perienial	annual	annual	annual	annual
Root	stolon	rhizome	rhizome	stolon	rhizome

Appendix Table 9 (Continued)

GS.NO.	10548	10549	10550	10551	10552
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	59	95	52	88	76
Culm	decumbent	seminderect	decumber	decumbent	decumbent
Diameter	3	5	3	3	2
Leaf sheat color	green	purple	light purple	purple	dark green
Leaf blade color	green	purple at magin	purple at magin	purple at magin	purple line
Tiller namber	71	45	102	85	51
Adventitious root	present	present	present	present	present
Ligule color	colorless	purple	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	29	25	12	29	28
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	3	3	5	5	3
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	24.4	62.5	30	37.5	33.5
Leaf blade width	0.8	1.1	0.5	0.6	0.7
Flag leaf angle	intermediate	intermediate	horizontal	intermediate	intermediate
Flag leaf length	14.9	42.7	19.5	23.7	20.3
Flag leaf width	0.9	1.5	0.7	0.7	0.8
Spikelet color	straw	black	straw	straw	straw
Apiculus color	red	red	purple black	purple black	colorless
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	exserted	well exserted	well exserted	well exserted
Stigma size	big	small	big	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	red	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	87	119	82	99	85
Bearing tillers	36	12	38	73	28
Panicle length	20	20	17.5	22	16.5
Panicle type	open	intermediate	open	open	open
Branching	absent	some	absent	intermediate	some
Fertility	>50%	0nd50%	> 50%	0nd50%	0nd50%
Shattering	high	high	high	high	high
Hull color	dark brow	dark brow	black	brown black	black
Grain pubesence	glabrous	glabrous	glabrous	glabrous	glabrous
Panicle base length	5	7	6	7.5	5
Grain length	8.28	9.31	7.9	795	9.06
Grain width	2.53	2.69	2.52	2.46	2.24
Grain thickness	1.75	13.84	1.68	1.71	1.69
Awn length	9.5	4	5	10	4
Sterile lemma length	short	short	short	short	short
100 Grain weighth	2.3	2.4	1.4	1.6	1.9
Pericarp color	red	white	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	stolon	rhizome

Appendix Table 9 (Continued)

