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# STABILITY ANALYSIS OF SOME RELEASED VARIETIES, LOCAL CULTIVARS AND PROMISING CULTURES OF DRY AND SEMI-DRY PADDY

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A set of fifteen geno types of dry and semi-dry paddy were evaluated for stability of performance for yield and four yield components in four different environments. Stress conditions of moisture especially in the rainfed crops reduced the mean values, the maximum reduction being observed in productive tillers followed by plant height, grain yield, days to flowering and grains per panicle. The dry and semi-dry paddy were, in general, characterised by low tillering potential. The geno type-environment interaction was significant and both the linear and non-linear components were equally important. Both TKM 9 and Poongar were the high yielding genotypes with wider adaptability and high stability in addition to being specifically suitable to unfavourable environments. Kuruvaikalangiam was the best performer for all characters excepting grains per panicle for which PM 1023 was the best performer.

Dry and semi-dry paddy are grown in an estimated area of three lakh hectares in Tamil Nadu. Dry daddy depends entirely on rainfall, while semi-dry rice depends on the rainfall in the initial stages and later irrigated through the rainfed tanks. High variation in the time of the on set of the monsoon and in the amount and distribution of rainfall renders the timely preparation of lands, stand establishment, weeding, manuring etc. difficult. The rainfall pattern is quite erratic and it is observed that only one year in a cyclic period of five years is a normal one, while the other four years encounter uncertain and inadequate rainfalls. Besides, high precipitation in a short spell usually result in flooding of fields thereby causing submergence of crops for a week or even ten days in these areas, and paddy seems to be the only choice of crop for these areas. Under these circumstances it has become a necessity to bestow due attention towards the development of high yielding varieties of rice adapted to unfavourable conditions combined with stability of performance. Not much work has been done in this aspect. The present investigation was taken up with the object of evaluating the performance of fifteen genotypes of dry and semi-dry paddy under four different environments and to identify the high yielding genotypes with good stability.

## MATERIALS AND METHODS

Fifteen genotypes of dry and semi-days to flowering, plant height, productive tillers and grains per panicle were studied and data on the first two were collected on plot basis and for the latter three on ten random plants from each dry paddy constituted the materials for the present study. They comprised of five local cultivars (Kuruvai kalangiam, Nootripathu, Norungan, Poongar and Varappukondanchan), five improved genotypes (ASD 4, C 22, IET 1444, MDU 1 and TKM 9) and five promising cultures (PM 1002, PM 1023, PM 1036, PM 1121 and TM 3709). The experiment was conducted at Multi Crop Experiment Station, Paramakudi during the year 1982-'83. The crop was raised in four environments ($E_1$ to $E_4$; $E_1$ to $E_3$ in the main crop season-September - October and $E_4$ in summer season - February - June): $E_1$ - rainfed, dry seeded in fields of sandy loam soil type with low water holding capacity; $E_2$ - rainfed dry seeded in fields of clayey loam soil type with normal water holding capacity; $E_3$-transplanted under puddled conditions with continual saturation, and $E_4$ - transplanted under puddled conditions superimposed by unsaturated soil moisture conditions for a period of seven days at tillering and flowering stages of growth. A completely randomised block design with two replications was adopted following the normal cultural and manurial practices. The plot size was 5.0 X 1.6 m and the spacing was 20 X 15 cm. Five characters viz., grain yield

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plot at the time of harvest. Mean values were used for stability analysis following the method of Eberhart and Russel (1966).

## RESULTS AND DISCUSSION

The individual environmental mean along with the range and environmental index for yield and yield components are presented in Table 1. The environmental means for grain yield and days to first flowering were the highest in $E_1$. Similarly the mean values for plant height, productive tillers and grains per panicle were the highest in $E_4$. The mean values for all characters were comparatively low in $E_1$ and $E_3$. Both $E_3$ and $E_4$ had continual moisture saturation as against $E_1$ and $E_2$, which were the rainfed crops and which experienced moisture stress at intermittent intervals during the growth period. Positive and higher magnitude of environmental index (Ij) serving as a measure of fitness of environment, both $E_3$ and $E_4$ could be considered as favourable environments as manifested by the higher mean values for all the characters under these two environments. On the other hand, $E_1$ and $E_2$ were found to be unfavourable environments as reflected by the reduced mean values. The extent of reduction of performance varied with the characters and it was maximum for the character productive tillers (31.62 per cent) followed by plant height (19.78 per cent), grain yield (17.30 per cent), days to first flowering (15.24 per cent) and grains per panicle (9.73 per cent) This could be attributed to the combined effects of edaphic, agroclimatic and moisture stress conditions that prevailed in $E_1$ and $E_2$. A noteworthy features of dry and semi-dry paddy grown under rainfed conditions was its reduced tillering capacity necessitating thereby the adoption of higher seed rate so as to make up the total tillers through increased population. It was also observed that dry paddy crops ($E_1$) flowered earlier in 69 days compared to other three environments, which showed a range of 78 to 95 days. This would enable the crop to escape drought at a later stage of growth.

