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Screening of some rice genotypes for aerobic condition in Northeast India

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Abstract
In an experiment conducted during 2015-2016, about 150 rice genotypes from different ecotypes were collected and screened for drought response. Out of 150 genotypes, some genotypes showed tolerance under drought condition. The genotypes were grouped into three numbers *viz.* highly tolerant (HT, survive 25-37 DAS), medium tolerant (MT, 20-24 DAS), susceptible (ST, 10-19 DAS) based on germination, survival and growth from days of sowing. After screening, five genotypes *viz.* Banglami, Inglongkiri, Boga ahu, Ronga ahu, and Bengungutia ahu were selected and evaluated to understand the mechanism of tolerance under aerobic and normal condition by comparing with aerobic rice variety CR Dhan. Some genotypes *viz.* Ronga ahu, Inglongkiri and Banglami recorded higher seedling vigour index (SVI), therefore seed of those genotypes easily survived for even 30-35 days under aerobic condition. Thus identification of long-coleoptile trait in rice may improve seedling establishment and yield stability of the rice under aerobic condition in farmers' field. Such genotypes may be used for future breeding material for moisture stress condition.

Keywords: Aerobic, coleoptile, genotypes, rice, survivability and vigour

Introduction
Water shortage is a crucial yield constraint of rice in rainfed low land areas of India. According to Tuong and Bouman (2002) [26], 15 out of 75 million hectares of Asia's flood-irrigated rice will experience water scarcity by 2025. Rice calls for approximately 3000-5000 litres of water to grow one kilogram of rice historically (Joshi *et al*., 2009) [13]. Consequently, there is an urgency to develop system that needs less water for rice cultivation. Aerobic rice cultivation is a new technology which reduces the water input in rice cultivation by reducing water loss due to seepage and percolation and needs almost 50% lesser water than the lowland rice (Vijayakumar *et al*., 2006) [28]. However, there may be need for further research for identification of genotypes particularly for aerobic condition. Accordingly, since 1980, China started some programme for development of aerobic rice variety and new variety such as HD 277, HD 297 and HD 502 rereleased and similarly, IRRI also identified variety like APO and CT 6510-24-1-2 which perform well under aerobic condition.

Uneven rainfall is nowadays a common phenomenon worldwide and almost 25% of the world's rice is grown under rainfed lowland and is frequently affected by moisture stress during the growing season (Bouman *et al*., 2007) [5]. Because of threatened sustainability of the irrigated lowland due to water deficit, it has encouraged researches on the development and identification of water use efficient aerobic rice varieties. Combining high yielding traits of lowland varieties with drought resistant characteristic of upland varieties (Belder *et al*., 2005) [2] is now new area of research. Therefore, numerous water saving cultivation strategies were advanced to deal with water shortage, together with the distinctly new aerobic rice cultivation approach where rice is grown in non-puddle and non-saturated soil (Bouman, 2001 and Bouman *et al*., 2005) [6, 7], which may helps to store water with the aid of minimizing seepage, percolation and evaporation (Bouman *et al*., 2007) [5]. Moreover aerobic rice genotypes can also develop with less lodging, responsiveness and tolerance to occasional flooding (Bouman, 2001; Laffite *et al*., 2002 and Sashidar *et al*., 2007) [6, 16, 23].

Upland rice (broadcasted summer season rice) is the second predominant critical rice of Assam, which offers the buffer stock of food grain and fodder in the course of the length of flood or post flood. It covers an area of fifty four million hectares and has a productivity only

0.75 t/ha. Low productivity of upland rice is mainly because of low soil moisture throughout germination and intermittent moisture stress during panicle initiation which is a common problem in upland rice (Goswami, 1991; Kalita, 1996) [10, 14]. So identification or development of line from existing one is an important task for sustainable production and food security for such situation for near future. Traditional rice genotypes of N. E. India are reported to have many valuable genes possessing resistance to biotic and abiotic stresses and they do have unique qualities and plant architecture to fit the unfavourable condition (Singh *et al*., 2000) [24]. So, it is necessary to screen out the line which helps to menace such situation.

