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Screening of Rice (*Oryza sativa* L.) Genotypes for Early Vigour under Dry Direct Sowing Condition

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ABSTRACT

A laboratory experiment was conducted in completely randomized design replicated five times with thirty six aerobic rice genotypes at department of crop physiology S.V. Agricultural College, Tirupati during kharif, 2015-16. The screening was conducted both in petriplate (0, -5 and -10bars) and paper roll method (0, -1 and -2bars) at three different concentrations through Poly ethylene glycol (PEG) induced moisture stress. A significant variation was observed among the genotypes for germination percentage, seedling vigour index and co-efficient of velocity of germination. From the results Eight genotypes were taken as early vigorous viz., JGL-11727, JGL-20171, MTU-7029, MTU-1010, NLR-40024, NLR-33671, NLR-3042, NLR-4002 and two late vigorous genotypes viz., MTU-1112 and MTU-1075 were selected for dry direct sowing based on their performance evaluated through germination percentage, seedling vigor index and co-efficient of velocity of germination. Among several problems of dry direct sowing, weed menace is the major one. In order to cope up with this situation the cultivars developed for dry direct sowing must have weed competitiveness. It can be achieved through high seedling vigor. Thus the aim of the present experiment was to screen the rice genotypes for 'early vigour' which is said to be one of the prime characters of rice genotypes for dry direct sowing in aerobic cultivation. Genotypes exhibited high seedling vigour in the laboratory reflected the same in the field.

Key words: *Dry direct seeded rice– seedling vigor –PEG induced screening*

INTRODUCTION

Rice is cultivated in different types of practices such as low land rice (rainfed low land and irrigated low land), deep water rice, floating rice and upland rice (direct seeded aerobic rice). Irrigated rice dominates among the four rice ecosystems in both area coverage and production. In global rice productivity, irrigated rice ecosystem comprises 55 % of the world's rice growing area and provides 75% of global rice production[9]. However current evidence with respect to this system shows a decline in grain yield and productivity due to decrease water table, mounting labour shortage, increasing input prices and changing climatic conditions[12].

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Hence, the situation demands a major shift in the rice cultivation from low land transplanted rice to the direct seeded system[5]. Dry direct seeded rice is practiced in the areas where the water supply is unpredictable[3].

Compared to wet and water seeding, It is more advantageous in many aspects *viz.*, less labour intensive, time saving in sowing the crop, consumes less water, suitable for lowland areas, crop matures7-14 days earlier and there is 80-85% less methane emission, thereby it reduces global warming[2].

Dry direct seeded rice requires specially breed cultivars having good mechanical strength in the coleoptiles to facilitate early emergence of the seedlings under crust conditions and early seedling vigour for weed competitiveness. Inspite of the genetic variation for seedling vigour in rice, breeders have had difficulty in improving the seedling vigour in the semi dwarf cultivars. The poor success achieved by breeders using conventional breeding methods, in both temperate and tropical growing areas could be partly due to the traits associated with undesirable characters such as tallness, lodging susceptibility, large grain size and earliness that are selected against during the breeding process. The present study aimed at screening of rice genotypes suitable for dry direct sowing.

MATERIAL AND METHODS

The present investigation was carried out at P.G Laboratory, Department of crop physiology, S.V. Agricultural College, Tirupati during *kharif*, 2015-16. In order to screen the available genotypes of rice for early vigour under moisture stress condition, thirty six popular aerobic rice genotypes were procured from various research stations of Andhra Pradesh viz., ARS (Nellore), APRRI (Maruteru), RARS (Jagtial), ARS (Ragolu) and DRR (Hyderabad).

