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# EFFECT OF GEOGRAPHICAL PARAMETERS, SOWING DATE AND FLOWERING DURATION ON GRAIN YIELD OF RICE*

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Coordinated rice experimental data of 5 varieties belonging to different maturity groups for 5 years (1985-90) grown during the wet seasons was scanned to study the relationship between grain yield and latitude, longitude, altitude, sowing date and days to 50 per cent flowering from amongst 60 test locations in the country. Longitude and days to 50 per cent flowering had a significant effect on grain yield in all the 5 varieties. From the cause effect analysis, it was noticed that relatively dry weather favours higher grain yield besides more days to flowering. Further, it was pointed out that low grain yoields in Eastern India could be attributed to high relative humidity, higher night temperture coupled with low evapotranspiration values resulting in low nutrients uptake.

**Key words :** Rice, yield relationship, geographical parameters, cause effect analysis, harvest index

Rice is grown under diverse agro-climatic conditions in India from 8° N - 36° N latitudes, 68° E - 97°E longitudes and at varying altitudes sometimes even higher than 4,000 feet. The crop can be grown even upto 6,500 feet height (Wilsie, 1974). The geographical parameters alongwith sowing date and days taken to 50 per cent flowering of a rice variety affect the grain yield substantially. Undoubtedly, the application of inputs at their optimum levels based on the nature of soil and other factors also enhances the grain yield to a great extent in a particular environment. Grain yield is influenced by days to 50 per cent flowering (Das and Borthakur, 1975; Mahajan and Rao, 1990) in dry and wet season under irrigaqted conditions. Effect of geographical parameters on days to 50 per cent flowering were studied by Mahajan and Rao (1991). This study was undertaken to study the effect of latitude, longitude, altitude, date of sowing (number of days to sowing from 1st June) and days taken to 50 per cent flowering on the grain yield of rice varieties belonging to different maturity groups.

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## MATERIALS AND METHODS

Data on sowing dates ($X_4$), days taken to 50 per cent flowering ($X_5$) and grain yield (Y) of 5 rice varieties, 'Rasi' (very early duration), 'IR 36 and Ratna' (early duration), 'Jaya' (medium duration) and 'Pankaj' (late duration) for 5 years from *kharif* 1985 to 1990 at 60 locations were extracted from the Annual Reports of the Directorate of Rice Research, Hyderabad from the Uniform Variety Trials only. Averages of flowering duration, sowing date and grain yield were computed. Location wise data on latitude ($X_1$), longitude ($X_2$) and altitude ($X_3$) were taken from Randhawa (1958) and their ranges are presented in Table 1. The $X_1$'s were then regressed against grain yield through multiple regression technique. The bi's are the partial regression coefficients to the corresponding $X_i$'s.

## RESULTS AND DISCUSSION

Nearly 60-80 per cent variation in grain yield was explained by latitude, longitude, altitude, sowing date and days to 50 per cent flowering in all the varieties except 'Rasi'. This indicated that some other factors are also responsible for variation in grain yield. Longitude and days taken to 50 per cent flowering affected the grain yield significantly in all the varieties.While sowing date had a significant negative effect on grain yield of 'Ratna', altitude had a significant effect of 'Rasi' and 'Pankaj'. An increase in longitude was resulted in decreasing the grain yield, the magnitude depending upon the variety. Similarly, delayed 50 per cent flowering resulted in increasing the grain yield potential, with the maximum in 'IR 36'. From the results, it was quite clear that as we move from Western (lower longitude values) to Eastern (higher longitude values) India, the grain yield of five varieties belonging to different maturity groups were decreasing. A look at the agroclimatic map of the country indicates that the mean daily temperature for October month is slightly higher (27.5°C) in the central than in the western coast (25°C). But the mean minimum temperatures (i.e., night temperature) are slightly higher in the eastern coast belt, around 22.55°C, than in the interior 20-22.5°C (IMD, 1978). Rice requires relatively lower minimum temperature for better grain yields (Papadakis, 1970). Secondly, the relative humidity during afternoon hours in October was found to increase from around 60 per cent to 75 per cent in the eastern coast. The related evapotranspiration (ET) values showed a decreasing trend from around 6 mm/day in the interior to almost 4 mm/day in the east coast indicating thereby lower potential transpirational rates because as the relative humidity increases the vapour pressure deficit decreases. This ultimately results in lower grain yields as the uptake quantum of nutrients like Ca, Mg, Mn etc. depends on mass flow mechanism. With the decrease in transpirational rate, the level of uptake of these nutrients will also be low and thereby resulting in lower yields (Tomar and Toole, 1980; Hirai *et al.*, 1985). The lower grain yield in east coast are thus likely to be due to the combined influence of low ET values and relatively higher night temperature than in the interior of the country.