Based on this hypothesis the main objective of this study was to identify some lines from traditional one which are able to thrive under low moisture. The identified line might be used not only for farmers practice but also for breeding materials for future variety development programme.

Materials and Methods

The present experiment was carried out during Rabi season in the year 2015-2016 at the experimental field and laboratory, Department of Crop Physiology, Assam Agricultural University, Jorhat-13.

Plant material

About 150 rice genotypes were collected from various ecosystem of Northeast region of Assam Agricultural University and were screened for low moisture stress tolerance by Screening Evaluation Score (SES), method developed IRRI, Philippines (Anonymous, 1996).

Growing condition for evaluation

About 150 numbers of rice (*Oryza sativa* L) line of different adaptation and of similar growth duration were used for study under simulated condition as per method of Pieters and Souki (2005) and Kato and Okami (2011) with slight modification. Seeds were soaked in water for 24 h at 30°C, incubated for another 24 h in petri-dishes, and then sown in plastic glass. Fine and sterilized field soil and the plastic glasses of 8 cm diameter & 10 cm height were used for SES test.

The glasses were filled with a mixture of soil and organic matter (50: 50). Then 30 sterilized, uniform and healthy seeds were sown in each glass. The glasses were kept inside temperature gradient tunnel (TGT) maintaining a uniform temperature at 30ºC for 15 days withholding of water. Small amount of water was sprinkled on each glass as life saving irrigation (8 days after sowing). Genotypes were screened out under the above simulated moisture stress condition for studying the drought recovery and tolerant ability of the lines using SES scoring as described by IRRI (1984). After screening, potential germplasms were designated as plant material for aerobic condition and that was further evaluated by studying the Seedling Vigour Index (SVI) and coleoptile length. Here, seeds of screened genotypes were shown under 7-8% of moisture condition and then compared with national check variety CR dhan, a variety from ICAR-National Rice Research Institute, Cuttack, India and coleoptile length was measured as the length of first leaf of the emerged seedlings at 7 days after sowing. The length was measured in five randomly selected seedlings and the average value was recorded and expressed in cm.

Five numbers of seedlings from each genotype and each treatment were carefully uprooted with minimum root damage ten days after sowing and brought to the laboratory after proper labelling. Seedlings were washed in tap water and their root length and shoot length were measured with the help of measuring scale. The average total length (root length + shoot length) of five seedlings were then multiplied with their germination (emergence) percentage to get seedling vigour index.

Seedling vigour index=Germination % X Total length of seedling

Result and Discussion

During the screening some important character were taken into consideration for evaluation of genotypes under moisture stress situation *viz*. Days taken to Leaves start to fold (Days), leaves rolling due to v shaped (Days), Leaves margin developed to O shaped (Days), Leaves rolling to U shaped (Days), Leaves fully rolled (Days), Slight tip drying (Days), Tip drying extend to ¼(Days), ¼ to 1/5 of leave fully dried(Days), more than 2/3 rd of leave fully dried(Days) and Whole pant die (Days).

After completion of record, data set were generated and genotypes were grouped as tolerant, moderately tolerant and susceptible with characteristics of symptoms developed at days after sowing in tabulated from (Table No. 1). Results revealed that, out of total 150 genotypes, 9 genotypes were designated as highly tolerant, 72 as Medium tolerant and 69 as susceptible genotypes based on survivality and summarized in Table. 2

Results and Discussion

Variation in coleoptile length (cm) of different rice genotypes in two different situations