The list of genotypes was presented in Table1

Table 1: List of Procured Aerobic Rice Genotypes

S.No	GENOTYPES						
1	NLR – 33671	6	NLR – 34449	11	NLR – 33358	16	MTU – 1075
2	NLR – 4002	7	NLR – 34242	12	MTU – 1010	17	MTU – 1140
3	NLR – 40024	8	NLR – 30491	13	MTU – 7029	18	MTU – 1121
4	NLR – 33359	9	NLR – 3217	14	MTU – 1006	19	MTU – 2716
5	NLR – 40065	10	NLR – 3042	15	MTU – 1010	20	MTU – 3626
21	MTU – 1156	25	MTU – 1064	29	JGL – 20171	33	DRR dhan 15
22	MTU – 1166	26	MTU – 4870	30	JGL – 11727	34	DRR dhan 34
23	MTU – 1112	27	MTU – 1061	31	RGL – 2624	35	DRR dhan 29
24	MTU – 1081	28	JGL – 17004	32	RGL – 1880	36	DRR dhan 18

Water Stress was induced artificially with Poly ethylene glycol (PEG) in the laboratory by using aqueous solutions having osmotic pressures of 0, -5 bar and -10 bar for petriplate and 0, -1bar and -2bar for paper towel method. Aqueous solutions of 0, -5 bar and -10 bars were obtained by dissolving 0, 20.3g and 29.6g of Poly ethylene glycol in 100ml of distilled water respectively by using the formula as suggested by Michel Kaufman, 1972. Well filled and uniform seeds of different varieties were collected and these seeds are placed on moistened filter paper in glass petridishes and similarly seeds were placed in horizontal rows on a crepe paper for paper toweling method. After the seeds were placed the paper was properly rolled and loosely tied at both ends with twine thread. Filter papers and paper towels were moistened in the beginning and at regular intervals with the above mentioned solutions.

The experiment was conducted in a Completely Randomized design with 36 aerobic rice genotypes. There were three treatments with five replications.

Germination percentage

Seed germination was recorded at every alternate day after placing the seeds in petridishes and paper towels, upto 10days and it was expressed in percentage. A seed was considered as germinated, when the radicle was protruded out the seed coat. Germination percentage of seed was worked out by the following formula[4]

$$\text{Germination \%} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds kept for germination}} \times 100$$

Co-efficient of velocity of germination (CVG)

Number of seeds germinated on each day was counted starting from day1 to 10th day and the Coefficient of Velocity of germination was calculated using the following formula suggested by Kotowski[6].

$$CVG = \frac{N_1+N_2\ldots\ldots\ldots\ldots\ldots\ldots N_K}{N_1T_1+N_2T_2+\ldots\ldots\ldots\ldots\ldots N_KT_K} \times 100$$

Where,

'N' is the number of germinating seeds within the consecutive intervals of time 'T' and 'T' is the time between beginning of the test and the end of the particular intervals of measurement.

Seedling vigour index (SVI)

Shoot length and root length of seedlings were recorded in both petriplates and paper towels on fifth day and 10th day from the date seeds were kept for germination. Seedling vigour index was calculated by the following formula suggested by Abdul baki and Anderson[1] and averaged.

SVI = (Shoot length + Root length) × Germination percentage.

Statistical analysis

The data recorded on various parameters was statistically analysed, following the analysis of variance for completely randomized design on the basis of the model proposed by Panse and Sukhatme[11].

RESULTS AND DISCUSSION

The data on effect of induced moisture stress on germination percentage, seedling vigor index and co-efficient of velocity of germination using petriplate and paper towel methods was presented here.

Petriplate Method

Germination percentage

A significant difference was observed among different aerobic rice genotypes screened for high germination percentage using petriplate method at three different concentrations *viz.*, control, -5bar and -10bar.

In control highest germination percentage was recorded in NLR-33671(95%) which was at par with NLR-4002 (95%), NLR-34449(95%), NLR-40065(95%), DRRdhan34(95%) and MTU-1061 (94.75%).Whereas least germination percentage was observed in MTU-2716(77%) followed by NLR-33358(78.25%), MTU-1081 (79%) which is at par with MTU-1064(82.75%) and MTU-1121(84.75%). The remaining genotypes performed moderate germination percentage.

At -5bar highest germination percentage was observed in NLR-30491(80.33%), which was at par with MTU-1156(79.17%), DRRdhan15 (77.80%), NLR-4002(76.83%), DRRdhan29 (75.67%), NLR-34449(75.33%) and NLR-3042(75.17%).Least germination percentage was recorded in MTU-2716(15.67%) followed by MTU-1075(19%) which was at par with MTU-1112(24.83%), NLR-33358(31%) and MTU-1140(32.67%).