GS.NO.	10553	10554	10555	10559	10560
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	76	79	60	96	91
Culm	decumbent	decumbent	decumbent	semirect	semirect
Diameter	4	5	3	4	5
Leaf sheath color	purple	green	purple	light purple	green
Leaf blade color	purple line	green	green	green	green
Tiller number	51	43	77	41	67
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	purple	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	21	13	12	28	42
Auricle color	purple	purple	purple	colorless	colorless
Number of leaves	5	4	6	6	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	52	31	26.7	57	73
Leaf blade width	1.2	1.2	0.6	0.9	1.1
Flag leaf angle	intermediate	erect	intermediate	droopy	horizontal
Flag leaf length	37	35.5	18.5	37.8	82
Flag leaf width	1.5	1.3	1	1.1	1.6
Spikelet color	straw	brown	straw	straw	straw
Apiculus color	purple black	colorless	purple black	red	colorless
Anther length	1/2 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	colorless	black	black	colorless
Stigma exertion	well exerted	exerted	well exerted	well exerted	exerted
Stigma size	big	small	big	big	small
Awned	present	present	present	present	present
Awn color	red	colorless	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	89	102	101	135	83
Bearing tillers	33	35	25	19	11
Panicle length	18	25	23	30.5	29.5
Panicle type	open	compact	open	open	open
Branching	some	intermediate	absent	many	intermediate
Fertility	0nd50%	0nd50%	0nd50%	<50%	0nd50%
Shattering	high	high	high	high	high
Hull color	brown black	brown black	black	brown black	straw
Grain pubescence	glabrous	glabrous	glabrous	glabrous	pubescent
Panicle base length	7.8	3.5	1.5	10.5	3
Grain length	8.6	8.16	8.86	9.42	9.81
Grain width	2.58	2.42	2.76	2.41	2.4
Grain thickness	1.73	1.81	1.86	1.83	1.87
Awn length	7.6	0.5	9	6.5	5.2
Sterile lemma length	short	short	short	medium	short
100 Grain weight	2.1	2.2	2	1.9	1.9
Pericarp color	red	red	red	red	white
Life span	perennial	annual	perennial	perennial	perennial
Root	rhizome	rhizome	stolon	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	10585	10587	10589	10590	10591
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	64	89	106	91	125
Culm	decumbent	seminderect	decumbent	seminderect	seminderect
Diameter	3	3	4	4	5
Leaf sheat color	green	purple	purple	green	green
Leaf blade color	green	green	green	green	green
Tiller nimber	126	49	56	160	34
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	23	28	22	35	35
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	7	4	6	5	6
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	56.5	42	60	52	83.5
Leaf blade width	1.8	1.5	1.8	1.5	2
Flag leaf angle	horizontal	horizontal	droopy	droopy	intermediate
Flag leaf length	27	20	39	29	61
Flag leaf width	2	1.8	2	1.6	2.2
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	red	red	red
Anther length	1/2 spikelet	1/2 spikelet	3/4 spikelet	1/2 spikelet	3/4 spikelet
Stigma color	black	black	black	black	black
Stigma exsertion	well exserted	well exserted	weel exserted	exserted	well exserted
Stigma size	big	big	big	small	big
Awned	present	present	present	present	present
Awn color	red	red	colorless	red	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	155	188	160	138	209
Bearing tillers	82	13	11	58	15
Panicle length	23	29	17	16	34
Panicle type	open	open	open	open	open
Branching	absent	absent	absent	intermediate	intermediate
Fertility	0%	nd	0nd50%	<50%	0nd50%
Shattering	high	high	high	high	high
Hull color	straw	yellow	straw	straw	brown black
Grain pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Panicle base length	11.8	12.4	5.6	9.7	15
Grain length	8.12	7.63	8.58	8.78	9.03
Grain width	1.91	1.88	2.19	2.15	2.62
Grain thickness	1.64	1.31	1.59	1.54	1.88
Awn length	8	3.9	7	5.6	4
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.78	1.9	2.6	2.2	2.8
Pericarp color	red	red	red	red	white
Life span	perienial	perienial	perienial	perienial	perienial
Root	stolon	stolon	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	10592	10593	10594	10595	10596
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	90	127	71	51	54.5
Culm	decumbent	decumbent	decumbent	decumbent	decumbent
Diameter	3	3	3	4	6
Leaf sheath color	green	green	purple	dark green	green
Leaf blade color	green	green	purple at margin	green	green
Tiller number	145	77	137	42	66
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	purple	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	23	25	20	15	8
Auricle color	colorless	colorless	purple	light purple	colorless
Number of leaves	6	7	5	4	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	32	57.5	51	38	33
Leaf blade width	1.5	1.5	0.7	0.8	0.8
Flag leaf angle	horizontal	droopy	intermediate	intermediate	horizontal
Flag leaf length	20	34.5	36	28	27
Flag leaf width	1.5	1.8	1	1	0.9
Spikelet color	yellow	straw	straw	straw	straw
Apiculus color	red	red	red	red	colorless
Anther length	1/2 spikelet	full	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	colorless
Stigma exertion	well exerted	Well exerted	exserted	exserted	exserted
Stigma size	big	big	small	small	small
Awned	present	present	nd	present	present
Awn color	colorless	red	colorless	red	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	146	196	115	102	88
Bearing tillers	18	23	58	26	49
Panicle length	25	16.5	20	20	22
Panicle type	open	open	open	open	open
Branching	absent	adsent	adsent	some	intermediate
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	high	low	high	high	high
Hull color	yellow	black	black	black	straw
Grain pubescence	intermediate	intermediate	glabrous	intermediate	intermediate
Panicle base length	22	15	14	12	8
Grain length	8.55	7.75	8.2	8.45	8.21
Grain width	2	2.13	2.41	2.47	2.21
Grain thickness	1.58	1.47	1.64	1.71	1.52
Awn length	5	5.6	9	3.2	6
Sterile lemma length	short	short	short	short	short
100 Grain weight	2.52	1.6	1.7	1.9	2.1
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	stolon