The result presented in Table 3 revealed a significant reduction (38.46%) in coleoptiles length under aerobic condition compared to normal rice. Among the genotypes, the lowest coleoptiles length was recorded in Boga ahu (0.20cm). There was a significant variation in coleoptile length due to interaction. In aerobic condition highest coleoptile length (0.61cm) was recorded in Ronga ahu followed by Banglami (0.51cm) indicating a significant variability amongst the genotypes. Considerable variation exists among rice genotypes in coleoptile extension during anoxia were also reported by Setter *et al.*, 1994, Ogiwara and Terashima, 2001 [19]; Bosetti *et al.*, 2012. Some other workers found that there was a direct co-relation between seedling establishment and coleoptile length. The genotypes that had ability for rapid enlongation of coleoptile under low O2 might influence good crop establishment since coleoptile extension plays a key role in enabling the seedlings to make contact with the atmosphere and thus to gain access to O_2 (Huang *et al*., 2003) [11]. Rice is one of the important cereals whose seeds can germinate and whose coleoptiles can elongate under flooded situations (Kato Noguchi *et al.*, 2011) [15]. Hence, coleoptile elongation is a prerequisite for the seedling establishment of direct-sown rice in submerged or hypoxic conditions.

But, Jackson and Ram (2003) [12] opined that, there is a negative correlation between elongation under water and survival, because the metabolic costs of rapid elongation shorten survival times by competing with cell maintenance processes for limited energy. Coleoptile and mesocotyl are considered important structure in rice involving in seedling emergence. Main role of coleoptile and/or mesocotyl elongation help to projects the seedling tip out of the soil and water after germination and allow leaves to make contact with atmosphere. This process enables seedling to develop into a normal rice plant. Turner *et al*., (1981) [28] and Dilday *et al*.

(1988) [8] also reported that combined force associated with coleoptile and mesocotyl elongation is essential for successful seedling emergence. According to them, seedlings with long coleoptiles and mesocotyls may be able to emerge through the soil better than those with short ones. Genotypes which have longer coleoptiles and or mesocotyls are thought to emerge better than those with shorter ones. From our current study it is clear that genotypes *viz*. Banglami, Inglongkiri and Ronga Ahu maintained longer coleoptile and which might have helped in seedling emergence and have been attributed through higher SVI in these particular variety as compared to other. Under field conditions, elongation of the mesocotyl elevates the coleoptile to a point within a few millimetres of the soil surface. Alibu *et al.* (2011) [1] also reported that coleoptile extends outwards, making contact with the atmosphere and allows the primary leaves to emerge in rice, however, coleoptile and mesocotyl lengths are genetically controlled, but coleoptile and mesocotyl elongation are influenced by seeding depth and environmental factors (Turner *et al*., 1982) [27].

Variation in seedling vigour index (%) of different rice genotypes in two different situations

Our data revealed a significant reduction in SVI in aerobic rice (28.81%) than the normal rice cultivation (Table.4). Highest reduction in SVI was found in Bengungutia ahu (46.93%) followed by Boga ahu (44.07%) while the lowest reduction was found in Ronga ahu (12.29%). Under aerobic condition, the interaction effects of treatment and genotype revealed highest SVI in Inglongkiri (701.53%) followed by Banglami (657.12%) whereas lowest was recorded in Bengungutia ahu (405.85%) followed by Boga Ahu (442.38%) indicating some adaptation by Inglongkiri and Banglami under aerobic situation.

Another important trait for aerobic germination is SVI which have been identified as a good indicator of seed vigour and viability (Regan *et al*, 1992; Redonˇa, 1962) [21] and which ultimately helps in crop establishment in early stages of growth in aerobic condition. Sun *et al*. (2007) [25] reported that seed lot showing the higher seed vigour index (SVI) is considered to be more vigorous, reflecting characteristic of seed quality, seedling growth, seed longevity, and tolerance to adversity. Similarly, Foolad *et al.* (2007) [9] also reported that high SVI lead to perfect field emergence, good crop performance, and even high yield under different conditions.

In the present investigation, we have noticed that, seeds of some genotypes *viz*. Ronga ahu, Inglongkiri and Banglami seeds had strong vigour therefore seed of those genotypes easily survived for even 30-35 days. This might be due to the speed and uniformity of seed germination which may be attributed to higher final percentage of germination and better root and shoot growth that may collectively be expressed as SVI under aerobic condition. Identification of the long-coleoptile trait in rice may improve seedling establishment and yield stability of the rice under aerobic condition in farmers' field and may be used for future breeding material for moisture stress condition.