Among 36 genotypes at -10bar, 11 genotypes did not germinate at all *viz*., MTU-1006, MTU-1075, MTU-1140, MTU-2716, MTU-4870, DRRdhan18, RGL-2624, RGL-1880, NLR-34449, NLR-33358 and NLR-3217. Whereas highest germination percentage was observed in MTU-1061(23.50%) which was at par with MTU-7029 (23%), MTU-3626 (16.33%), MTU-1010 (14.67%), NLR-3042 (13.67%), JGL-20171 (13.5%), NLR-33671(13.17%), DRRdhan15(13%) and MTU-1001(11.88%) followed by JGL-11727 (11%). Moderate germination percentage was recorded in remaining genotypes.

Rapid uniform germination and accumulation of biomass during initial phase of seedling establishment irrespective of

environmental effect is necessary for the success of direct seeded rice[8].

Seedling vigour `index

Seedling vigour index of aerobic rice genotypes differed significantly at control, -5bar and -10bar (Table 1; fig.1). Seedling vigour index is a good indicator to evaluate the ability of any seed to germinate and produce normal seedlings. Early vigour could be a key trait to select for higher weed competitiveness[10].

Among 36 aerobic rice genotypes screened, highest seedling vigour index in control was observed in NLR-4002 (1211.25) which was at par with MTU-3626 (1192.28), MTU-1010 (1166.27), MTU-1081 (1039.50), NLR-40024 (1002.06) and JGL-20171 (976.13)

Least seedling vigour index in control was observed in DRRdhan 18 (684.79) which was at par with MTU-1064 (657.75), MTU-1140(663), NLR-34242 (673.04) and DRRdhan34 (693.50).

At -5bar highest seedling vigour index was recorded in MTU-1010 (692.77) which was at par with MTU-1001(654.22). NLR-33359(569.09), NLR-3042(561.22), NLR-30491(511.73), DRRdhan15 (504.16), RGL-1880 (447.83), NLR-4002 (438.30) and MTU-7029 (413.54) followed by NLR-34449(372.18).Whereas lowest seedling vigour index at -5bar was observed in MTU-1075 (4.87) which is at par with MTU-1112 (8.46), MTU-2716 (16.57) and MTU-1140 (25.40) followed by JGL-17004(44.16). The remaining genotypes performed moderate seedling vigour index.

Seedling vigour index at -10bar was performed by only 8 genotypes. They showed a significant variation among them. The highest seedling vigour index was recorded in JGL-20171 (21.85) which was at par with NLR-3042 (11.20), NLR-33671 (10.15), JGL-11727 (9.90),JGL-17004 (9.90) and MTU-7029 (2.04) followed by NLR-40024 and NLR-4002. Moderate seedling vigour index was showed by the remaining genotypes.

Co-efficient of velocity of germination (CVG)

Co-efficient of velocity of germination denotes the status of seed vigour and speed of emergence. Existence of a positive relationship between germination rate and seedling vigour was also reported[7].

At control highest CVG was observed in DRRdhan34 (67.67) which was at par with MTU-1061 (66.67), NLR-33671 (66.67), NLR-34449 (66.67), NLR-40065 (66.67.). Moderate CVG was observed in remaining genotypes.

At -5bar the highest CVG was performed by DRRdhan15 (16.29) which was at par with MTU-1156 (16.10) followed by NLR-30491 (15.91), NLR-3042 (15.86), NLR-33671 (15.72), MTU-1006 (15.54), RGL-1880 (15.51), NLR-34449 (15.45), JGL-11727 (15.42) and RGL-2624 (15.42).Least CVG at -5bar was recorded in MTU-1166(14.33) which was at par with MTU-1075 (14.41), MTU-1064 (14.45), MTU-4870 (14.50) and MTU-2716 (14.65).

Highest CVG at -10bar was recorded in NLR-3042(15.16) followed by JGL-17004 (14.99), JGL-11727 (14.94), JGL-20171 (14.92), NLR-40024 (14.73), MTU-1064 (14.70), NLR-34242 (14.68), MTU-1061 (14.58), NLR-33671 (14.42) and DRRdhan15 (14.37).CVG at -10bar was not performed by 10genotypes *viz.*, MTU-1006, MTU-1075, MTU-1140, MTU-2716, RGL-2624, RGL-1880, NLR-3217, NLR-33358, NLR-34449 and DRRdhan18.

