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Influence of production environment on seed quality in rice (*Oryza sativa* L.) hybrid ADTRH 1

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Abstract : Seed samples of rice hybrid ADTRH 1 collected from 25 locations spread over in two different agro-climatic zones of Tamil Nadu revealed significant variations in various seed quality components *viz.* physical (purity, ODV, split husk seeds and 100 seed weight), physiological (seed germination, speed of germination, dry matter production, vigour index and electrical conductivity of seed leachate) and health. Among the centres of hybrid rice seed production, Coimbatore and Bhavanisagar centres in Western Zone of Tamil Nadu were adjudged as the best and suitable places for hybrid rice seed production.

Key words : Production environment, seed quality, hybrid rice

Introduction

Good quality seeds are the seeds of green revolution. It has been emphatically shown that 10-20 per cent increased yield could be attained by the use of good quality seeds alone. The production and supply of good quality seeds therefore, is one of the most important requirements to achieve higher production and productivity in any crop. The success in hybrid rice in India could be visualized only if there is adequate quantity of quality seeds made available for cultivation. Therefore, sufficient quantity of hybrid seeds is to be produced for adoption of hybrid rice technology in large scale by the farmers. The seed quality is governed by variety of factors *viz.* edaphic, environmental, biotic, etc., and the production of good quality seed depends on complex condition evoking the most favourable interactions between the genetic make up of the seed and the environment under which it is produced, harvested, processed and stored. Hence the present investigation was undertaken to study the influence of production environment on seed quality in rice hybrid ADTRH 1.

Materials and Methods

To study the influence of environment on hybrid rice seed production regions on resultant seed quality, seed samples of ADTRH 1 rice hybrids produced in *kharif* 2002 were collected from 25 locations of two agroclimatic zones as detailed in Table 1 and evaluated for various seed quality parameters.

To analyse physical purity of seed lot, the working sample (400 g) was manually separated into four fractions *viz,* pure seed, inert matter, other crop seeds and weed seeds. Each fraction was weighed accurately and expressed in percentage (ISTA, 1999). The presence of other distinguishable var'eties of paddy in each seed sample of 400 g was manually separated with the help of hand lens based on the morphological variations, counted and expressed in number kg of seed^{-1} (Verma, 1996). Percentage of split husk seeds from total weight of seeds taken was calculated as per the method suggested by Kamaraj (2001).

Table 1. Details of production environment to study the influence on seed quality of ADTRH 1 rice hybrid produced in farmers' field during *kharif* 2002

Agroclimatic Zone	TNAU Centre	Location Number	Location Name
Western Zone	Deartment of Rice, Coimbatore	L_1	Alanthurai
Western Zone	Deartment of Rice, Coimbatore	L_2	Narasipuram
Western Zone	Deartment of Rice, Coimbatore	L_3	Vedapatti
Western Zone	Deartment of Rice, Coimbatore	L_4	Perur
Western Zone	Deartment of Rice, Coimbatore	L_5	Semmedu
Western Zone	ARS, Bhavanisagar	L_6	Kothamangalam
Western Zone	ARS, Bhavanisagar	L_7	Erangattur
Western Zone	ARS, Bhavanisagar	L_8	Erangattur
Western Zone	ARS, Bhavanisagar	L_9	Ariappanpalayam
Cauvery Delta	SWMRI, Tanjore	L_{10}	Vandaya Irruppu
Cauvery Delta	SWMRI, Tanjore	L_{11}	Valamarakottai
Cauvery Delta	SWMRI, Tanjore	L_{12}	Pasupathikovil
Cauvery Delta	SWMRI, Tanjore	L_{13}	Vilar
Cauvery Delta	SWMRI, Tanjore	L_{14}	Neithalur
Cauvery Delta	SWMRI, Tanjore	L_{15}	Mathur
Cauvery Delta	SWMRI, Tanjore	L_{16}	Peraurani
Cauvery Delta	SWMRI, Tanjore	L_{17}	Kattuthottam
Cauvery Delta	SWMRI, Tanjore	L_{18}	Pattukottai
Cauvery Delta	TRRI, Aduthurai	L_{19}	Thiruvidaimaruthur
Cauvery Delta	TRRI, Aduthurai	L_{20}	Aduturai
Cauvery Delta	TRRI, Aduthurai	L_{21}	Kuthalam
Cauvery Delta	TRRI, Aduthurai	L_{22}	Thiruneelakudi
Cauvery Delta	ADAC and RI, Trichy	L_{23}	Kombadipatti
Cauvery Delta	ADAC and RI, Trichy	L_{24}	Srirangam
Cauvery Delta	ADAC and RI, Trichy	L_{25}	Pettaivaithalai