The pooled analysis of variance (Table 2) showed that the mean differences between the genotypes were highly significant. The environmental differences as well as the genotypes environment interaction (linear) were also significant indicating that the genotypes differed in their adaptability and stability. A major portion of the genotype-environment interaction was accounted by the linear component and both the linear and non-linear components were equally important in the stable performance of the genotypes.

It is necessary to identify dry and semi-dry rice genotypes that are better suited to medium and unfavourable environments combined with stability. A number of methods are now available for evaluating the stability of performance of difrerent crop varieties. Finlay and Wilkinson (1963) used linear regression as a quantitative measure of phenotypic stability to describe varietal adaptability on a range of enviroments. The absolute phenotypic stability of line was expressed by $b=0$ and an ideally adapted variety was the one having maximum yield potential in the most favourable environments and also maximum phenotypic stability. Eberhart and Russel (1966) suggested that both linear (bi) and non-linear components ($s^2di$) of the genotype environment interaction should be considered in judging the phenotypic stability of a particular genotype. A genotype with high mean, unit regression coefficient ($bi=1.0$) and least deviation from regression ($s^2di=0$) was considered as an ideal, widely adapted and stable genotype. Breese (1969), Samuel *et al.* (1970), Paroda and Hays (1971) and Jatasra and Paroda (1979) emphasized that linear regression could simply be regarded as a measure of response of a measure of response of a particular genotype whereas the deviation around the regression ($s^2di$) as the most suitable measure of stability, genotypes with least deviation around the regression line being the most stable and viceversa.

The statistical constants of the mean, regression coefficient (bi) and the standard deviation from regression ($s^2di$) for different characters of the fifteen genotypes are given in Table 3. A Simultaneous consideration of the three parameters of the individual

Table 1 Mean, Range and Environmental Index for yield and yield characters in four environments

| Characters | | Environments | | | | Fav. Envt. mean ($E_3 + E_4$)/2 | Unfav. Envt. mean ($E_1 + E_2$)/2 | %-reduction in unfav. envt. |
|---|---|---|---|---|---|---|---|---|
| | | $E_1$ | $E_2$ | $E_3$ | $E_4$ | | | |
| Grain yield (kg) | Mean | 1.203 | 1.288 | 1.657 | 1.474 | 1.566 | 1.295 | 17.30 |
| | Range | 0.45— 2.00 | 0.30— 2.30 | 0.85 — 2.65 | 0.975— 1.900 | | | |
| | Ij | —0.203 | —0.118 | 0.252 | 0.069 | | | |
| Days to first flowering | Mean | 69.230 | 78.50 | 94.80 | 78 10 | 86.45 | 73.87 | 15.24 |
| | Range | 55.5— 103.5 | 65.0 — 102.5 | 71.0 - 118.5 | 61.5 — 97.5 | | | |
| | Ij | —10.93 | —1.66 | 14.65 | —2.06 | | | |
| Plant height (cm) | Mean | 79.75 | 81.49 | 90.42 | 108.09 | 99.25 | 80.62 | 19.78 |
| | Range | 53.5— 107.5 | 33.0— 122.35 | 59 6— 122 6 | 82.5— 141.95 | | | |
| | Ij | —10.19 | —8.45 | 0.49 | 18.15 | | | |
| Productive tillers (no.) | Mean | 3.83 | 6.15 | 7.13 | 7 47 | 7.30 | 4.99 | 31.62 |
| | Range | 1.50— 8 25 | 3.50 11.00 | 5 50— 9.20 | 5.50— 11.20 | | | |
| | Ij | —2.32 | 0.00 | 0.99 | 1.33 | | | |
| Grains per panicle (nos) | Mean | 102.80 | 82.39 | 89.98 | 115.16 | 102.52 | 92.59 | 9.73 |
| | Range | 79.0— 125.0 | 32.0— 116.45 | 58 0 - 121.0 | 86.0— 164.3 | | | |
| | Ij | 5.22 | 5.19 | —7.60 | 17.57 | | | |

genotypes for the character grain yield indicated that seven genotypes viz., Kuruvaikalangiam, ASD 4, TKM 9, Nootripattu, MDU 1, Vaiappukodanchan and Poongar recorded yields higher than the general mean but with varied response to changes in environment and stability. Three genotypes viz Nootripatti, IET 1444 and PM 1002 had significant values for both bi and $\bar{s}^2$ di pointing out to the relative importance of both linear and non-linear components of genotype environment interaction. Four genotypes namely, Norungan, Poongar, TKM 9 and TM 3709 had the least deviation from regression when all others had highly significant $\bar{s}^2$ di value. TKM 9 was the only high yielding variety with wider adaptability and high stability. Poongar, a local cultivar was another stable variety with high mean and specifically suitable to unfavourable environments. Norungan and TM 3709 were the other two most stable varieties but with low mean. When Norungan was suitable to unfavourable environment, TM 3709 was suitable to highly favourable environments.