Paper Towel Method

Germination percentage

The highest germination percentage at control in paper towel method was observed in JGL-11727 (100%) which was at par with NLR-34242 (100%). However lowest germination percentage recorded in NLR-33358 (41%) was followed by MTU-1112 (57%) which was at par with MTU-1061 (58%), MTU-1075(65%) and MTU-1081 (66%). Remaining genotypes recorded moderate germination percentage.

At -1bar the highest germination percentage was recorded in MTU-1010 (86%) which was at par with NLR-4002 (84%) and DRRdhan 34(82%). Whereas lowest germination percentage was recorded in NLR-3217 (26%) which was at par with MTU-2716 (28%) followed by MTU-1061 (36%), MTU-1112 (40%) and MTU-1006 (40%).

Among the thirty six genotypes at -2bar, highest germination percentage was observed in JGL-11727 (88%) which was at par with NLR-3042 (66%), NLR-40024 (66%), MTU-7029 (56),NLR-34242 (56), NLR-4002 (56%), NLR-40065 (56%), MTU-1010 (54%), NLR-33671 (54%), followed by

JGL-20171 (48%). Five genotypes did not germinate at all *viz*., MTU-1075, MTU-1112, MTU-2716, MTU-4870 and DRR dhan- 18.

Seedling vigour index

Seedling vigour index of thirty six genotypes was recorded analyzed statistically and presented (Table.2, Fig.2)

As per the results obtained by the paper towel method, Highest seedling vigour index at control were recorded in RGL-2624 (1933.84) which was at par with DRRdhan29 (1675.31), DRRdhan15 (1546.47), JGL-11727 (1534.38), DRRdhan34 (1477.63), MTU-3626 (1417.56), MTU-1121-(1395.19). Whereas lowest SVI was recorded in NLR-33358 (412.75) followed MTU-1081 (664.19), NLR-40065 (759.25) NLR-40024 (804.94) and MTU-1061 (836.72).

Highest seedling vigour index at –1bar was recorded in MTU-1010 (998.78) which was at par with MTU-7029 (990.13), MTU-1121 (833.75), JGL-11727 (722.40), NLR-33671 (712.88), NLR-4002(630.20), DRRdhan-15 (623.60). Whereas lowest seedling vigour index was recorded in NLR-3217 (79.75) which was at par with NLR-33359 (101.70), MTU-1112 (101.70).

At -2bar highest seedling vigour index was observed in JGL-11727 (630.80) which was at par with DRRdhan 15 (171.40), NLR-33671 (98.10), RGL-2624 (86.70), MTU-7029 (83.40), MTU-1010 (82.40), DRRdhan 34 (67.45), NLR-30491 (65.18), MTU-1121 (52.60) and NLR-34242 (50.05). The genotypes MTU-1075, MTU-1112, MTU-2716, MTU-4870, NLR-3217, NLR-33358, DRRdhan 18 did not show seedling vigour index at-2bar.

Das *et al*. studied on locally grown rice cultivars of Assam under different moisture regions like 0 bar, -2bars and -6bar. They observed that moisture deficit resulted in lowering the seedling vigour and speed of germination in all cultivars but the cultivars varied significantly in their response to moisture stress.

Co-efficient of velocity of germination (CVG)

Data on CVG at control on thirty six genotypes showed a significant variation among them. Highest CVG was recorded in RGL-2624 (13.34) which was at par withMTU-7029 (13.33), JGL- 11727 (13.33), MTU-3626 (13.33), NLR-3042 (13.33), NLR-34242 (13.33), NLR-4002(13.33) and NLR-30491 (13.28). Whereas least CVG was recorded in MTU-2716 (12.75), JGL-17004 (12.73), MTU-1075 (12.68), MTU-1140 (12.68) and MTU-1112 (12.57) which were at par.

CVG at -1bar recorded highest in MTU-7029 (13.33) which was at par with NLR-40024 (13.33), JGL-20171 (13.16), JGL-11727 (13.16) and NLR-3042 (13.16). Least CVG was recorded in MTU-1075 (11.43) which was at par with MTU-1061 (11.74), NLR-3217 (11.81), MTU-1112 (11.84) and MTU-2716 (12).

