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Effect of plant characters on sheath blight disease development

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ABSTRACT

Experiment on the effect of plant characters *viz*., Plant height, leaf length, leaf width, leaf angle, culm strength, number of tillers, culm diameter, sheath length and duration of the crop on sheath blight disease development was carried out at Regional Agricultural Research Station, Maruteru and found that Plant height, leaf length, leaf width, leaf angle, culm strength, no. of tillers and sheath length were positively correlated with sheath blight disease development , culm diameter and duration of the crop were negatively correlated with disease severity. Leaf angle, culm strength and culm diameter and total number of tillers significantly influence the disease development. Out of 12 different genotypes tested, MTU-7029 (70.44%), IR-64 (66.35%) and MTU-3626 (61.28%) having more sheath length, leaf angle and more no. of tillers recorded maximum severity than other genotypes. MTU-1001(53%) showed less disease incidence than other genotypes due to more culm strength, diameter and less duration.

Key words: *Plant Characters. Rhizoctonia solani,Rice and Sheath Blight.*

Rice (*Oryza sativa* L.) is one of the most important food crops of the world and is the staple food for more than half of the human race. It accounts for about 43% of food grain production and 55% of cereal production in the country. India ranks first in area (44 M ha) and second in production in the world (102.7 M t) after China. To meet the food needs of ever growing population in India, there is need to raise rice production to around 130 M t by 2030 (Viraktamath *et al*., 2012). The sheath blight disease is an important fungal disease of rice. Of late, sheath blight is causing concern to the farmers of major rice growing states of India, like Andhra Pradesh, Karnataka, West Bengal, Assam, Uttar Pradesh and Jammu and Kashmir. Currently this disease is distributed in almost all the rice growing states (Reddy and Reddy, 1986).

MATERIAL AND METHODS

A field experiment was conducted during *Kharif,* 2015-16 at APRRI and RARS Maruteru, to find out the influence of different plant characters *i.e.,* leaf length, plant height, width of leaf blade, leaf angle from the tiller (divergence or compactness of the tillers), leaf is erect or drooping, culm strength, culm diameter, no. of tillers, sheath length, duration of the variety on the sheath blight disease development. For this, a Randomized Block Design with three replications was adopted and twelve divergent genotypes (susceptible as well as known tolerant varieties) were selected *viz*., MTU 3626 (Prabhat), MTU 2077 (Krishnaveni), MTU 1001 (Vijetha), IR 64, MTU 1112 (Pre released culture), BPT 5204 (Samba Mahsuri), JASMINE – 85, MTU 1064 (Amara), PLA 1100 (Badava Mahsuri), MTU 1061(Indra), MTU 7029 (Swarna) and MTU 1166 (Pre released culture). The genotypes were raised in individual plots of 10 m^2 each, and in each plot eight hills at one place were selected as one replication. Likewise second and third replications (each constituting eight hills) were also selected from the same plot at random.

Artificial inoculation

The fungus, *R. solani* was multiplied on sterilized rice culm bits for use in artificial inoculation, and inoculation was done by placing the infected rice culm bits in between the tillers and tied with thread rope.

Evaluation of Sheath blight Severity

Twenty four hills from each unit plot randomly considered for grading the severity of disease on standing plants were tagged. The severity of sheath blight disease was recorded by using RLH

(Relative Lesion Height) formula. The per cent relative lesion height was calculated as per the formula given below (Ansari, 1995):

Relative Lesion Height (RLH) (%)

$$RLH\ (\%) = \frac{\text{Lesion height}}{\text{Plant height}} \times 100$$

The RLH is the average vertical height of uppermost lesion on leaf or sheath expressed as a percentage over the average plant height. The mean value of rating (% RLH) will be determined to get rating score of the material under each treatment.

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Regression analysis was performed with sheath blight severity as dependent variable and different plant characters *viz*., plant height, leaf length, leaf width, leaf angle, culm strength, culm diameter, no. of tillers, sheath length and duration of the crop as independent variables for finding the goodness of fit for multiple regression models by the coefficients of determination (R^2).

Stepwise multiple regression analysis was performed using the following equation:

$$y = b_o + b_1x_1 + b_2x_2 + b_3x_3 \ldots\ldots\ldots\ldots\ldots + b_nx_n$$

where y = per cent disease index,
b_o = intercept,
$b_1, b_2 \ldots\ldots b_n$ = regression coefficient, and
$x_1, x_2, \ldots\ldots x_n$ = independent variables.

Data was collected on following parameters

1. **Leaf length:** Third leaf from the top of the plant was selected for measuring leaf length at vegetative stage, and expressed in centimetres.
2. **Plant height:** From the base of the plant to tip of the last leaf was measured using meter scale, and expressed in centimetres.
3. **Width of leaf blade:** Third leaf from the top of the plant was selected for measuring leaf width at vegetative stage, and expressed in centimetres.
4. **Leaf angle from the tiller (divergence or compactness of the tillers):**
   Third leaf from the top of the plant was selected for measuring leaf angle from tiller prior to maturity stage. For this, different codes were given as 1. Erect, 3. Intermediate, 5. Horizontal and 7. Descending.
5. **Leaf is erect or drooping:** Based on the leaf angle, leaf is erect or drooping was conformed.
6. **Culm strength:** Culm strength is first rated after heading by gently pushing the tillers back and forth a few times. This test gives some indication of culm stiffness and resilience. Final observation at maturity is made to record standing position of plants. Scale adopted as follows. 1. Strong (No. bending), 3. Moderately strong (most plants bending), 5. Intermediate (most plants moderately bending), 7. Weak (most plants flat) and 9. Very weak (all plants flat).
7. **Culm diameter:** Measured in millimeters from the outer diameter of the culms at the basal portion of the main culm at maturity stage. It is measured with the help of Vernier callipers.
8. **No. of tillers:** Total number of tillers present in selected culms.
9. **Sheath length**: Measured in centimetres
10. **Duration of the variety:** From time of sowing to date of harvesting.
11. **Incidence:** The incidence of sheath blight was recorded by using the following formula

