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STUDIES ON CORRELATION AND CAUSE-EFFECT ANALYSIS IN RILS OF MTU 1010 X BR 2655 FOR YIELD AND NUTRITIONAL TRAITS IN RICE

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ABSTRACT

The Research was conducted with an aim to study the character association and cause-effect analysis for yield, yield attributing and nutritional traits in 190 F_7 RILs derived from MTU-1010 and BR-2655 during *Kharif* 2016. Study revealed that panicle length (0.206*), productive tillers per plant (0.308*), filled grains per panicle (0.215*) and 1000-grain weight (0.307**) are positively associated with grain yield, indirect selection for these traits might improve the grain yield. Path analysis demonstrated that 1000-grain weight (0.367), plant height (0.129), filled grains per panicle (0.050), days to 50 per cent flowering (0.014) and productive tillers per plant (0.016) exerted positive direct effect on grain yield indicating that the selection for these characters was likely to bring about an overall improvement in grain yield per plant directly. These characters can be used in the selection programme to isolate superior lines with genetic potentiality for high yield in rice genotypes.

INTRODUCTION

Rice (*Oryza sativa* L.), a model cereal species occupies the enviable prime place among the food crops cultivated around the world. The slogan "Rice is life" suits the most for Indian culture, as this crop plays a crucial role in livelihood for millions of rural households and describes its importance in food and nutritional security. It is the principle food for more than half of the world's population (Sasaki and Burr, 2000). Micronutrient malnutrition has been designated as the most serious challenge to humanity (Copenhagen Consensus, 2008) as two-third of the world's population is at risk of deficiency in one or more essential mineral elements (Cakmak, 2002; White and Broadley, 2009; Stein, 2010).

The mineral elements most commonly lacking in human diets are iron and zinc (White and Broadley, 2009; Stein, 2010) which ranked fifth and sixth, respectively, among the top ten risk factors contributing to burden of disease (WHO, 2002). In Asia and Africa, it is estimated that 500-600 million people are at risk for low zinc intake (HarvestPlus, 2010). To overcome this, a genetic approach called Biofortification (Bouis, 2002) has been developed, which aims at biological and genetic enrichment of food stuffs with vital nutrients (vitamins, minerals and proteins). Ideally, once rice is biofortified with vital nutrients, the farmer can grow the variety indefinitely without any additional input to produce nutrient packed rice grains in a sustainable way. This is also the only feasible way of reaching the malnourished population in rural India.

Correlation between grain yield and other characters is helpful in selection of suitable plant type. When more characters are included in correlation study, the association becomes more complex. In such situations, selection on the basis of direct and indirect effects is more useful than selection for yield *per se*. Path co-efficient analysis developed by Wright (1921) helps in partitioning of the correlation coefficients into direct and indirect effects and to assess the relative contribution of each component character to grain yield. With this information the study was planned to estimate correlation coefficient and path effects among yield, yield components and nutritional traits in recombinant inbred lines of rice.

MATERIALS AND METHODS

The experimental material consisted of a 190 recombinant inbred lines (RILs) mapping population derived from a cross of MTU1010 x BR2655. The RIL population was planted along with parents in randomized block design with 3 replications each with a pacing of 20 x 15cm. All the recommended agronomic package of practices was adopted besides providing necessary prophylactic plant protection measures to raise a good crop. Observations were recorded for yield and yield attributing traits *viz.*, days to 50% flowering (DFF), plant height (PH), panicle length (PL), productive tillers per plant (PT), filled grains per panicle (FG), 1000-grain weight (TW) and grain yield per plant (GY) and subjected to statistical analysis. Statistical analysis for the above characters were done following Singh and Chaudhary (1985) for correlation coefficient and Dewey and Lu (1959) for path analysis. Nutritional traits grain iron and zinc concentration in the unpolished rice grains were determined by X – Ray fluorescence Spectrometry (XRF) (Paltridge *et al*., 2012).

RESULTS AND DISCUSSION

Association studies

Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for improvement of the character. Genotypic correlation coefficients between yield, yield attributing and nutritional characters were analysed and results are presented in (Table.1).

Days to 50% flowering showed a non-significant positive association with grain yield per plant (0.080), 1000-grain weight (0.143) and filled grains per panicle (0.069). Negative and significant association recorded with plant height (-0.252**) and non-significant negative for panicle length (-0.013), productive tillers per plant (0.067), grain zinc (-0.133) and iron concentration (-0.087). Similar findings were recorded by Sarker *et al.* (2014) for number of filled grains per panicle, Rao *et al*. (2014) for 1000-grain weight and panicle length, Nandan *et al*. (2010), Rao *et al*. (2014) for grain yield per plant and Ajmera *et al*. (2017) for grain zinc and iron concentration.