For the character days to first flowering, three genotypes viz. Kuruvaikalangiam, Poongar and TKM 9 had less than unit and significant regression coefficient indicating their high adaptedness to unfavourable,

Table 2. Pooled analysis of variance of mean values for yield and yield characters in dry and semi-dry paddy

| Source | d.f. | Grain yield | Days to first flowering | Plant height | Productive tillers | Grams per panicle |
|---|---|---|---|---|---|---|
| Genotypes | 14 | 0.893** | 380.230** | 1183.455** | 7.820** | 820.11** |
| Envt + (G x E) | 45 | 0.189** | 176.221** | 380.200** | 5.557** | 546.010** |
| Envt. (linear) | 1 | 0.615** | 703.600** | 2522.740** | 40.393** | 3124.590** |
| G x E (Linear) | 14 | 0.493** | 350.480** | 471.509** | 6.061** | 716.484** |
| Pooled devitation (non-linear) | 30 | 0.027 | 30.413** | 91.324** | 1.463** | 138.017 |
| Pooled error | 60 | 0.022 | 3.430 | 12.750 | 0 402 | 91.524 |
| Non linear-linear ratio | | 1:18.26 | 1:11.52 | 1:5.16 | 1:4.14 | 1:5,19 |

* Significant at 5 per cent level
** Significant at 1 per cent level

environments. All genetypes excepting Nootripathu, Poongar and TKM 9 had significant $\bar{s}^2$ di value. Poongar and TKM 9 were earlier in flowering by eleven days compared with general mean (80.15 days) and would be the most suitable ones for the unfavourable environments. These two varieties were also stable for this character.

The general tendency of the genotypes in showing differential response to fluctuating environmental conditions and stability of performance was also observed for the character, plant height. Four genotypes viz., Kuruvaikalangiam, Norungan, TKM 9 and TM 3709 had highly significant linear regression (bi) and deviation from linear regression ($\bar{s}^2$ di) values. Inspite of their unstable performance, the first three genotypes were highly suitable for unfavourable environments. Highly significant bi and non-significanf $\bar{s}^2$ di values in respect of the genotypes C 22, 1444 and PM 1023 indicated that the linear component of geno types environment interaction determined the expression of the character. When a majority of the genotypes were unstable, four genotypes viz.; Varappukodanchan, C 22, IET 1444 and PM 1023 were stable as indicated by the negative values of $\bar{s}^2$ di. A distinguishing feature of Varappukodanchan was its wider adaptability combined with an acceptable height conforming to semi-dwarf type.

The non-significant values of bi and $\bar{s}^2$ di of the individual genotypes for the character productive tillers clearly showed the absence of genotype-environment interaction for all genotypes excepting Poongar which was significant for bi only. Kuruvaikalangiam produced the maximum number of productive tillers followed by ASD 4, TKM 9, MDU 1, PM 1121, Varappukondanchan and PM 1002.

Table 3. Stability parameters of 15 genotypes of dry and semi-dry paddy for yield and yield characters