Table 1: Grouping as per survibiility

Group	Days	Remark
highly tolerant (HT)	25-37	Survive
Medium tolerant (MT)	20-24	Survive
Susceptible (ST)	10-19	Dried

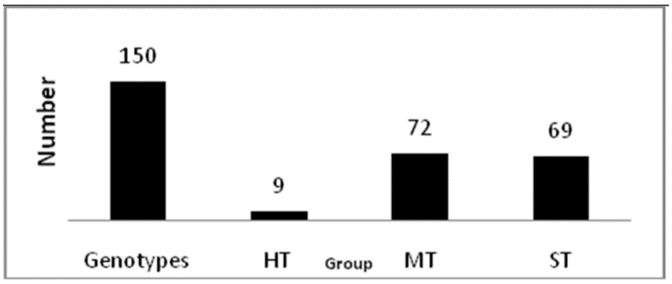

Fig 1: Highly tolerant genotypes can survive

Table 2: Variation in coleoptile length (cm) of different rice genotypes in two different situations

Treatment	Banglami	Inglongkiri	Boga ahu	Ronga ahu	CR Dhan	Bengungutia ahu	Mean
Normal	0.69	0.66	0.59	0.67	0.63	0.67	0.65
Aerobic	0.53	0.48	0.20	0.61	0.27	0.28	0.40
Mean	0.61	0.57	0.40	0.64	0.45	0.48	
	S Ed ±			CD (0.05%)			
T	0.04			0.08			
V	0.06			0.13			
T X V	0.07			0.15			

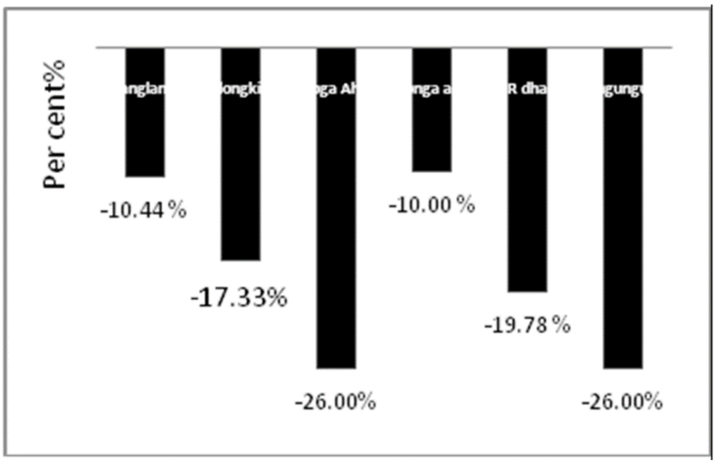

Fig 2: Percent decrease of coleoptile length (cm) due to interaction

Table 3: Variation in seedling vigour index (%) of different rice genotypes in two different situations

Treatment	Banglami	Inglongkiri	Boga ahu	Ronga ahu	CR Dhan	Bengungutia ahu	Mean
Normal	837.69	843.67	790.96	795.71	776.36	764.76	801.53
Aerobic	657.12	701.53	442.38	697.88	518.67	405.85	570.57
Mean	747.41	772.60	616.67	746.80	647.52	585.31	
	S Ed ±			CD (0.05%)			
T	17.89			37.60			
V	30.66			65.34			
T X V	33.58			71.54			