At -2bar highest CVG was recorded in JGL-11727 (12.84) followed by MTU-7029 (12.71), NLR-40024(12.70), NLR-4002 (12.59), MTU-1010 (12.54), NLR-33671 (12.54), NLR-40065 (12.54), NLR-3042(12.51), MTU-3626 (12.44) and JGL-20171 (12.44). CVG was not observed in MTU-1075, MTU-2716, MTU-4870, DRRdhan 18 and MTU-1112 at -2 bars.

Screening of the genotypes

The following genotypes were selected based on their performance as expressed by seedling vigour index in high osmotic potential (-10bar). Alongside seedling vigour index at -10bars, reasonable germination percentage, coefficient of velocity of germination, seedling vigour index at other treatments (control and -5 bars) was also considered as a selection criteria. Similarly results obtained at -2bar in paper towel method and those genotypes performed highest seedling vigour index, germination percentage and co-efficient of germination were observed at other treatments (control and -1bar) were also considered.

Genotypes selected based on the results obtained from this experiment were JGL-11727, JGL-20171, MTU-7029, MTU-1010, NLR-40024, NLR-33671, NLR-3042, NLR-4002 as a high vigour performers and besides two least vigor performers MTU-1075 and MTU-1112 were also selected as a check for further studies.

MTU-1010 is selected because it is a mega variety, occupied very large area in Andhra Pradesh and other states across the country and it also showed highest seedling vigour index at -5bar and control.

Table: 1. Screening of aerobic rice genotypes for high seedling vigor index through induced moisture stress with poly ethylene glycol (Control, -5 and -10 Bars) using petriplate method

S.No	Genotype	Control	- 5 Bar	- 10 Bar
1	MTU-1006	694.17	102.91	0.00
2	MTU1156	892.70	292.23	0.00
3	MTU-1166	914.53	52.33	0.00
4	MTU-1075	931.25	4.87	0.00
5	MTU-1140	663.00	25.40	0.00
6	MTU-1121	867.65	254.00	0.00
7	MTU-7029	838.94	413.54	2.04
8	MTU-1112	833.10	8.46	0.00
9	MTU-2716	770.00	16.57	0.00
10	MTU-3626	1192.28	227.03	0.00
11	MTU-1081	1039.50	342.07	0.00
12	MTU-1061	768.35	306.71	0.00
13	MTU-1064	657.75	277.79	0.00
14	MTU-4870	933.12	363.89	0.00
15	MTU-1010	1166.27	692.77	0.00
16	MTU-1001	803.26	654.22	0.00
17	JGL-20171	976.13	225.93	21.85
18	JGL-11727	907.11	129.71	9.90
19	JGL-17004	719.99	44.16	9.90
20	RGL-2624	694.99	248.47	0.00
21	RGL-1880	714.46	447.83	0.00
22	NLR-3217	712.69	124.77	0.00
23	NLR-3042	844.76	561.22	11.20
24	NLR-33358	806.15	139.63	0.00
25	NLR-33671	950.00	299.27	10.15
26	NLR-34242	673.04	253.45	0.00
27	NLR-33359	856.19	569.09	0.00
28	NLR-4002	1211.25	438.30	1.30
29	NLR-34449	867.83	372.18	0.00
30	NLR-40024	1002.06	262.91	1.47
31	NLR-30491	837.19	511.73	0.00
32	NLR-40065	706.33	308.12	0.00
33	DRRdhan29	777.42	276.18	0.00
34	DRRdhan34	693.50	100.64	0.00
35	DRRdhan15	823.24	504.16	0.00
36	DRRdhan18	684.79	231.15	0.00
	MEAN	**845.14**	**280.10**	**1.89**
	CD	**47.20**	**28.04**	**1.33**
	SE(m)	**16.87**	**10.02**	**0.48**

Table: 2 Screening of aerobic rice genotypes for high seedling vigourindex through induced moisture stress with poly ethylene glycol (Control, -1 and -2 Bars) using paper-towel method