Plant height recorded a significant negative association with grain yield per plant (-0.113), grain zinc (-0.188*) and iron concentration (-0.132*), positive non-significant association with panicle length (0.114), productive tillers per plant (0.098) and 1000-grain weight (0.023) and negative non-significant association with filled grains per panicle (-0.024). Similar with Rao *et al*. (2014) for number of productive tillers per plant, Sala *et al*. (2015) for panicle length, Dhurai *et al*. (2014) for 1000-grain weight, Nagesh *et al*. (2012) for grain zinc and iron concentration, Reddy *et al*. (2013), Patel *et al*. (2014), Biswash *et al*. (2015), Thippeswamy *et al*. (2016) and Priya *et al*. (2017) with grain yield per plant.

Panicle length showed significant positive association with grain yield (0.206*) indicating that selection for this trait could improve the grain yield. This trait showed non-significant positive association with filled grains per panicle (0.015) and non-significant negative association with productive tillers per plant (-0.005), 1000-grain weight (-0.039), grain zinc (-0.114) and iron concentration (-0.148). Similar were reported by Rao *et al*. (2014) for days to 50 % flowering, Sala *et al*. (2015) for plant height, Rahman *et al*. (2014) for number of filled grains per panicle, Nagesh *et al*. (2012) for grain zinc concentration, Dhurai *et al*.. (2014) for 1000- grain weight and number of productive tillers per plant, Thippeswamy *et al*. (2016)and Priya *et al*. (2017) for grain yield per plant.

Table 1: Correlation coefficients for yield contributing and nutritional characters in rice

Characters	Days to 50% flowering	Plant height	Panicle length	productive tillers per plant	filled grains per panicle	1000-grain weight (g)	Grain iron concen tration (ppm)	Grain zinc concen tration (ppm)	Grain yield per plant (g)
Days to 50 per cent flowering	1	-0.252**	-0.013	-0.067	0.069	0.143	-0.087	-0.133	0.08
Plant height		1	0.114	0.098	-0.024	0.023	-0.132*	-0.188*	-0.113*
Panicle length			1	-0.005	0.015	-0.039	-0.148	-0.114	0.206*
Number of productive tillers per plant				1	-0.055	-0.046	-0.113	-0.07	0.308**
Number of filled grains per panicle					1	0.02	-0.095	-0.083	0.215*
1000-grain weight (g)						1	-0.056	-0.041	0.307**
Grain iron concentration (ppm)							1	-0.212	-0.393**
Grain zinc concentration (ppm)								1	-0.424**

P -represents phenotypic correlation coefficient; G- represents genotypic correlation coefficient, *Significant at 5 percent level, **Significant at 1 percent level

Table 2: Direct and indirect effects of yield attributing and nutritional traits in rice

Characters	Days to 50% flo wering (cm)	Plant height (cm)	No of productive tillers/plant	Panicle length	No. of filled grains per panicle	1000-grain weight (g)	Grain iron (ppm)	Grain zinc (ppm)	Grain yield per plant(g)
Days to 50% flowering	0.014	-0.003	-0.001	-0.002	0.001	0.002	-0.002	-0.002	0.08
Plant height (cm)	-0.032	0.129	0.011	0.014	-0.003	0.003	-0.014	-0.024	0.215**
No of productive tillers/plant	-0.001	0.001	0.016	-0.001	-0.009	-0.007	-0.001	-0.001	0.037
Panicle length (cm)	0.001	-0.006	0.001	-0.005	-0.001	0.002	0.005	0.003	0.03
No. of filled grains per panicle	0.003	-0.001	-0.002	0.008	0.05	0.001	-0.003	-0.004	0.102*
1000-grain weight	0.052	0.008	-0.015	-0.014	0.007	0.367	-0.015	-0.015	0.393**
Grain iron concentration (ppm)	0.035	0.062	0.014	0.009	0.035	0.014	-0.268	-0.297	-0.324**
Grain zinc concentration (ppm)	0.039	0.056	0.021	0.032	0.023	0.012	-0.323	-0.254	-0.424**-

Residual effect = 0.8050, Bold values- direct effects, Normal values-indirect effects,*Significant at 5 percent level, **Significant at 1 percent level

Productive tillers per plant exhibited negative non-significant association with filled grains per panicle (-0.055), 1000-grain weight (-0.046), grain zinc (-0.070) and iron concentration (-0.113). Grain yield per plant had a significant positive association (0.308**) with this trait suggesting that direct selection for higher productive tillers per plant may increase the grain yield per plant. Similar with Rao *et al*. (2014) for plant height and 1000-seed weight, Dhurai *et al*. (2014) for panicle length and Nagesh *et al*. (2012) for grain zinc concentration, Ratna *et al*. (2015); Ashok *et al*. (2016); Priya *et al*. (2017) for grain yield per plant.