Appendix Table 9 (Continued)

GS.NO.	10598	10604	10605	10606	15136
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	53	95	86	95	76
Culm	decumbent	seminderect	decumbent	decumbent	decumbent
Diameter	3	5	5	5	4
Leaf sheat color	green	green	green	green	purple
Leaf blade color	green	green	green	green	all purple
Tiller number	112	99	59	63	35
Adventitious root	present	present	present	present	absent
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	2 clip
Ligule length	16	31	30	37	19
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	5	5	4	5	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	29	57.5	44	69.5	36
Leaf blade width	1	1.5	1.4	1.8	0.6
Flag leaf angle	intermediate	horizontal	droopy	intermediate	intermediate
Flag leaf length	22	38	27	33.5	20
Flag leaf width	1.1	1.7	1.5	2	0.7
Spikelet color	straw	straw	straw	straw	brown
Apiculus color	colorless	red	dark purple	red	red
Anther length	1/2 spikelet	1/2 spikelet	1/2 spikelet	1/2 spikelet	3/4 spikelet
Stigma color	colorless	black	black	black	black
Stigma exertion	Well exerted	Well exerted	Well exerted	Well exerted	enclosed
Stigma size	big	big	big	big	small
Awned	present	present	present	present	present
Awn color	colorless	colorless	red	red	yellow
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	102	171	131	182	132
Bearing tillers	30	24	10	37	33
Panicle length	18	27.5	14	29	26.5
Panicle type	open	open	open	intermediate	open
Branching	absent	absent	some	intermediate	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	dark brown	black	black	black	dark brown
Grain pubescence	glabrous	intermediate	glabrous	glabrous	glabrous
Panicle base length	20.5	3.5	7.7	7.6	9.8
Grain length	8.42	8.93	8.14	8.14	8
Grain width	2.49	2.5	2.47	2.47	2.16
Grain thickness	1.83	1.76	1.78	1.78	1.68
Awn length	3.5	5	3	2.5	10.5
Sterile lemma length	short	short	short	short	short
100 Grain weight	2.4	2	2.1	1.9	1.72
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	stolon	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	15151	15157	15181	15185	15186
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	79	89	60	51	50
Culm	erect	erect	decumbent	decumbent	decumbent
Diameter	4	7	3	5	4
Leaf sheath color	dark green	purple	dark green	dark green	dark green
Leaf blade color	purple at margin	all purple	purple at margin	dark green	dark green
Tiller number	15	13	37	21	28
Adventitious root	absent	absent	absent	absent	absent
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	2 clip	2 clip	2 clip	2 clip
Ligule length	20	19	17	20	13
Auricle color	colorless	purple	purple	colorless	colorless
Number of leaves	3	4	4	6	7
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	33	46	26	39	42
Leaf blade width	0.7	0.8	0.7	1	1
Flag leaf angle	erect	erect	erect	erect	erect
Flag leaf length	30	23	22	24	24
Flag leaf width	0.7	1	0.8	1	1
Spikelet color	brown	yellow	straw	straw	brown
Apiculus color	red	red	red	red	red
Anther length	1/2 spikelet	1/2 spikelet	3/4 spikelet	1/2 spikelet	3/4 spikelet
Stigma color	purple	purple	black	black	black
Stigma exertion	enclosed	enclosed	exserted	Well exerted	Well exerted
Stigma size	small	small	small	big	big
Awned	present	present	present	present	present
Awn color	red	red	yellow	red	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	85	133	95	130	120
Bearing tillers	13	11	39	15	25
Panicle length	24.5	22.5	20	23	16.5
Panicle type	intermediate	intermediate	intermediate	intermediate	intermediate
Branching	intermediate	intermediate	intermediate	intermediate	intermediate
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	>50%
Shattering	medium	high	high	high	high
Hull color	straw	dark brown	dark brown	dark brown	black
Grain pubescence	glabrous	glabrous	glabrous	glabrous	glabrous
Panicle base length	2	5.8	13	9.5	4.5
Grain length	7.9	8.2	8.81	6.8	7.9
Grain width	2.23	2.1	2.2	2	2.3
Grain thickness	1.82	1.6	1.42	1.58	1.62
Awn length	5.3	11.3	9.5	13	9.5
Sterile lemma length	short	nd	nd	nd	nd
100 Grain weight	1.68	nd	nd	nd	nd
Pericarp color	red	nd	nd	nd	nd
Life span	perennial	nd	nd	nd	nd
Root	stolon	nd	nd	nd	nd