| Variety | Grain yield | | | Days to first flowering | | | Plant height | | | Productive tillers | | | Grains per panicle | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | bi | $S^2d$ | M | bi | $S^2d$ | M | bi | $S^2d$ | M | bi | $S^2d$ | M | bi | $S^2d$ |
| Kuruvai kalangium | 2.00 | 0.319 | 0.079** | 99.00 | −0.186** | 29.145** | 116.71 | 0.033** | 62.289 | 8.86 | −0.185 | 2.633 | 111.86 | 0 332** | −70.315 |
| Nootri-pathu | 1.65 | -2.715** | 0.031** | 71.13 | 1.595 | 26.101 | 84.33 | 0.879 | 106.161** | 5.63 | 0.946 | 1.573 | 85 80 | 0.256 | 297.642** |
| Norungan | 1.13 | 0,141 | −0.008 | 72.50 | 1.510 | 44.216** | 88.60 | -0.183** | 86.269** | 4.80 | 0,835 | 4.317 | 74.38 | 1.511* | −75.336 |
| Poongar | 1.53 | 0.610 | 0.009 | 67.28 | 0.268** | 0.091 | 112.30 | 0.632 | 76.811** | 5.36 | 0.544** | -0.102 | 90.40 | −0.085** | − 58.969 |
| Varappu-kodanchan | 1.58 | 0.615 | 0.082** | 73,631 | 1.555 | 66.967** | 85 73 | 0.909 | −11.055 | 6.59 | 0 847 | 0.052 | 92.50 | 1.099 | −43 654 |
| ASD 4 | 1.98 | 0.745 | 0.134** | 98 380 | 0.844 | −101.934** | 116.13 | 0 599 | 145.999** | 8.29 | 0.957 | −0.010 | 108.46 | 0,223** | −77.574 |
| C 22 | 1.10 | 1.674 | 0.118** | 89,25 | 1.670 | 111.681** | 82 60 | 1.326** | -7.188 | 4.76 | 1.313 | 0 370 | 111.23 | 1.090 | 90,297 |
| IET 1444 | 1.23 | 4.999** | 0.061** | 77.25 | 1.343 | 15 482** | 69.88 | 0 681** | -5.481 | 4.90 | 1.196 | 1.535 | 102.50 | 1.239 | 603.154** |
| MDU 1 | 1.58 | 1.113 | -0.709** | 87.88 | 0.669 | 46.722** | 113.80 | -0.163 | 72 297** | 7.30 | 0.558 | 0 308 | 98.14 | 0 235** | −37.609 |
| TKM 9 | 1.72 | 1.151 | -0.020 | 69.38 | 0.129** | −2 928 | 87.24 | -0.073** | 87.797** | 7.36 | 0.891 | 1.015 | 91.14 | 0.221** | − 67.633 |
| PM 1002 | 0,66 | 1 949** | 0.039** | 76.28 | 1,395 | 13.973** | 86 93 | 2.128 | 170.769** | 6,30 | 1.535 | 0.148 | 105.70 | 1.925** | −6.434 |
| PM 1023 | 1.18 | 1.365 | 0.119** | 79.63 | 1.125 | 12.492** | 85.36 | 3.171** | −1 280 | 5 18 | 1 221 | 0.248 | 118.33 | 1.493 | 29.814 |
| PM 1036 | 1.40 | 2.298 | 0.096** | 81,00 | 1,849 | 71.187** | 86.80 | 0.810 | 119 168** | 4 73 | 1,444 | 0.272 | 98.83 | 3.668** | 78.891 |
| PM 1121 | 1.41 | 0.213 | 0.036** | 75.88 | 1.121 | 18 255** | 64.98 | 1.220 | 7.513 | 6 74 | 1.665 | 5 859 | 76.69 | 0.481 | 269.472** |
| TM 3709 | 1.00 | 1.688 | 0 001 | 83.25 | 1 081 | 52.168** | 67.75 | 2 162** | 269 027 | 5 60 | 1.055 | -2.285 | 84 33 | 2.412 | 275.405** |
| Mean | 1.40 | 0.996 | | 80.15 | 1.031 | | 89 94 | 0 975 | | 6,15 | 0.998 | | 97.58 | 0.996 | |

ASD 4 was the widely adapted genotype. Kuruvaikalangiam, Varappukodanchan, MDU 1 and TKM 9 were highly adapted to unfavourable/stress environments. Though TM 3709 was the one with average response it had low mean.

As many as eight genotypes had more number of grains per panicle than the general mean. Seven of these had highly significant bi values indicating the presence of lineal portion of geno type-environment interaction. Varappukodanchan and C 22 were the widely adapted genotypes. When Kuruvaikalangiam, ASD 4 and MDU 1 were suitable to unfavourable environments: Norungan, PM 1002 and PM 1036 were adapted for favourable environments. Four geno types viz. Nootripattu, IET 1444, PM 1121 and TM 3709 were highly unstable as revealed by the highly significant $\bar{s}^1$ di values while the rest could be considered stable for the character, grains per panicle.

The data on stability parameters for components of yield and fitness revealed that the most stable and high yielding genotype TKM 9 had higher and close to general mean values for productive tillers and plant height respectively. The other high yielding and stable geno type, Poongar was tall in height and hence prone to lodging. It had low mean values in respect of other three characters. Considering regression, TKM 9 had less than unity for all characters excepting grain yield for which it was close to unity. TKM 9 would merit consideration as a superior genotype specifically suitable to unfavourable/stress environments. Poongar was similar to TKM 9 in its adaptability and stability. Both of these genotypes were stable for all characters excepting plant height. The behaviour of these two genotypes in regard to adaptability and stability was so similar and nearly identical too that it would suggest a parallelism in the evolutionary history of these two genotypes. Further, Kuruvaikalangiam was the best performer for all characters excepting grains per panicle for which PM 1023 was the best performer. TM 3709 was the most widely adapted genotype for days for flowering. ASD 4 was the most stable and widely adapted genotype for productive tillers.

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