ARS : Agricultural Research Station SWMRI : Soil Water Management Research Institute

TRRI : Tamil Nadu Rice Research Institute ADAC & RI : Anbil Dharmalingam Agricultural College and Research Institute

Eight replicates of 100 seeds each were weighed in a sensitive electronic balance and expressed as 100 seed weight in g (ISTA, 1999). The moisture content was estimated by hot air oven method as prescribed by ISTA (1999). Four replicates of 100 seeds each selected at random were used for germination in roll towel in the germination room maintained at a temperature of 25+1°C and 95+3 per cent relative humidity (RH) and evaluated after 14 days. All normal seedlings were counted and expressed as germination percentage. To

Table 2. Influence of production environment on physical seed quality in rice hybrid ADTRH 1

Zone	Centre	Physical purity							
		Pure seed (%)	Inert matter (%)	Other crop seeds (No. kg^{-1})	Weed seeds (No. kg^{-1})	ODV (%)	Split husk seeds (%)	100 seed weight (g)	Seed moisture content (%)
Western	Coimbatore	99.70	0.30	–	–	0.25	11.00	2.108	10.67
Western	Coimbatore	99.87	0.13	–	16	0.25	8.00	2.053	10.64
Western	Coimbatore	99.78	0.22	–	–	1.00	10.00	2.034	10.12
Western	Coimbatore	99.36	0.64	29	–	0.50	8.00	1.887	10.06
Western	Coimbatore	99.86	0.14	–	–	1.50	16.50	2.005	10.62
Western	Bhavanisagar	98.47	1.53	–	–	1.50	8.00	1.968	10.58
Western	Bhavanisagar	99.72	0.28	–	–	0.50	21.25	2.101	10.30
Western	Bhavanisagar	99.33	0.67	–	15	0.75	15.50	1.963	10.35
Western	Bhavanisagar	99.25	0.75	–	–	0.25	9.25	1.928	10.04
Cauvery Delta	Tanjore	99.61	0.39	–	–	q1.00	18.25	1.774	10.26
Cauvery Delta	Tanjore	99.55	0.45	–	13	3.00	35.00	1.821	10.21
Cauvery Delta	Tanjore	99.45	0.55	–	–	5.00	28.75	1.815	10.04
Cauvery Delta	Tanjore	99.60	0.40	–	–	4.00	25.50	1.749	10.08
Cauvery Delta	Tanjore	98.88	1.12	–	–	1.50	38.50	1.695	10.41
Cauvery Delta	Tanjore	98.62	1.38	–	16	4.00	30.25	1.627	9.97
Cauvery Delta	Tanjore	99.31	0.69	–	–	1.25	37.75	1.789	10.38
Cauvery Delta	Tanjore	99.84	0.16	–	–	1.00	12.25	1.708	10.29
Cauvery Delta	Tanjore	99.36	0.64	–	–	2.00	19.25	1.880	10.22
Cauvery Delta	Aduthurai	97.87	2.13	–	–	4.00	22.25	1.864	10.09
Cauvery Delta	Aduthurai	96.91	3.09	–	–	9.00	26.00	1.862	9.98
Cauvery Delta	Aduthurai	98.44	1.56	–	–	0.50	41.00	1.853	10.24
Cauvery Delta	Aduthurai	97.70	2.30	–	–	2.00	33.50	1.964	1 1 .67
Cauvery Delta	Trichy	96.65	3.35	–	–	1.50	39.25	1.898	10.52
Cauvery Delta	Trichy	97.00	3.00	–	–	1.00	38.00	1.900	10.60
Cauvery Delta	Trichy	96.30	3.70	–	–	1.75	40.00	1.890	10.45
SEd		0.59	0.60	0.28	1.44	0.67	2.02	0.03	NS
CD (p=0.05)		1.23	1.24	0.58	2.97	1.33	4.03	0.06	

assess speed of germination, seeds were germinated in sterilized sand medium replicated four times with 100 seeds each. The germination was counted daily upto the final count day. Emergence of seedlings above the sand surface was taken as criterion for germination. From the number of seeds germinated on each counting day, the speed of germination was calculated as per the procedure by Maguire (1962).