Appendix Table 9 (Continued)

GS.NO.	15187	16115	16116	16132	16139
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	65	80	84	86	52
Culm	decumbent	seminderect	decumbent	decumbent	seminderect
Diameter	3	4	4	6	7
Leaf sheat color	purple	purple	purple	purple	dark green
Leaf blade color	purple at magin	green	purple at magin	purple at magin	dark green
Tiller nimer	28	17	28	17	25
Adventitious root	absent	present	present	present	absent
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	2 clip	clip
Ligule length	18	26	17	26	20
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	7	7	6	9	4
Pubesence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	42	47	48	39	42
Leaf blade width	0.5	0.8	0.9	1	1.2
Flag leaf angle	erect	erect	erect	horizontal	horizontal
Flag leaf length	27	23	32	19	28
Flag leaf width	0.7	1	1	1.1	1.5
Spikelet color	straw	yellow	straw	straw	straw
Apiculus color	red	red	red	red	colorless
Anther length	1/2 spikelet	1/2 spikelet	3/4 spikelet	full	full
Stigma color	black	black	black	black	purple
Stigma exsertion	exserted	enclosed	Well exserted	enclosed	Well exserted
Stigma size	small	small	big	small	small
Awned	present	present	present	present	present
Awn color	red	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	120	151	153	165	160
Bearing tillers	20	16	25	12	24
Panicle length	22	25	31	30	25.2
Panicle type	intermediate	open	intermediate	open	open
Branching	intermediate	some	some	intermediate	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	dark brown	yellow	black	dark brown	black
Grain pubesence	glabrous	intermediate	glabrous	glabrous	glabrous
Panicle base length	19.3	13	22.5	20.5	31.7
Grain length	8.42	6.52	7.98	8.31	7.31
Grain width	2.28	2.34	2.1	2.5	2.25
Grain thickness	1.54	1.6	1.82	7.91	1.98
Awn length	8.2	8.6	12	5	2.2
Sterile lemma length	short	short	short	medium	short
100 Grain weighth	2.6	2.2	2.1	2.01	2
Pericarp color	red	red	white	white	white
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	rhizome	rhizome

Appendix Table 9 (Continued)

GS.NO.	16154	16171	16172	16174	16185
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	77	88	73	102	85
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	5	5	4	4	7
Leaf sheat color	purple	light purple	purple	purple	purple
Leaf blade color	dark green	purple line	dark green	purple at magin	green
Tiller nimer	18	56	20	18	16
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	2 clip	clip	clip	2 clip	2 clip
Ligule length	17	31	15	18	17
Auricle color	colorless	colorless	purple	colorless	colorless
Number of leaves	3	3	4	8	8
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	25	36	45	50	53
Leaf blade width	1	0.8	0.9	0.8	1
Flag leaf angle	intermediate	horizontal	erect	horizontal	erect
Flag leaf length	17	19	39	24	32
Flag leaf width	1	1	1.2	1	1.3
Spikelet color	straw	straw	yellow	straw	straw
Apiculus color	red	colorless	dark purple	red	red
Anther length	1/2 spikelet	1/4 spikelet	1/2 spikelet	1/2 spikelet	full
Stigma color	black	colorless	black	black	black
Stigma exsertion	enclosed	Well exserted	enclosed	exserted	enclosed
Stigma size	small	big	small	small	small
Awned	present	present	present	present	present
Awn color	red	colorless	red	red	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	141	180	112	203	177
Bearing tillers	13	29	19	14	15
Panicle length	23	30	21	27.5	30
Panicle type	intermediate	open	intermediate	intermediate	intermediate
Branching	intermediate	intermediate	intermediate	intermediate	intermediate
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	medium
Hull color	dark brown	black	dark brown	dark brown	dark brown
Grain pubescence	glabrous	intermediate	glabrous	glabrous	intermediate
Panicle base length	14.3	27	6	12	20
Grain length	9.4	9.6	8.7	8.26	13.14
Grain width	2.5	2.26	2.22	2.43	2.6
Grain thickness	1.73	1.62	1.91	1.78	1.52
Awn length	7.1	4	10.3	6.3	9.1
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.5	1.5	1.4	1.6	2.8
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	stolon	stolon	stolon	stolon	rhizome

