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RELATION OF PLANT TYPE WITH DISEASE RESISTANCE AGAINST BROWN SPOT OF RICE

BY

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In the present study an attempt was made to find out relationship of thirteen plant characters, considered to be yield attributes with incidence of brown spot disease of rice. Days to flower, height of the plant in association with other characters, were found to be positively correlated with this disease. Number of total tillers per hill and percentage of non effective tillers showed negative relationship while length and breadth of flag leaf had positive contributing effect. Angle of flag leaf in association with other characters did show any significant correlation, but when considered alone showed positive contribution indica ing important intrinsic role of this character. Angle of second and third leaf were negatively, panicle length and grain density positively correlated with the disease. Spikelet sterility and grain weight did not have any effect.

INTRODUCTION

Rice (*Oryza sativa* L.) the most important cereal in South East Asia, including India suffers from attack of a large number of diseases. The disease situation in rice is rapidly changing particularly with the shift to new high yielding dwarf indica varieties and adoption of new pakage of practices for their effective exploitation. Severe incidence of a number of new diseases on rice have noticed (Khatua, 1980). The present situation definitely indicates the need of integrated management with emphasis on use of resistant varieties. As the rice crop is attacked by a large number of diseases, a variety thus will require resistance against a number of them under varying agroclimatic conditions. But it is quite likely that high degree of vertical resistance which may be desirable from both theoretical and practical stand point against major diseases can not possibly be incorporated into a single variety, hence attention has to be paid to broad based multiple horizontal resistance against major pathogens which will enable a variety to be moderately to fairly resistant to major pathogens. Field or horizontal resistance is dependent to a large extent on expression of morphological characters with which it may be linked in direct or indirect manner.

Importance of anatomical characters in relation to resistance to brown spot disease has been emphasised (Chattopadhyay and Chakrabarti, 1957). Attempt has been made to correlate morphological characters with resistance to brown spot diseases.

Ono (1953), Dasgupta and Chattopadhyay, (1975) found the relationship of the position of the leaf with the incidence of brown spot disease and Gangopadhyay and Chattopadhyay (1974) the leaf angle in seedling phase. It has been felt that there might be some relationship between the morphological characters which are considered to be yield attributes and reaction towards disease in a variety. The present study was undertaken with the objective of finding out existence of relationship, if any,between some characters including reaction towards bacterial leaf blight, determining plant type and yield potential in a number of varieties with incidence of brown spot disease. Influence of a factor both in the plant type as a whole and when considered individually has been studied.

Table 1. *Multiple correlation coefficient for relation of brown spot disease with bacterial leaf blight and thirteen plant characters.*

Seasons	Multiple correlation coefficient	F. ratio	Confidence level
K-I	0.77146	3.780	99.936
K-II	0.78486	4.125	99.970
K-III	0.7670	3.674	99.918
B-I	0 80638	4.2496	99.965
B-II	0.80804	5.5960	99.977

K-I Kharif crop at Mohanpur, 1975
K-II Kharif crop at Mondouri, 1975
K-III Kharif crop at Mondouri, 1976
B-I Boro crop at Mondouri, 1976
B-II Boro crop at Mondouri, 1977

MATERIALS AND METHODS

Present investigation consisted of five discreet field experiments on rice conducted during both Kharif (July-November) and boro (January-June) from 1975 to 1977 in the Teaching Farm at Mohanpur-Mondouri of the Bidhan Chandra Krishi Viswavidyalaya, West Bengal. Fifty one cultivars of rice including both tall and dwarf high yielding indicas and japonicas having different grades of resistance against brown spot were taken for the study. Usual cultivation practices were followed in all the seasons.

Randomised block design was followed in all the experiments with three replications. Each block (replication) was divided into two sub-blocks. One sub-block was meant for tall varieties and other for dwarf varieties. In each replication, seedlings of each variety were transplanted in four consequitive rows of four metre length, with a spacing, row to row 25 cm and plant to plant 15 cm. On each side of each block, there was plot of two metre width along the length for planting of highly susceptible variety (Benibhog). Rows in these plots were arranged in opposite direction to the main block of experimental varieties.