S.No	Genotype	Control	- 1 Bar	- 2 Bar
1	MTU-1006	1114.22	169.40	0.50
2	MTU1156	980.56	244.73	1.05
3	MTU-1166	1020.00	533.39	0.90
4	MTU-1075	1146.22	180.15	0.00
5	MTU-1140	941.06	259.48	13.00
6	MTU-1121	1395.19	833.75	52.60
7	MTU-7029	1327.50	990.13	83.40
8	MTU-1112	1081.67	101.70	0.00
9	MTU-2716	921.09	157.13	0.00
10	MTU-3626	1417.56	475.63	13.81
11	MTU-1081	664.19	215.60	37.80
12	MTU-1061	836.72	190.35	0.15
13	MTU-1064	1043.50	252.20	8.77
14	MTU-4870	1257.88	333.55	0.00
15	MTU-1010	1361.72	998.78	82.40
16	MTU-1001	926.63	512.10	7.94
17	JGL-20171	1124.00	561.55	42.40
18	JGL-11727	1534.38	722.40	630.80
19	JGL-17004	1052.63	335.58	38.35
20	RGL-2624	1933.84	596.10	86.70
21	RGL-1880	1250.72	536.48	5.24
22	NLR-3217	932.81	79.75	0.00
23	NLR-3042	1212.53	435.95	4.06
24	NLR-33358	412.75	390.75	0.00
25	NLR-33671	1264.38	712.88	98.10
26	NLR-34242	1330.00	483.90	50.05
27	NLR-33359	1000.19	101.70	0.64
28	NLR-4002	936.38	630.20	7.24
29	NLR-34449	1242.00	236.15	44.00
30	NLR-40024	804.94	345.00	13.57
31	NLR-30491	1191.28	540.80	65.18
32	NLR-40065	759.25	556.90	40.30
33	DRRdhan29	1675.31	339.35	32.80
34	DRRdhan34	1477.63	579.80	67.45
35	DRRdhan15	1546.47	623.60	171.40
36	DRRdhan18	1373.94	264.90	0.00
	MEAN	**1152.53**	**431.16**	**47.24**
	CD	**23.18**	**24.20**	**3.61**
	SE(m)	**16.39**	**17.11**	**2.55**

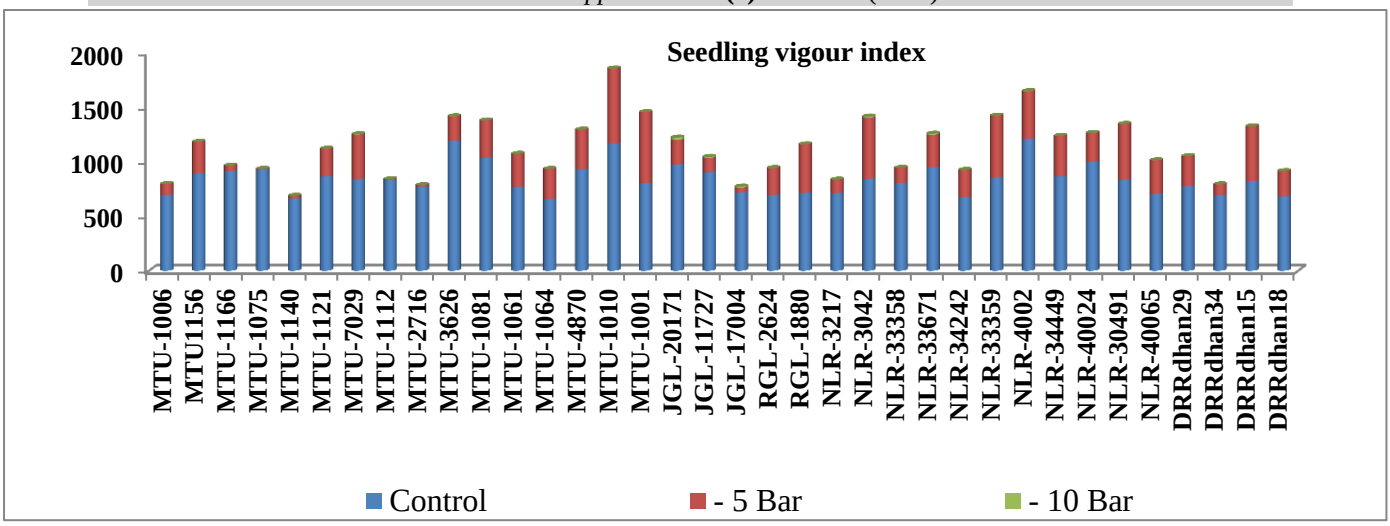


Fig. 1: Screening of aerobic rice genotypes for high seedling vigour index through induced moisture stress with poly ethylene glycol (control, - 5 bar, -10 bar) using petriplate method