Appendix Table 9 (Continued)

GS.NO.	16187	16188	16191	16222	16225
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	82	81	70	90	71
Culm	decumbent	seminderect	decumbent	decumbent	decumbent
Diameter	6	5	4	6	6
Leaf sheat color	purple	purple	purple	light purple	light purple
Leaf blade color	green	green	green	green	green
Tiller number	15	25	14	37	37
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	2 clip	2 clip	2 clip	clip	clip
Ligule length	17	13	20	25	25
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	6	8	8	4	4
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	47	35	45.5	40.5	34.5
Leaf blade width	1.2	0.7	1.2	1.1	0.9
Flag leaf angle	intermediate	erect	erect	horizontal	horizontal
Flag leaf length	21	24	28.2	21	21
Flag leaf width	1.1	1	1.3	1.4	1
Spikelet color	straw	straw	straw	straw	straw
Apiculus color	red	red	colorless	red	colorless
Anther length	full	1/2 spikelet	full	3/4 spikelet	1/4 spikelet
Stigma color	black	colorless	colorless	black	black
Stigma exertion	exserted	enclosed	enclosed	exserted	Well exerted
Stigma size	small	small	small	small	big
Awned	present	present	present	present	present
Awn color	red	colorless	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	169	127	180	117	160
Bearing tillers	14	13	12	20	12
Panicle length	29.3	23.2	33.2	24	25
Panicle type	intermediate	intermediate	open	open	open
Branching	intermediate	some	intermediate	absent	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	medium	medium	hight	hight	hight
Hull color	dark brown	black	black	black	dark brown
Grain pubescence	intermediate	intermediate	intermediate	glabrous	glabrous
Panicle base length	20	16.4	12.5	17.5	1.89
Grain length	12.65	12.61	10.82	9.59	8.64
Grain width	2.24	2.58	2.76	2.24	2.48
Grain thickness	1.78	1.81	1.72	1.8	1.82
Awn length	8.3	6.8	10	7	7
Sterile lemma length	short	short	short	short	short
100 Grain weight	2.43	2.12	2.41	1.3	1.2
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	rhizome	rhizome	rhizome	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	16226	16227	18155	18156	18227
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	60	56	34	36	70
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	5	6	3	4	4
Leaf sheat color	light purple	light purple	purple	purple	purple
Leaf blade color	purple line	purple line	dark green	purple at magin	purple at magin
Tiller nimer	45	21	67	6	22
Adventitious root	present	present	present	absent	present
Ligule color	colorless	colorless	colorless	purple	purple
Ligule shape	clip	clip	clip	2 clip	2 clip
Ligule length	15	13	15	11	22
Auricle color	colorless	colorless	purple	purple	colorless
Number of leaves	3	4	4	4	7
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	47	45.5	27	43	34
Leaf blade width	1.1	0.9	0.6	0.6	0.5
Flag leaf angle	horizontal	horizontal	intermediate	horizontal	erect
Flag leaf length	25	26.5	18	21.5	19
Flag leaf width	1.4	1.2	0.7	0.7	0.7
Spikelet color	straw	straw	straw	red	yellow
Apiculus color	red	colorless	red	red	red
Anther length	3/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	full
Stigma color	black	black	black	purple	black
Stigma exsertion	exserted	exserted	exserted	exserted	Well exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	red	colorless	red	red	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	155	128	50	77	170
Bearing tillers	19	26	33	2	13
Panicle length	25	23	11	15	28.5
Panicle type	open	open	intermediate	intermediate	open
Branching	some	some	absent	some	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	dark brown	black	dark brown	nb	dark brown
Grain pubescence	glabrous	glabrous	intermediate	intermediate	intermediate
Panicle base length	14.5	17	15.4	18	17.5
Grain length	8.91	9.14	8.84	7.92	8.21
Grain width	2.31	2.42	2.46	2.14	2.21
Grain thickness	1.71	1.9	1.8	1.81	1.92
Awn length	5.5	9	6.5	7.4	10
Sterile lemma length	short	short	short	short	short
100 Grain weigth	1.6	1.4	2.1	2.2	1.9
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	stolon	stolon	stolon	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	18246	18282	18283	18295	18297
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	95	63	35	76	61
Culm	seminderect	seminderect	decumbent	decumbent	decumbent
Diameter	6	6	5	5	6
Leaf sheat color	green	light purple	purple	light purple	dark green
Leaf blade color	green	purple line	purple at magin	purple line	dark green
Tiller nimber	43	34	13	82	60
Adventitious root	present	present	absent	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	2 clip	clip	clip
Ligule length	13	19	8	10	17
Auricle color	colorless	purple	colorless	purple	purple
Number of leaves	3	3	4	4	3
Pubesence	pubescent	intermediate	intermediate	intermediate	intermediate
Leaf blade length	52	40	17.7	17	42
Leaf blade width	1	1.3	0.6	0.7	0.8
Flag leaf angle	intermediate	droopy	intermediate	horizontal	horizontal
Flag leaf length	41	26	12	13	24
Flag leaf width	1.5	1.4	0.6	0.8	0.9
Spikelet color	straw	yellow	yellow	straw	straw
Apiculus color	colorless	red	red	red	red
Anther length	3/4 spikelet	3/4 spikelet	1/2 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	colorless	black	black	colorless	black
Stigma exsertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	absent	present	present	present	present
Awn color	colorless	colorless	colorless	colorless	red
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	174	133	59	115	80
Bearing tillers	29	23	10	43	28
Panicle length	39	23	13	17	18
Panicle type	open	open	intermediate	open	intermediate
Branching	some	absent	some	absent	absent
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	black	dark brown	straw	dark brown
Grain pubesence	intermediate	glabrous	intermediate	glabrous	intermediate
Panicle base length	7.5	14	6.2	12.18	13.5
Grain length	8.4	7.9	7.72	9.14	9.2
Grain width	2.68	2.9	2.01	2.71	2.62
Grain thickness	1.81	1.84	1.4	1.72	1.65
Awn length	11	6.5	7	5.5	7.5
Sterile lemma length	short	short	short	short	short
100 Grain weigth	2.4	1.4	1.8	1.5	1.7
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	annual
Root	stolon	stolon	stolon	stolon	rhizome