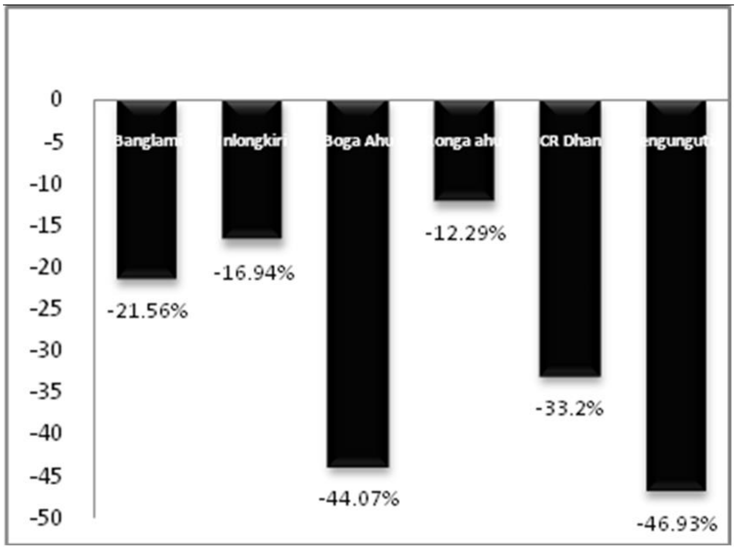

Fig 3: Percent decrease of coleoptile length (cm) due to interaction

Table 4: Screening different line under moisture stress situation

			Leaf rolling						Other symptoms						
Sl. No.	Genotypes / line /cultivar	Place From Where collect	Healthy (Days)	Leaves start to fold (Days)	Leaves rolling due to v shaped (Days)	Leaves margin (o shaped) (Days)	Leaves rolling (U shaped) (Days)	Leaves fully rolled (Days)	No symptoms	Slight tip drying (Days)	Tip drying extend to ¼ (Days)	¼ to 1/5 of leave fully dried (Days)	More than 2/3 rd of leave fully dried(ys)	Whole pant die (Days)	Remarks
			0	1	3	5	7	9	0	1	3	5	7	8	
1	Nolsuti Sali	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
2	Kuluri Sali	Dhemaji	3	5	7	-	-	-	4	8	10	12	14	16	ST
3	kunti Sali	Dhemaji	2	4	6	-	-	-	5	8	10	12	14	16	ST
4	Tarabali	Dhemaji	4	6	8	10	-	-	7	9	14	16	18	20	MT
5	Boga ahu	Dhemaji	7	12	15	18	21	24	26	28	29	30	32	35	HT
6	Boga joha	Nalbari	2	3	6	-	-	-	4	8	10	12	14	16	ST
7	Mala Boga	Jorhat	2	5	6	-	-	-	6	8	10	12	14	16	ST
8	Soklanglu	Diphu	4	6	8	10	-	-	7	9	14	16	18	19	MT
9	Mulviya	Pachighat	5	9	11	15	16	17	19	25	27	28	30	31	HT
10	Senikumal Sali	Dhemaji	4	6	7	9	-	-	7	9	14	16	17	18	MT
11	soksu bijuri	Diphu	4	5	8	9	-	-	5	9	13	16	18	20	MT
12	M. longpi	Diphu	7	11	12	17 dys	19	20	21	23	24	27	29	30	HT
13	Sokmiri	Diphu	4	6	7	9	-	-	7	9	14	16	18	20	MT
14	Biria bhonga	Dhemaji	4	5	8	9	-	-	7	9	14	16	18	19	MT
15	Kalia jira	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	15	ST
16	Bengunguti	Dhemaji	8	14	16	18	21	24	26	28	29	31	34	35	HT
17	Badam bao	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	15	ST
18	Hamsek	Pachighat	4	6	7	-	-	-	4	8	11	12	14	16	ST
19	Dubri Bao	Dhemaji	4	6	7	-	-	-	6	8	10	12	14	16	ST
20	Karjorgker	Diphu	4	6	8	10	-	17	7	9	14	16	18	21	MT
21	Bali Bao	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	17	ST
22	Ijung	Dhemaji	5	6	7	9	-	-	7	9	14	16	17	17	MT
23	Huwakmoni	Dhemaji	4	6	8	9	-	-	7	9	14	16	18	21	MT
24	Ronga Sali	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	15	ST
25	Bor joha	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	17	ST
26	Sina mashuri	Jorhat	4	6	7	-	-	-	4	8	10	12	13	14	ST
27	Kokuwa Bao	Dhemaji	4	6	7	-	-	-	6	8	10	12	14	16	ST
28	Soku Bora	Diphu	3	5	7	-	-	-	5	8	10	12	14	16	ST
29	Amna Bao	Dhemaji	3	5	7	-	-	-	4	8	10	12	14	16	ST
30	Gomiri Sali	Dhemaji	4	6	7	-	-	-	4	8	11	12	14	16	ST
31	Hur	Pachighat	4	6	8	10	-	18	7	9	14	16	18	21	MT
32	Ranga Sali	Dhemaji	4	5	7	-	-	-	4	8	10	12	14	16	ST
33	Jania	Dhemaji	4	6	8	9	-	-	7	9	14	16	18	19	MT
34	Adolia	Dhemaji	4	6	8	10	-	-	7	9	14	16	18	20	MT
35	Negeri Bao	Dhemaji	4	5	8	-	-	-	4	8	10	12	14	16	ST
36	Super	Dhemaji	4	6	7	-	-	-	5	8	9	12	14	16	ST
37	Boka	Nalbari	4	6	7	-	-	-	4	8	10	12	14	16	ST