Among the varieties tested, it is clear that as the days to 50 per cent flowering increases, the grain yield also shows an increasing trend. Naturally, as the flowering gets delayed, the chances for accumulating greater biomass during the pre-flowering period are more. On the assumption of a more or less stable harvest index for different varieties, the grain yields will be more with higher biological yields (total dry matter). In varieties with less duration to flowering, there will be a heavy competition between the simultaneously growing organs (viz., vegetative tillers and generative panicles) for the available photosynthates (Yoshida, 1981)

**Table 1. Range of latitude, longitude, altitude, sowing date, flowering duration and mean grain yield of 5 rice varieties**

| Variety | $X_1$(°N) | $X_2$(°E) | $X_3$(m) | $X_4$(days) | $X_5$(days) | Y(t/ha) |
|---|---|---|---|---|---|---|
| 'Rasi' | 9.5-30.2 | 72.4-94.2 | 1.5-961.5 | 10-56 | 76.96 | 3.61 |
| 'IR 36' | 10.5-31.5 | 72.4-94.2 | 1.5-961.5 | 15.68 | 84-102 | 4.10 |
| 'Ratna' | 10.5-31.5 | 72.4-94.2 | 1.5-961.5 | 15-70 | 81-104 | 4.17 |
| 'Jaya' | 9.5-32.0 | 72.4-92.3 | 1.5-764.5 | 6-48 | 94-116 | 4.38 |
| 'Pankaj' | 12-26.6 | 74.5-88.2 | 8.6-764.5 | 18-44 | 116-132 | 4.59 |

**Table 2. Estimates of partial regression coefficients for different varieties**

| Variety | a | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | $R^2$ |
|---|---|---|---|---|---|---|---|
| 'Rasi' | 17.74 | 0.006 | –0.132** | 0.002** | 0.011 | –0.011 | 61.2 |
| 'IR 36' | 5.36 | –0.032 | –0.085** | 0.000 | 0.003 | 0.066* | 60.3 |
| 'Ratna' | 15.04 | 0.011 | –0.081** | 0.000 | –0.023* | 0.038* | 63.2 |
| 'Jaya' | 14.42 | 0.000 | –0.185** | 0.000 | 0.014 | 0.044* | 81.1 |
| 'Pankaj' | 12.56 | 0.104 | –0.179** | –0.002* | 0.038 | 0.035* | 73.2 |

* $P \leq 0.05$, ** $P \leq 0.01$

With regards to altitude, only two varieties showed significance viz., 'Rasi' (positive effect) and 'Pankaj' (negative effect) relationship with grain yield. It is known that with increasing altitude, for every 100 m, rise, a decrease of 1° C in temperature will result (Anonymous, 1972). It is also reported that at higher attitudes, the solar spectrum wil be richer in ultra-violet rays and the diurnal range in temperature is greater than at lower altitudes

(Critchfield, 1975). Seshu *et al.* (1989) reported that with increase in altitude, the dsays to 50 per cet flowering will increase as was noticed in this study (original data is not reported here. As already stated, the delay in flowering in 'Rasi' resulted in higher grain yield. However, in the case of 'Pankaj' the same analogy of not seem to be applicable perhaps due to too much of delay in flowering, the variety might have encountered sufficiently too low temperature affecting anthesis besides being subjected to harmful ultra- violet radiation for a longer time than in 'Rasi'.

From this study, it can be concluded that the lower yields in areas with higher longitudes (Eastern India) could be due to higher relative humidity, higher night temperature coupled with lower evapotranspiration values which might have resulted in lesser uptake of nutrients, viz. Ca, Mg, Mn etc. and thereby in poor grain yields.

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