Appendix Table 9 (Continued)

GS.NO.	18298	18303	18304	18305	18306
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	71	44	47	40	53
Culm	decumbent	decumbent	nd	decumbent	decumbent
Diameter	5	4	4	5	5
Leaf sheath color	light purple	dark green	dark green	dark green	dark green
Leaf blade color	purple line	green	green	dark green	green
Tiller number	67	52	60	68	60
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	truncate	clip	clip	clip	clip
Ligule length	8	18	14	14	13
Auricle color	colorless	purple	colorless	purple	colorless
Number of leaves	3	3	3	3	3
Pubescence	intermediate	intermediate	intermediate	intermediate	intermediate
Leaf blade length	22	29	24	20	29
Leaf blade width	0.7	0.8	0.8	0.6	0.7
Flag leaf angle	horizontal	horizontal	erect	erect	horizontal
Flag leaf length	16	26.6	16.5	14	22
Flag leaf width	0.7	0.9	0.9	0.6	0.8
Spikelet color	brown	straw	straw	straw	straw
Apiculus color	red	dark purple	red	red	red
Anther length	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet
Stigma color	black	black	black	black	black
Stigma exertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	colorless	colorless	red	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	143	75	79	69	68
Bearing tillers	43	40	18	40	41
Panicle length	16	18	18	17	17
Panicle type	open	open	intermediate	intermediate	intermediate
Branching	some	absent	absent	absent	absent
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	dark brown	dark brown	dark brown	black
Grain pubescence	glabrous	intermediate	intermediate	intermediate	intermediate
Panicle base length	11	7.5	5.5	9	10.4
Grain length	9.4	7.1	7.4	6.82	9.39
Grain width	2.41	1.58	1.41	1.31	1.65
Grain thickness	1.92	1.4	1.42	1.16	0.94
Awn length	6	4.5	8	10	8.5
Sterile lemma length	short	short	short	short	short
100 Grain weight	1.7	1.6	1.6	1.8	1.8
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	annual	annual	annual
Root	stolon	rhizome	rhizome	rhizome	stolon

Appendix Table 9 (Continued)

GS.NO.	18311	18313	18318	18322	18337
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	57	45	58	110	88
Culm	decumbent	decumbent	decumbent	erect	seminderect
Diameter	4	4	4	5	5
Leaf sheath color	green	dark green	light purple	green	green
Leaf blade color	green	dark green	purple line	green	green
Tiller number	33	60	160	26	68
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	12	16	12	17	17
Auricle color	colorless	purple	purple	colorless	colorless
Number of leaves	3	3	3	4	4
Pubescence	intermediate	intermediate	intermediate	intermediate	pubescent
Leaf blade length	45	42	45.5	45	29
Leaf blade width	1	0.8	1	1.2	0.8
Flag leaf angle	horizontal	intermediate	horizontal	intermediate	intermediate
Flag leaf length	16	30	29.5	27	19
Flag leaf width	1.1	0.9	1	1.3	1
Spikelet color	straw	straw	straw	brown	straw
Apiculus color	red	dark purple	red	colorless	colorless
Anther length	1/2 spikelet	1/4 spikelet	1/4 spikelet	1/4 spikelet	1/2 spikelet
Stigma color	black	black	black	colorless	colorless
Stigma exertion	Well exerted	exserted	exserted	exserted	exserted
Stigma size	big	small	small	small	small