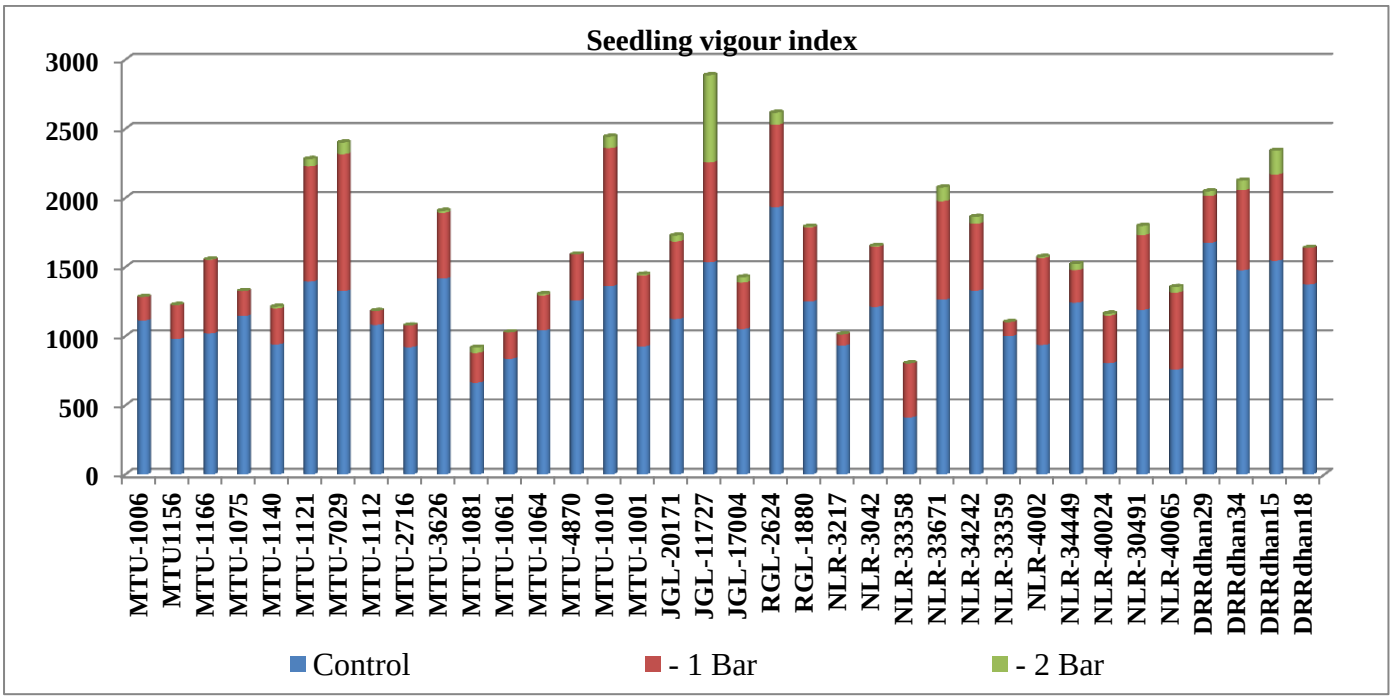
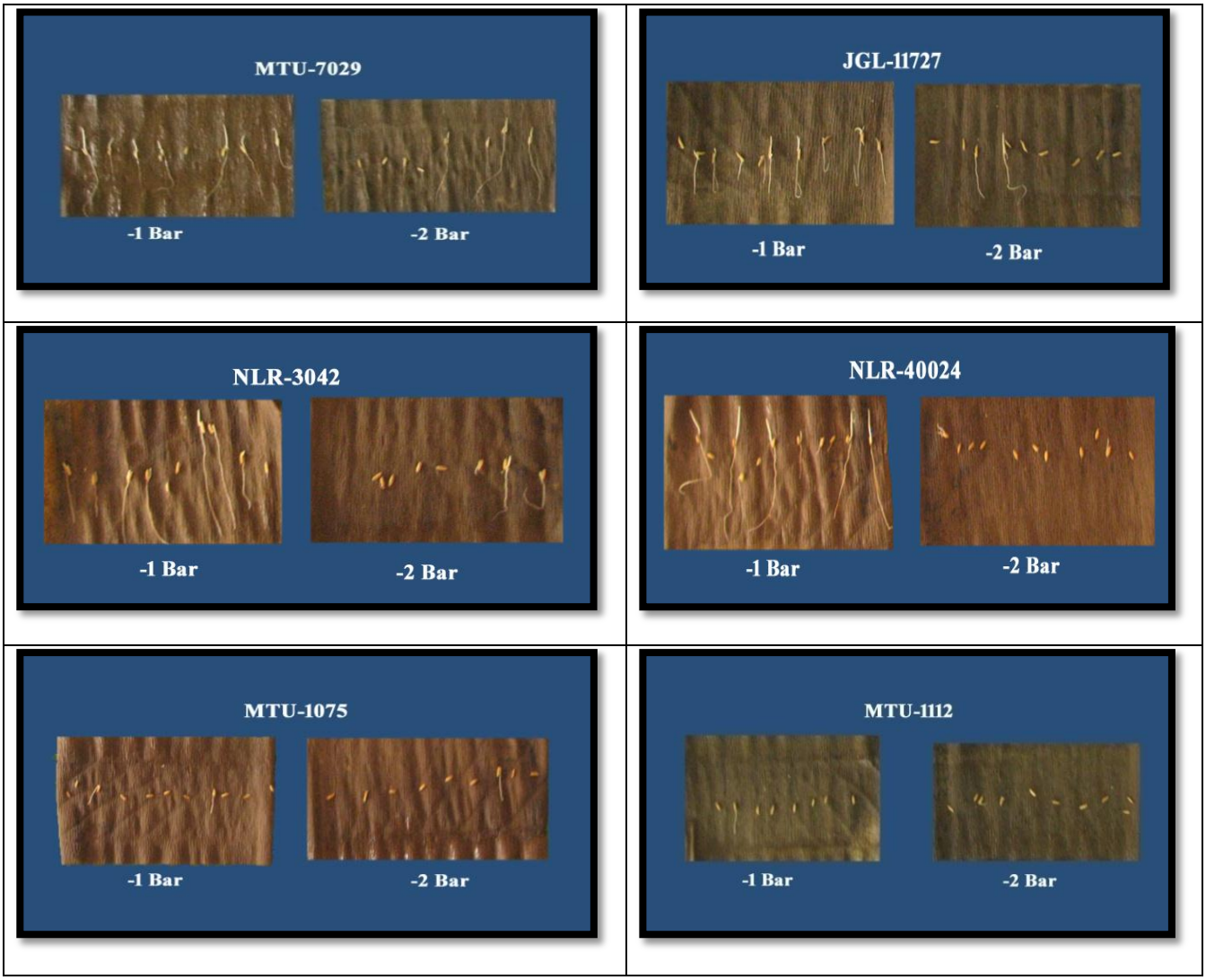


Fig. 2: Screening of aerobic rice genotypes for high seedling vigour index through induced moisture stress with poly ethylene glycol (control, -1 bar and -2 bar) using paper-towel method

Plate: 1 Screening of aerobic rice genotypes through PEG induced moisture stress (control,-5bar and -10bar) using Paper towel method

Plate: 2 Screening of aerobic rice genotypes through PEG induced moisture stress (-1bar and -2bar) using Paper towel method



CONCLUSION

PEG induced moisture stress could be used as effective method for Screening of genotypes suitable for dry direct sowing. Seedling vigour index is a good indicator to evaluate the ability of any seed to germinate and produce normal seedlings. To improve initial crop establishment and competitiveness of direct-seeded rice, varieties with higher germination and faster seedling emergence with more vigorous seedlings under anaerobic conditions must be selected.

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