At final count, ten normal seedlings in each replication were taken at random, shade dried for 24 h and then in hot air oven maintained at 85 + 1°C for 72 h. Then, they were cooled in a silica gel desiccator for 30 min, weighed in digital balance and expressed as dry matter production in mg seedling $^{-1}$. The vigour index of the seedling was computed using the formula suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

To estimate the field emergence, four replicates of 100 seeds from each sample were manually sown in lines at uniform depth of two cm with a spacing of 25x5 cm on a raised bed under nursery condition and the emergence of seedlings was recorded on 20 days after sowing and expressed in percentage. The electrical conductivity of seed leachate was measured in a digital conductivity meter (Type MCD 287) with an electrode possessing cell constant of 1.0 and expressed in decisimens (dSm^{-1}) (Presley, 1958).

Seed health test was carried out on all the seed samples using blotter technique. On 7th day, the number of infected seeds was counted and mean of four replicates was expressed in percentage. The data from various experiments were analysed by the F-test for significance following the methods described by Panse and Sukhatme (1985).

The data on maximum and minimum temperature and relative humidity were obtained from the 'Agromet' documentation of Department of Meteorology, TNAU, Coimbatore and the following Heat unit concepts were derived for weather correlation studies.

The GDD or the accumulated degree days or effective heat unit was computed using the formula suggested by Iwata (1984). Considering the tropical conditions, base temperature was taken as 13°C for rice.

The Relative Temperature Disparity (RTD) for the cropping period was calculated using the formula given below:

$$\text{Relative Temperature Disparity} = \frac{\text{Maximum - Minimum temperature (°C)}}{\text{Maximum temperature (°C)}} \times 100$$

The Relative humidity disparity (RHD), for the cropping period was calculated using the following formula:

$$\text{Relative Temperature Disparity} = \frac{\text{Maximum - Minimum RH (\%)}}{\text{Maximum RH (\%)}} \times 100$$

Results and Discussion

The agro ecological conditions under which the seeds are produced exert more than one effect on the performance of the resultant seeds. The seeds produced in different locations, seasons and soil fertility brought about changes both in seed quality and quantity. The selection of locality for seed production is therefore very important to produce good quality seeds as the environment under which the seed develops ultimately determines its quality. The results of various response parameters studied in the present study brought out the significant influence of production environment on hybrid rice seed quality.

Table 3. Influence of production environment on physiological seed quality and pathogen infection in rice hybrid ADTRH 1