38	Gudmoni	Gossaigaon	4	6	8	10	-	16	7	9	14	16	18	19	MT
39	Sokjarman	Diphu	4	7	9	9	-	-	7	9	14	16	18	21	MT
40	Kunkuni joha	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
41	Pakuni Bora	Dhemaji	3	5	6	-	-	-	4	8	10	12	14	15	ST
42	Jol Bao	Dhemaji	4	6	7	-	-	-	5	8	10	12	14	16	ST
43	Joldubi	Dhemaji	3	6	8	-	-	-	5	8	10	11	12	13	ST
44	Happy bao	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
45	Lao dubi	Dhemaji	4	6	8	-	-	-	5	8	11	12	15	16	ST
46	Borjahinga	Dhemaji	4	6	7	-	-	-	4	8	11	12	14	16	ST
47	Banni	Nalbari	4	6	8	9	-	-	7	9	14	16	17	18	MT
48	Amena	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
49	Dekhu	Pashighat	4	6	7	10	-	17	7	9	14	16	18	19	MT
50	Kula bora	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
51	soru jahinga	Dhemaji	4	6	8	9	-	-	7	9	14	16	18	18	MT
52	Biyoi bao	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
53	Joha dhan	Dhemaji	4	6	7	-	-	-	5	8	10	12	13	15	ST
54	Kulamoni bao	Dhemaji	5	6	8	-	-	-	4	8	9	12	14	16	ST
55	soru sikra	Dhemaji	4	6	7	-	-	-	4	8	9	12	15	16	ST
56	Sticky rice	Dhemaji	3	6	8	-	-	-	5	8	9	12	14	16	ST
57	Phulphaki	Dhemaji	4	6	8	-	-	-	5	8	10	12	13	15	ST
58	Bogi Sali	Dhemaji	4	6	7	-	-	-	5	8	10	12	14	16	ST
59	Ammo	Pachighat	5	6	8	-	-	-	4	8	10	12	13	14	ST
60	Dilu Sali	Dhemaji	4	6	7	-	-	-	4	8	11	12	14	16	ST
61	Lothuwa	Dhemaji	4	6	7	10	-	-	7	9	14	16	18	20	MT
62	Amphaki	Dhemaji	3	5	7	-	-	-	4	8	10	12	13	15	ST
63	Ampatti	Dhemaji	4	6	8	10	-	-	7	9	14	16	18	20	MT
64	Banglami	Gossaigaon	8	10	13	15	19	23	16	18	19	21	24	29	HT
65	Bas dhan	Dhemaji	3	5	8	10	-	-	7	9	14	16	18	20	MT
66	Sokpi	Diphu	4	6	8	10	-	-	7	9	14	16	18	20	MT
67	Ronga ahu	Dhemaji	7	12	15	18	21	24	26	28	29	30	31	36	HT
68	Inglongkiri	Diphu	7	12	15	18	21	24	26	28	29	30	31	33	HT
69	Naga Bora	Diphu	4	6	7	-	-	-	4	8	10	12	13	14	ST
70	Bali lahi	Dhemaji	3	5	7	-	-	-	4	8	10	12	14	16	ST
71	Taiyai longpi	Nagaland	4	6	8	10	-	-	7	10	15	16	18	19	MT
72	Tsungiki	Nagaland	3	6	7	9	-	-	6	9	14	16	17	20	MT
73	Sticky choupi	Nagaland	4	6	8	9	-	-	7	9	15	16	18	20	MT
74	Singda Maa	Nagaland	8	10	13	15	19	23	16	18	19	21	24	30	HT
75	Malokeen	Nagaland	4	6	8	10	-	-	7	9	14	16	18	20	MT
76	khangsa longpi	Nagaland	4	6	8	10	-	-	6	9	15	16	18	19	MT
77	Longpi makka	Nagaland	4	6	8	10	-	-	7	10	14	16	18	20	MT
78	Honey maa	Manipur	3	5	7	9	-	18	6	9	14	16	18	19	MT