Table 2. *Summarised statistical findings on relationship of fourteen plant characters with incidence of brown pot of rice*

Plant Characters	Seasons	Correlation coefficient (r)	t values for r	Partial correlation coefficient (r_p)	t values for r_p	Regression coefficient	t values for regression coefficient
1	2	3	4	5	6	7	8
Reaction towards Bacterial leaf blight (X_1)	K - I	0.068	0.476	0.080	0.485	0.075	0.464
	K - II	0.002	0.019	0.267	1.666	0.243	1.667
	K - III	0.136	0.958	0.217	1.334	0.286	1.334
	B - I	0.109	0.128	0.213	1.224	0.172	1.236
	B - II	0.131	0.785	0.314	1.523	0.224	1.518
Days to flower (X_2)	K - I	0.426**	3.292	0.008	0.050	0.001	0.050
	K - II	0.417**	3.207	-0.190	1.667	-0.023	1.164
	K - III	0.502**	4.066	-0.248	1.539	-0.042	1.539
	B - I	0 354*	2.536	-0.235	1.356	-0.041	1.370
	B - II	0.346*	2.153	0.116	0.539	0.019	0.537
Height of the plant (X_3)	K - I	0.416**	3.208	0.164	0.998	0.019	0.988
	K - II	0.394**	3.003	0.321*	2.035	0.048*	2.035
	K - III	0.394**	3.004	0.010	0.061	0.001	0.061
	B - I	0 304*	2.138	0.148	0.835	0.016	0.844
	B - II	0.062	0.359	-0.208	0.982	-0.023	0.979
Number of total tillers (X_4)	K - I	-0.326*	2.413	0.0001	0.0008	0.0001	0.0008
	K - II	-0.436**	3.996	-0.204	1.248	-0.173	1.248
	K - III	-0 221	1.592	0.295	1.849	0.345	1.849
	B - I	-0.342*	2.439	-0.337	2 006	-0.141	2.027
	B - II	-0.491**	3.283	-0.076	0.349	-0.031	0.349
Percentage of non effective tillers (X_5)	K - I	-0.382**	2.891	-0.126	0.760	-0.049	0.760
	K - II	-0.242	1.741	0.245	1.515	0.104	1.515
	K - III	-0.384**	2.909	-0.320*	2.030	-0.144*	2.030
	B - I	0.318*	2.232	-0.160	0.909	-0.019	0.918
	B - II	0.144	0.846	-0.029	0.137	-0.005	0.137
Length of flag leaf (X_6)	K - I	0.209	1.498	0.031	0.185	0.012	0.185
	K - II	0.369**	2.708	0.253	1.571	0.046	1.571
	K - III	0.308*	2.666	0.191	1.166	0.112	1.167
	B - I	0.384*	2.791	0.302	1.777	0.091	1.796
	B - II	0.296	1.810	0.529**	2.872	0.287**	2.862

1	2	3	4	5	6	7	8
Breadth of flag leaf (X_7)	K - I	0.289*	2.119	0.221	1.361	2.206	1.362
	K - II	0.234	1.683	0.083	0.498	0.973	0.499
	K - III	0.405**	3.102	0.232	1.432	3.269	1.433
	B - I	0.094	0.635	-0.025	0.142	-0.216	0.144
	B - II	0.351*	2.182	0.197	0.924	1.725	0.921
Angle of flag leaf (X_8)	K - I	-0.045	0.315	0.391*	2.553	0.058*	2.554
	K - II	-0.038	0.267	0.380*	2.465	0.056*	2.466
	K - III	-0.137	0.967	0.386*	2.135	0.080*	2.508
	B - I	0.004	0.002	0.345	2.060	0.039*	2.081
	B - II	0.035	0.201	0.360	1.775	0.042	1.769
Angle of second leaf (X_9)	K - I	-0.496**	3.998	-0.389*	2.531	-0.185*	2.531
	K - II	-0.491**	3.943	-0.463**	3.136	-0.226**	3.136
	K - III	-0.482**	3.487	-0.409*	2.689	-0.247*	2.690
	B - I	-0.510**	3.979	-0.275	1.589	-0.099	1.616
	B - II	-0.512**	3 464	-0.372	1 822	-0.126	1.835
Angle of third leaf (X_{10})	K - I	-0.312*	2.300	0 005	0.028	0.001	0.029
	K - II	-0.312*	2.295	0.159	0.972	0.045	0 972
	K - III	-0.206	1.472	0.146	0.884	0.050	0.885
	B - I	-0.425**	3.147	-0.253	1.466	-0.064	1.482
	B - II	-0.569**	4.043	-0.138	0.640	-0.035	0.638
Panicle length (X_{11})	K - I	0.266	1.933	0.089	0.537	0.082	0.538
	K - II	0.326*	2.419	-0.132	0.790	-0.174	0.791
	K - III	0.446**	3.504	0.338*	2.158	0.426*	2.159
	B - I	0.284	1.983	-0.128	0.722	-0.074	0.730
	B - II	-0.017	0.097	-0.545**	2.986	-0.483**	3.388
Grain density (X_{12})	K - I	0.212	1.518	-0.044	0.265	-0.085	0.265
	K - II	0.301	2.205	0.037	0.221	0.077	0.221
	K - III	0.295*	2.163	0.226	1.395	0.584	1.395
	B -I	-0.093	0.627	-0.688	0.495	-0.143	0.500
	B - II	0.218	1.306	-0.046	0.212	-0.072	0.212
Spikele sterility (X_{13})	K - I	-0.130	0.920	0.165	1.007	0.250	1.007
	K - II	-0.191	1.349	-0.011	0.063	-0.013	0.064
	K - III	-0.337*	2.509	0.023	0.141	0.054	0.141
	B - I	0.343*	2.449	0.265	1.539	0.311	1.555
	B - II	0.239	1 434	-0.115	0.534	-0.129	0.532
1000 grain weight (X_{14})	K - I	0.105	0.741	0.032	0.190	0.014	0.190
	K - II	0.063	0.441	-0.046	0.278	-0.022	0 279
	K - III	-0.092	0.646	0.199	1.221	0.124	1.222
	B - I	0.054	0.362	-0.068	0.383	-0.019	0.387
	B - II	0 036	0.209	0.121	0.563	0.055	0.561