Zone	Centre	Seed germination (%)	Speed of germination	Dry matter production (mg seedling^{-1})	Vigour index	Field emergence (%)	EC of leachate (dSm^{-1})	Pathogen infection (%)
Western	Coimbatore	93 (74.66)	3.31	12.8	3427	70 (56.79)	0.124	2
Western	Coimbatore	90(71.57)	3.78	13.1	3317	82 (64.90)	0.111	0
Western	Coimbatore	92 (73.57)	3.09	12.2	3085	74 (59.34)	0.098	4
Western	Coimbatore	77(61.34)	3.06	11.4	2985	45(42.13)	0.117	6
Western	Coimbatore	78 (62.03)	3.24	11.7	2864	66 (54.33)	0.097	4
Western	Bhavanisagar	85 (67.22)	3.29	12.6	2960	62(51.94)	0.099	4
Western	Bhavanisagar	87 (68.87)	3.23	12.1	2809	55 (47.87)	0.093	4
Western	Bhavanisagar	91 (72.54)	3.72	11.3	3241	59(50.19)	0.103	4
Western	Bhavanisagar	90(71.57)	3.19	11.6	2932	63 (52.54)	0.131	2
Cauvery Delta	Tanjore	72 (58.05)	2.68	10.6	2107	67 (54.94)	0.183	18
Cauvery Delta	Tanjore	85 (67.22)	2.57	11.4	2734	49 (44.43)	0.157	10
Cauvery Delta	Tanjore	75 (60.00)	2.73	11.1	2316	40 (39.23)	0.190	22
Cauvery Delta	Tanjore	58 (49.60)	2.45	10.7	1783	33 (35.06)	0.182	16
Cauvery Delta	Tanjore	60 (50.77)	2.37	11.6	1955	28(31.95)	0.227	6
Cauvery Delta	Tanjore	47(43.28)	1.27	11.1	1517	30(33.21)	0.144	34
Cauvery Delta	Tanjore	68 (55.55)	2.12	11.5	2361	50(45.00)	0.156	26
Cauvery Delta	Tanjore	65 (58.05)	2.10	11.0	2219	43 (40.98)	0.178	4
Cauvery Delta	Tanjore	68 (55.55)	3.41	11.0	2209	50 (45.00)	0.153	12
Cauvery Delta	Aduthurai	72 (58.05)	3.14	11.6	2132	62(51.94)	0.121	14
Cauvery Delta	Aduthurai	64(53.13)	2.55	12.0	1996	46(42.71)	0.126	18
Cauvery Delta	Aduthurai	63 (52.54)	2.68	10.8	1950	57 (49.03)	0.145	12
Cauvery Delta	Aduthurai	66 (54.33)	2.00	12.0	2123	37 (37.47)	0.141	16
Cauvery Delta	Trichy	65(53.73)	1.67	11.9	2334	57 (49.60)	0.145	14
Cauvery Delta	Trichy	68(55.55)	1.75	12.1	2289	62(51.94)	0.150	10
Cauvery Delta	Trichy	62(51.94)	1.59	11.7	2302	58 (49.60)	0.140	18
SEd		8.25	0.38	0.56	25.50	5.94	0.012	1.18
CD (p=0.05)		17.07	0.79	1.17	52.51	11.85	0.025	2.35

Physical quality

The quality is considered to be good if pure seed percentage is above 98 and the other species seeds and inert matter are as low as 0-1 per cent (Agrawal, 1980). In the present investigation, considerable variations were noticed in pure seed fractions of hybrid seed samples collected from different production environments. Only 19 out of 25 samples constituting 76 per cent of samples had the minimum requirement of pure seed (98 per cent) and other six samples, three each from Aduthurai and Trichy centres failed to meet the minimum requirement (Table 2). Lack of seed processing facilities at village level, poor sanitation of threshing and drying yard and improper post harvest handling of hybrid rice seed samples lead to lack of minimum standard of physical purity in certain samples. Reddy *et al.* (2000) found that nearly 50 per cent of rice samples collected from farmers of Andhra Pradesh was below certification standard for labeled seed in respect of physical purity.

In addition to physical purity, the presence of other crop seeds and weed seeds was also noticed. Out of 25 seed samples, only one sample from Coimbatore centre had other crop seeds (29 kg of seed^{-1}) and five samples each one from Coimbatore, Bhavanisagar and Aduthurai centres and two from Tanjore centre contained the weed seeds to the tune of 13 to 22 number kg of seed^{-1} (Table 2). The possible reason for the contamination of other crop seeds and weed seeds might be due to field level admixture, improper weeding cum rogueing operations and contamination during post harvest handling of seeds. The presence of other distinguishable variety (ODV) seeds was also observed in seed samples. Out of 25 samples, eight samples collected from Tanjore and Aduthurai centres of Cauvery Delta Zone gave ODV of more than two per cent (Table 2). Improper rogueing or contamination during post harvest handling of seed might have caused the higher percentage of ODV.

Seeds of rice hybrid as well as male sterile lines suffer a specific problem of split husk occurrence. The lemma and palea forming the husk do not close the caryopsis properly in a significant proportion of seeds probably due to mechanism of male sterility. The results of present investigation clearly indicated that production environment had significant influence on split husk occurrence. The seeds collected from Coimbatore and Bhavanisagar centres of Western Zone had less than 20 per cent of split husk seeds compared to rest of the centres of Cauvery Delta Zone (Table 2). Influence of weather might have brought about these differences between the production environments (Kamaraj, 2001).