Awned	present	present	present	present	present
Awn color	colorless	red	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	120	62	74	205	160
Bearing tillers	15	38	45	18	30
Panicle length	27	14	19	23	25
Panicle type	open	intermediate	open	intermediate	open
Branching	some	absent	some	some	some
Fertility	0nd50%	0nd50%	0nd50%	>50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	dark brown	dark brown	dark brown	black
Grain pubescence	intermediate	intermediate	glabrous	glabrous	intermediate
Panicle base length	11.5	13.5	14.5	20	18.5
Grain length	10.45	9.25	7.6	8.4	8.6
Grain width	2.38	1.74	2.6	2.7	2.5
Grain thickness	1.67	1.82	1.8	1.9	1.8
Awn length	7.5	7	6	9.5	6
Sterile lemma length	short	short	short	short	short
100 Grain weight	1.6	1.5	1.8	1.6	1.8
Pericarp color	red	red	red	red	red
Life span	perienial	annual	annual	perienial	perienial
Root	stolon	rhizome	rhizome	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	18343	18383	18384	18385	18386
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	65	84	50	71	83
Culm	seminderect	decumbent	decumbent	decumbent	decumbent
Diameter	5	6	5	6	4
Leaf sheat color	light purple	light purple	purple	green	green
Leaf blade color	purple line	green	purple line	green	green
Tiller number	112	37	32	14	38
Adventitious root	present	present	present	present	present
Ligule color	colorless	colorless	colorless	colorless	colorless
Ligule shape	clip	clip	clip	clip	clip
Ligule length	15	22	30	22	22
Auricle color	colorless	colorless	colorless	colorless	colorless
Number of leaves	3	4	3	4	3
Pubescence	intermediate	intermediate	intermediate	intermediate	pubescent
Leaf blade length	29	31	23	29	37
Leaf blade width	1	1	1	1.2	1.3
Flag leaf angle	horizontal	horizontal	droopy	intermediate	intermediate
Flag leaf length	22	14	13	20	24
Flag leaf width	1.1	1	1.4	1	1.5
Spikelet color	straw	straw	straw	straw	brown
Apiculus color	red	red	red	red	colorless
Anther length	1/4 spikelet	3/4 spikelet	3/4 spikelet	3/4 spikelet	3/4 spikelet
Stigma color	black	colorless	black	colorless	black
Stigma exertion	exserted	exserted	exserted	exserted	exserted
Stigma size	small	small	small	small	big
Awned	present	present	present	present	present
Awn color	colorless	colorless	colorless	colorless	colorless
Sterile lemma	colorless	colorless	colorless	colorless	colorless
Plant height	103	190	98	137	165
Bearing tillers	60	20	22	7	36
Panicle length	20	30	23	22	30
Panicle type	open	open	open	open	open
Branching	some	some	some	some	some
Fertility	0nd50%	0nd50%	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	hight	hight	hight
Hull color	black	black	black	black	black
Grain pubescence	glabrous	intermediate	intermediate	intermediate	intermediate
Panicle base length	17	15	21.5	26	16
Grain length	7.95	8.24	9.16	10.12	9.96
Grain width	2.65	2.52	2.48	2.45	2.45
Grain thickness	1.83	1.91	1.62	1.74	1.89
Awn length	7	4.5	6.5	5.5	11
Sterile lemma length	short	short	short	short	short
100 Grain weighth	2.4	1.7	1.3	1.4	1.7
Pericarp color	red	red	red	red	red
Life span	perienial	perienial	perienial	perienial	perienial
Root	stolon	stolon	stolon	stolon	stolon