** Significant at 1% level, *Significant at 5% level.

Observations were recorded for incidence of brown spot, bacterial leaf blight disease and thirteen plant characters (Table-2). Standard evaluation system as developed by International Rice Research Institute (Anonymous, 1975) was used for disease scoring at dough stage. In case of brown spot whole plant (hill) was taken into account in disease scoring and flag leaves in bacterial leaf blight. Grain density meant number of grain per centimetre length of the panicle. Score values for spikelet sterility was assigned using 0-9 scale (Anonymous, 1975). Angle of leaf was measured with the help of protector within 24 hours of flower emergence.

Statistical analysis of the recorded data were carried out for proper interpretation. Coefficient of correlation (r) was calculated using formula describsd by Chandel (1970). The multiple linear regression analysis on the observed data had been done on Burroughs B 6738 computer system, using BASIS, the Burroughs advance statistical analysis system, to find relationship of incidence of brown spot with bacterial leaf blight (X_1) and thirteen plant characters (X_2—X_{14}). This programme performed multiple linear regression by fitting an equation of the form $Y=A_0+A_1X_1+A_2X_2+ \ldots\ldots A_n X_n$ where

Y = the dependent variable

A = constant, X_1 to X_n the independent variable

Regression coefficient and partial correlation coefficient (r_p) were determined using the same computer system. Significance of correlation coefficient (r), regression coefficient, partial regression coefficient (r_p) were tested by 't' test (Chandel, 1970)

RESULTS AND DISCUSSION

Results of the study with fifty one varieties of rice including tall and dwarf 'indica', dwarf 'japonica' and thirteen plant characters normally considered as yield attributes were presented after statistical analysis, in Tables 1 and 2. Data presented in Table 1 showed existence of a good relationship between the plant morphological characters and incidence of brown spot disease caused by *Helminthosporium oryzae*. This was evident from the significant values of multiple regression coefficients. The values were, however, found to differ in different seasons, indicating the role of environmental factors in these characters. These factors have a direct influence on developmant of plant morphological characters, consequentty they exert an influence on the disease through host and also direct through pathogens which are equally affected by them regarding their perpetuation, multiplication and spread. As regard, the relationship between incidence of brown spot and bacterial leaf blight disease, brown spot was found to be influenced, to some extent, by bacterial leaf blight which might be interpreted due to weakening effect of the bacterial leaf blight disease on the host predisposing it to infection of brown spot.

The characters which have an effect on the incidence of the disease relate mostly to days to flower, height, number of effective and non effective tillers, flag leaf dimensions, leaf angles.

Days to flower have been found to be a positive correlating character in relation to brown spot. Partial correlation and regression coefficient values were not significant Non significant values of these coefficient indicate that duration of a variety, may not have any role of its own to play, but associated with other characters and under suitable environmental conditions, this may contribute in a significant manner to disease incidence.