Filled grains per panicle reported a non-significant positive correlation with 1000-grain weight (0.020) whereas non-significant negative correlation with grain zinc (-0.083) and iron concentration (-0.095). This character shown significant positive association with grain yield per plant (0.215*). Similar with Nandan *et al*. (2010), Sarker *et al*. (2014) for days to 50 % flowering, Nandan *et al*. (2010) for plant height, Rahman *et al*. (2014) for panicle length, Biswash *et al*. (2015), Thippeswamy *et al*. (2016), Lakshmi *et al*. (2017) for 1000 seed weight, Lakshmi *et al*. (2017) and Priya *et al*. (2017)) for grain yield per plant. Nagesh *et al*. (2013) for grain zinc and iron concentration.1000-grain weight showed highly significant positive correlation with grain yield per plant (0.307**) and non-significant negative correlation with grain zinc (-0.041) and iron concentration (-0.056). This trait acts as a selection criterion for improvement of grain yield per plant. Reported same with Ashok *et al*.(2016), Lakshmi *et al*. (2017), Priya *et al*. (2017) for grain yield per plant and Nagesh *et al*. (2013) for grain zinc and iron concentrations.

Grain zinc (-0.424**) and iron concentration (-0.393**) showed a negative significant correlation with grain yield per plant, this indicates that there is difficulty in simultaneous development of these traits with grain yield. The results were in accordance with Nagesh *et al*. (2013) for grain yield per plant.

Grain yield per plant had significant positive association with panicle length (0.206*), productive tillers per plant (0.308**), number of filled grain per panicle (0.215*) and 1000-grain weight (0.307**). Non-significant positive association observed with days to 50 per cent flowering (0.080). Plant height (-0.113*), grain iron (-0.424**) and zinc concentration (-0.393**) showed significant negative association with grain yield. Results suggests that, while improving grain yield due care is given to component traits *viz*., panicle length, number of productive tillers per plant, filled grains per panicle and 1000-grain weight as these traits are positively associated with grain yield, indirect selection for these traits might improve the grain yield.

Path analysis

The association of different component characters among themselves and with yield is quite important for devising an efficient selection criterion for yield. The total correlation between yield and its component characters may be some times misleading, as it might be an over-estimate or under-estimate because of its association with other characters. If relationship is due to multiple effects of gene(s) it is difficult to separate these effects by selecting a particular character. Hence, indirect selection by correlated response may not be some times fruitful.

When many characters are affecting a given character, splitting total correlation into direct and indirect effects of cause as devised by Wright (1921) would provide more meaningful interpretation to the cause of association between the dependent variable like yield and independent variables like yield component characters. This kind of information will be helpful in formulating the selection criteria.

If the correlation coefficient between caused factor and the effect is almost equal to its direct effect, then correlation explains the true relationship and direct selection of this trait will be effective. The correlation coefficient is positive and the direct effects are negative or negligible, the indirect effects seem to be the cause of correlation. In such situations the other factors influencing the trait have to be considered simultaneously. Correlation coefficients may be negative but the direct effect may be positive and high. Under these conditions a restricted simultaneous selection model is to be followed *i.e.,* restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effects. Path coefficient analysis shown in Table 2, revealed that 1000-grain weight exerted the highest positive direct effect (0.367) on grain yield followed by plant height (0.129), filled grains per panicle (0.050), days to 50 per cent flowering (0.014) and productive tillers per plant (0.016) indicating that the selection for these characters was likely to bring about an overall improvement in grain yield per plant directly. Therefore, it is suggested that preference should be given to these characters in the selection programme to isolate superior lines with genetic potentiality for high yield in rice genotypes. Negative direct effect on grain yield was exhibited by panicle length, grain zinc and iron concentration.

High direct effect of 1000-grain weight (0.367) on grain plant yield was reported by Thippeswamy *et al*. (2016), Tejaswini *et al*. (2016), Kalyan *et al*. (2017), Lakshmi *et al*. (2017), Priya *et al*. (2017). Plant height (0.129), filled grains per panicle (0.050), number of productive tiller per plant (0.016) and days to 50 per cent flowering (0.014) also had direct positive effect and positive genotypic correlation with grain yield. Rahman *et al*. (2014), Ashok *et al*. (2016), Lakshmi *et al*. (2017) and Priya *et al*. (2017) reported positive direct effect of plant height, number of productive tillers and number of filled grains per panicle. Nikhil *et al*. (2014), Ratna *et al*. (2015), Tejaswini *et al*. (2016) and Priya *et al*. (2017) reported positive direct effect of days to 50 per cent flowering.

Negative direct effect of panicle length (-0.005), grain zinc (-0.254) and iron concentration (-0.268) on grain yield was observed. The direct effect and correlation coefficient of grain zinc and iron concentration were negative, so the direct selection for these traits to improve the yield will not be desirable.Thippeswamy *et al*. (2016), Lakshmi *et al*. (2017) and Priya *et al*. (2017) also reported negative direct effect of panicle length on grain yield. Nagesh *et al*. (2013) reported negative direct effect of grain zinc and iron concentration on grain yield.

CONCLUSION

Traits such as *viz*., days to 50 per cent flowering, productive tillers per plant, filled grains per panicle and 1000-grain weight are the most contributing factors for the improvement of rice grain yield. Hence, those traits have to be taken in to consideration in rice breeding program for the improvement of grain yield.

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