Appendix Table 9 (Continued)

GS.NO.	18387	18884	18887
Species name	<i>O. rufipogon</i>	<i>O. rufipogon</i>	<i>O. rufipogon</i>
Height	87	110	97
Culm	seminderect	seminderect	erect
Diameter	6	7	6
Leaf sheat color	light purple	green	purple
Leaf blade color	purple line	green	green
Tiller nimber	30	23	13
Adventitious root	present	present	absent
Ligule color	colorless	colorless	colorless
Ligule shape	clip	2 clip	clip
Ligule length	16	23	18
Auricle color	colorless	colorless	purple
Number of leaves	3	3	6
Pubesence	pubescent	intermediate	intermediate
Leaf blade length	24	62	47
Leaf blade width	1.1	0.9	0.9
Flag leaf angle	intermediate	intermediate	erect
Flag leaf length	16	54	33.3
Flag leaf width	1.3	1.1	1
Spikelet color	straw	straw	straw
Apiculus color	colorless	colorless	red
Anther length	3/4 spikelet	3/4 spikelet	3/4 spikelet
Stigma color	black	colorless	black
Stigma exsertion	Well exserted	enclosed	exserted
Stigma size	big	small	small
Awned	present	present	present
Awn color	colorless	colorless	red
Sterile lemma	colorless	colorless	colorless
Plant height	167	132	178
Bearing tillers	25	20	12
Panicle length	28	32	26
Panicle type	open	open	open
Branching	some	some	intermediate
Fertility	0nd50%	0nd50%	0nd50%
Shattering	hight	hight	low
Hull color	black	dark brown	dark brown
Grain pubesence	intermediate	glabrous	intermediate
Panicle base length	21.5	16.2	11.8
Grain length	9.54	10.35	9.82
Grain width	2.4	2.58	2.26
Grain thickness	1.98	1.85	2.01
Awn length	9	5.2	8
Sterile lemma length	short	short	short
100 Grain weigth	1.7	1.7	1.69
Pericarp color	red	red	red
Life span	perienial	perienial	perienial
Root	stolon	stolon	stolon