A strong positive correlation between height of the plant and incidence of this disease clearly showed that taller plants were more prone to attack. In this case also significant value obtained in one season along with both partial correlation and regression coefficient indicated that this character has an intrinsic role. Field observation showed that tall indica plants suffer more from brown spot than dwarf plants.

Number of total tillers per hill was observed to be highly correlated with incidence of brown spot disease but the correlation was negatively significant in four out of five cases studied. Partial correlation coefficient and regression coefficients were insignificant in all these cases, but in two season, partial correlation values between number of total tillers and brown spot were high. But these two characters were either positively or negatively correlated indicating that tillering habit was dependent on environmental conditions. Though tillering habit is an important genetic, positive yield attributing character, nevertheless its expression is dependent on a number of environmental conditions, namely depth of standing water, fertility status, spacing, age of seedling, date of transplantation etc. Normally fertility status (Chattopadhyay and Dickson, 1960) are conducive to greater incidence of brown spot. Larger spacing which results in more number of tillers (Gangopadhyay and Chattopadhyay, 1974 b) are not favourable for the incidence of the disease. Hence relationship between tillering habit, as expressed under environmental conditions with brown spot disease may be considered indirect.

In case of percentage of non effective tillers, similar relationship was noticed. Partial correlation co-efficients and regression coefficients, were however found to be statistically significant in one case It might be expected that less incidence with greater number of non effective tiller was due to the fact that over all intensity of the disease is likely to be less being dispersed among more leaves. Tillering behaviour in relation to disease, needs more in-depth study, as the data show significant relationship.

Correlation coefficients, partial correlation coefficient and regression coefficient for length of flag leaf and brown spot disease are found to be positive. Correlation between characters was significant in three environments and in others though not significant it was also high. Effect was more pronounced in the plants in boro than those in kharif. As partial correlation coefficient, regression coefficient for the same were higher under the different condition studied in four season, this character can be considered to have a direct relationship with incidence of brown spot. Maximum breadth of flag leaf was found to be correlated with the resistance of rice plant against brown spot disease. Partial correlation coefficients and regression coefficients were not significant, nevertheless, they tend to point out role of possible direct relationship.

The angles subtended with stem axis by flag leaf, second and third leaf in sucession appeared to be an important character influencing incidence of the disease. In angle of flag leaf, partial correlation coefficient and regression coefficient were significant but correlation coefficient was not significant ; in second leaf correlation, partial correlation, regression coefficients were significant but negatively so ; in third leaf, only correlation coefficient was negatively significant but not partial correlation and regression coefficients. This indicated that when all plant characters were taken togather, angle of flag leaf might not have any effect on incidence of brown spot disease. But when considered alone, eliminating effect of other characters, a high positive correlation was noticed. Its direct effect towards the brown spot disease was significant in all cases studied excepting in the second boro season when direct contribution was high though not statistically significant. Gangopadhyay and Chattopadhyay (1974 a) had found a relationship of this character with incidence of the disease. Angle of second leaf when considered alone or with other character had good relationship with the disease in a negative manner but angle of third leaf had important role when considered with other characters.

So far panicle length and grain density in an earhead were concerned, longer panicle length was found to be associated with greater incidence of brown spot in a significant manner, partial correlation and regression coefficient values were also significant in some seasons. While in kharif, a positive correlation was noted, but in boro, correlation, partial and regression coefficients were negatively so.

Some what similar relationship was noted in repect of grain density. Differences in behaviour in two different seasons may be explained on the basis of chances of infection that might be associated with their characteristics. Greater panicle length is likely to expose the panicles to greater chances of infection of brown spot. Brown spot inciting pathogen also causes infection of grain. Conditions for grain infection are more congenial in kharif. Hence greater panicle length in kharif is aptly, correlated with greater incidence of disease. In boro season, at the time of panicle emergence, conditions for infection are less favourable. Whether this has any relationship with this contrasting behaviour needs to be studied in detail. It may be stated that effect of grain density on incidence of brown spot not so important when considered alone but along with other characters, it might play an important part.

Sterility of spikelets is influenced by a number of factors, genetical, environmental and pathological. So far disease are concerned, this is an effect of the disease rather than a factor contributing to development and spread of the disease, Under all conditions, sterility may not be pronounced, nor the disease may inflict high percentage of sterility. Under certain conditions, it may be indicative of intensity of the disease, which will be evident from the data. Grain weight, considered to be yield attributes, was not found to have any influence on the incidence of the disease.

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