79	Tsungikiri	Manipur	4	6	8	10	-	-	7	11	13	16	18	20	MT
80	Longpi Mokra	Manipur	4	7	8	9	-	-	6	9	13	16	18	19	MT
81	Lemonphou	Manipur	3	6	8	9	-	-	7	9	13	16	18	20	MT
82	Phougak	Manipur	4	5	8	10	-	-	6	9	14	15	18	20	MT
83	Akhanphou	Manipur	4	6	8	9	-	-	7	9	14	16	17	18	MT
84	Dehangi	Jorhat	4	6	8	10	-	17	7	9	14	16	18	20	MT
85	Khalsa bao	Dhemaji	3	5	8	-	-	-	4	8	10	12	12	13	ST
86	Panisali	Jorhat	4	6	7	-	-	-	4	8	10	12	14	16	ST
87	IR.504.04	Vietnum	4	6	8	10	-	-	6	10	14	16	18	20	MT
88	OM 7347	Vietnum	4	6	8	10	-	16	7	9	13	16	18	21	MT
89	OM5451	Vietnum	3	6	8	9	-	-	6	9	13	15	18	22	MT
90	Keh tulu	Manipur	4	6	8	10	-	-	7	11	14	16	18	19	MT
91	Thoibi	Manipur	3	6	8	9	-	18	4	9	12	16	17	20	MT
92	Athebu	Manipur	4	5	9	10	-	-	7	10	14	15	16	19	MT
93	Charvum Rice	Manipur	4	6	8	10	-	-	7	11	14	16	18	20	MT
94	Asi arik	Pachighat	4	6	9	9	-	-	7	9	13	16	18	20	MT
95	Asi amkel	Pachighat	5	6	8	9	-	-	5	10	14	16	17	19	MT
96	Keh lieh	Manipur	4	6	8	10	-	18	7	9	12	14	18	20	MT
97	Bira -2	Pachighat	3	6	8	10	-	-	6	9	14	16	18	20	MT
98	Namidrumphou	Manipur	4	6	8	10	-	18	7	9	14	16	17	21	MT
99	Keh jijiko	Manipur	4	6	7	9	-	-	7	9	13	16	18	20	MT
100	Tatki	Pachighat	4	5	8	9	-	19	7	9	14	16	18	19	MT
101	Amoamkel	Pachighat	4	6	8	10	-	-	7	8	15	16	18	20	MT
102	Bishnuprasad	Pachighat	4	7	8	9	-	-	7	9	14	16	18	19	MT
103	Misingneh	Pachighat	4	6	8	10	-	-	6	9	14	16	18	20	MT
104	Datungneh	Manipur	3	5	8	9	-	-	5	8	15	17	18	20	MT
105	Margina	Dhemaji	3	6	8	10	-	17	7	10	14	17	18	22	MT
106	Keh ambuba	Manipur	4	7	8	9	-	-	7	9	12	16	18	21	MT
107	Keh-jijiko	Manipur	4	5	8	10	-	17	6	8	14	17	17	20	MT
108	Bhogali bora	Dhemaji	4	6	7	-	-	-	5	9	10	12	13	14	ST
109	Cinnamoni rice	Dhemaji	3	5	7	-	-	-	4	8	9	11	14	16	ST
110	Jole bao	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
111	Deoka	Dhemaji	3	6	7	10	-	-	7	10	14	15	19	21	MT
112	Snigdaa	Pachighat	4	6	8	10	-	-	7	9	14	16	18	20	MT
113	Kulamoni bora	Diphu	4	6	8	10	-	19	7	10	14	16	19	20	MT
114	Aki ali	Pachighat	4	6	7	10	-	-	6	9	14	16	18	22	MT
115	Asi ankil	Pachighat	3	5	8	9	-	18	7	10	14	16	17	20	MT
116	Moniri Sali	Dhemaji	4	6	8	10	-	-	5	9	14	16	18	219	MT
117	Raitanga	Manipur	4	6	7	9	-	-	7	9	14	16	18	20	MT
118	Kulamoni lahi	Dhemaji	4	6	7	-	-	-	4	8	10	13	14	16	ST
119	Paniri Sali	Dhemaji	4	6	7	-	-	-	4	8	10	12	13	16	ST