In the present investigation, 100 seed weight also varied due to seed production environment. Out of 25 locations, only five locations, all from Coimbatore and Bhavanisagar centres of Western Zone had 100 seed weight of above 2 g (Table 2). Landermark (1983) also observed location differences on 1000 seed weight in certified seed lots of oats, barley, winter wheat, spring wheat and winter rye. It could be seen from the result that the moisture content of seeds collected from all the production environments did not vary significantly. However, it ranged from 9.97 to 11.67 per cent (Table 2). It indicated that the farmers of respective locations realized the importance of seed moisture content on vigour and viability and therefore dried the seeds properly.

Physiological quality

Environmental conditions during the pre-harvest period had a great influence on the quality of the harvested seeds. In the present investigation, except two locations from Coimbatore centre, rest of the Coimbatore and Bhavanisagar centres registered more than 80 per cent germination, whereas in other centres, Valamarakottai belongs to Tanjore centre only maintained 80 per cent germination (Table 3). Such variations in germination might be due

to the influence of agro-climatic conditions prevailed in their respective production environment as observed through derived weather parameters such as cumulative Relative Temperature Disparity (RTD) and cumulative Relative Humidity Disparity (RHD) along with Growing Degree Days (ODD). In the present study, the higher values of aforesaid derived weather parameters observed in Coimbatore and Bhavanisagar centres favoured better seed quality (Table 4).

The viability and vigour are the two important facets of seed quality and they go hand in hand while judging the quality of seeds. In the present study, speed of germination, a measure of seed vigour also reflected the differential status of seeds collected from different production environment. All the locations of Coimbatore and Bhavanisagar along with one each from Aduthurai and Tanjore had speed of germination of > 3 (Table 3). In addition, those samples which recorded the speed of germination of > 3 also recorded higher germination, indicating the high possible association between germination and speed of germination (Dahiya *et al.* 2002).

The present study also revealed the large variations in dry matter production (DMP) of 14 day old seedlings for the seeds collected from 25 locations. The higher DMP value of 12 mg was recorded in seven locations and in other locations it ranged from 10.6 to 11.9 mg (Table 3). The computed vigour index value also varied significantly and higher vigour indices of more than 2500 were recorded in 10 locations, of which nine locations were from Coimbatore and Bhavanisagar centres of Western Zone (Table 3). The field emergence also exhibited significant variations due to production environment. Only three samples collected from Coimbatore registered more than 70 per cent of field emergence and others failed to reach the same (Table 3).

The electrical conductivity of seed leachate (EC) is a good estimation of seed quality to reveal the facts at membrane level and also serves as a good index of seed deterioration. In the present investigation, only four locations, each two from Coimbatore and Bhavanisagar centres of Western Zone had the EC value of below 0.100 dSm^{-1} and 17 locations registered above 0.120 dSm^{-1} (Table 3), which is attributed to various agro-ecological conditions prevailed over the locations as well as the differences in the adoption of management practices besides the influence of production environment. The result on variation in seed quality due to production environment is in confirmity with the findings made by Nair (1996) in rice. *Seed health*

Seed health is a major consideration in any seed production programme next to vigour and viability of seeds. Seed borne fungi not only reduce the germination and vigour of the seedling but may also act as a source of inoculums for development of disease in the field (Srinivas *et al.* 2001). In the present investigation, out of 25 locations, only one location from Coimbatore centre of Western zone was completely free from pathogen infection and remaining from Coimbatore and Bhavanisagar centres of Western Zone along with two locations of Tanjore centre, registered below seven per cent of pathogen infection. All other locations had pathogen infection of 10 to 34 per cent (Table 3). Thus, the percentage of pathogen infection varied among the locations significantly.

From the foregoing discussion it could be concluded that among the different centres of ADTRH 1 hybrid rice seed production, all the nine locations from both Coimbatore and Bhavanisagar centres of Western Zone were identified as the best suitable place for ADTRH 1 hybrid seed production during *kharif* season based on various seed quality characters. In addition, Valamarakottai of Tanjore centre of