120	Medini	Dhemaji	4	5	8	9	-	-	7	9	14	16	18	20	MT
121	Singlam Soksa	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
122	Soksu Bora	Diphu	3	5	7	-	-	-	5	8	11	13	15	16	ST
123	Soru Jangia	Dhemaji	4	6	8	-	-	-	4	8	10	12	15	16	ST
124	Ponwari	Dhemaji	3	6	7	-	-	-	4	8	9	12	14	16	ST
125	Khanami	Manipur	8	10	13	15	19	23	16	18	19	21	24	27	HT
126	Adeng	Pachighat	4	6	8	10	-	-	7	9	14	16	18	20	MT
127	Keh –jerh	Pachighat	4	7	8	10	-	17	7	9	13	15	17	20	MT
128	Amdrangneh	Pachighat	4	6	8	9	-	17	6	9	15	16	19	21	MT
129	Bokul joha	Dhemaji	4 3	5	8	10	-	-	7	9	14	15	18	19	MT
130	Bhalum-3	Pachighat	4	6	8	9	-	-	7	9	14	16	19	20	MT
131	Tejai longpi	Nagaland	4	6	7	-	-	-	4	8	10	12	14	16	ST
132	Kayipvii	Nagaland	4	6	8	10	-	-	7	910	14	16	19	20	MT
133	Kejork-ker	Nagaland	4	5	8	10	-	-	8	9	14	15	18	20	MT
134	Iamuk	pachighat	4	5	8	9	-	-	6	9	14	16	18	20	MT
135	Jahinga	Jorhat	4	6	7	-	-	-	4	8	10	12	13	16	ST
136	Manui kharamul	Jorhat	4	6	7	-	-	-	4	8	10	12	14	16	ST
137	Dimoru	Dhemaji	4	6	8	10	-	-	7	9	14	16	18	20	MT
138	Haru mekuri dhan	Dhemaji	4	6	7	-	-	-	4	8	10	12	14	16	ST
139	Ikhojol	Jorhat	4	4	8	-	-	-	4	7	9	12	13	17	ST
140	Joria	Jorhat	3	6	7	-	-	-	6	8	10	12	14	16	ST
141	Kasala	Jorhat	3	4	8	-	-	-	4	8	11	12	14	15	ST
142	Kasalath	Jorhat	3	6	7	-	-	-	5	6	10	12	15	17	ST
143	Lal aus	Jorhat	4	5	7	-	-	-	4	8	9	12	14	16	ST
144	Lalkach	Jorhat	4	6	7	-	-	-	5	8	10	12	14	16	ST
145	Maizobiron	Diphu	4	5	8	10	-	18	7	9	14	16	18	20	MT
146	Maynamati	Nagaland	4	6	8	10	-	-	7	9	14	16	18	21	MT
147	Rangai	Jorhat	4	6	7	-	-	-	4	7	10	12	14	16	ST
148	Surya mukhi	Jorhat	3	5	7	-	-	-	5	8	9	12	13	14	ST
149	Tamadao	jorhat	4	6	7	-	-	-	4	8	10	12	14	15	ST
150	Dhirendra	Jorhat	4	5	7	-	-	-	4	7	10	12	13	5	ST

ST- Susceptible tolerance; MT- Medium tolerance; and HT- Highly tolerance

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