Disease incidence (%) =

$$\frac{\text{No.of tillers infected}}{\text{Total no.of tillers}} \times 100$$

RESULTS AND DISCUSSION

In the present study sheath blight severity showed positive correlation with plant height, leaf length, leaf width, leaf angle, culm strength, no. of tillers and sheath length. Culm diameter and duration of the crop were negatively correlated with disease severity.

In positively correlated plant characters, total tillers (+0.780) and leaf angle (+0.641) showed significantly positive correlation with sheath blight disease severity. Sheath length (+0.358), leaf width (+0.33), Plant height (+0.165) and leaf length (0.160) also showed positive relation but were non significant (Table 1). Peng *et al*. (2003) also stated that partial correlation analysis between phenotypic data and sheath blight ratings revealed significant correlation between plant compactness, plant height, heading date, leaf angle and resistance to sheath blight.

Further Willocquet *et al.* (2000) reported that results, *i.e*., high leaf area index and more no. of tillers/plant facilitate the horizontal spread of the disease by increasing leaf to leaf and leaf to sheath contacts. The length of sheath was also positively correlated with severity. Dey *et al.* (2016) also revealed lack of correlation between traits like plant height, heading date and sheath blight resistance.

Culm diameter was negatively (-0.0712) correlated with disease severity and it showed that only 7% decrease in disease severity with increased culm diameter. Dey *et al*. (2016) also reported that stem thickness was negatively correlated with disease severity. Culm strength was (+0.03) very less positively correlated with disease severity. It says that with increase in culm strength resulted in only 3% increase in the disease severity.

In the present experiment 12 different genotypes were taken out of which Swarna (MTU 7029), BPT 5204 and IR 64 showed more severity than other genotypes due to more sheath length and more no. of tillers.

Multiple regression analysis yielded ten distinct equations with P values ranging from 0.0214 to 0.0335 ($P \leq 0.05$). However, the best fit equation was obtained in plant height, leaf length, leaf width, leaf angle, culm strength and culm diameter, total no. of tillers and duration as independent variables (Table 2).

Y = 82.41 -0.6989 (plant height)*+1.8818 (leaf length)*+10.943 (leaf width) *+ 2.563 (leaf angle)* +5.834(culm strength)* -9.245 (culm diameter)* -1.729 (no. of tillers)* +0.4190 (duration)*

N = 10 R^2 = 0.9738 F value = 8.230 Standard error = 15.98 * Significant at 5% level.

The results revealed that the best fit equation showed 97 per cent plant characters influences sheath blight severity. Results were in accordance with the reports of earlier workers (Willocquet *et al*. 2000; Dey *et al*. 2016.).

Sheath blight incidence showed negative correlation with the following plant characters *viz*., plant height, leaf length, leaf width, culm strength, culm diameter and sheath length. No. of tillers, leaf angle and duration of the crop was positively correlated (Table 4). Plant height was negatively (-0.23) correlated with sheath blight incidence, indicating that if plant height increases incidence decreases by nearly 23%.

Culm strength (-0.051) and culm diameter (-0.118) were negatively correlated with sheath blight incidence. This resultwas in line with the Wu *et al*. (2012) Who reported that sheath blight intensity was negatively correlated with breaking resistance and positively correlated with lodging index.

Leaf angle (+0.742) was positively correlated with incidence, indicating that if angle between sheath and leaf increases incidence also increases because leaf to leaf contact will increase. Peng *et al*. (2003) also reported that leaf angle was significantly correlated with resistance to sheath blight. The results of the correlation analysis showed that total no. of tillers were (+0.655) positively correlated with disease incidence. Willocquet *et al.* (2000) also stated that more tillers facilitate the horizontal spread of the disease by increasing leaf to leaf and leaf to sheath contacts. Sheath length (-0.264) and leaf width (-0.24) were negatively correlated with sheath blight incidence. *i.e*., if leaf width and sheath length increase disease incidence will decrease. Duration of the crop showed positive correlation with incidence.

Regression analysis was performed with sheath blight incidence as severity. The results regarding multiple effect of plant characters on the incidence are presented in Table 5.

Multiple regression analysis yielded ten distinct equations with P values ranging from 0.321 to 0.952 (P e" 0.05). However, the best fit equation was not obtained. In this regression equation all plant characters did not show significant difference with disease incidence because for all characters p value is greater than 0.05. The results revealed that the best fit equation showed 81 per cent plant characters influence sheath blight incidence. Results were in accordance with the reports of earlier workers (Wu *et al*. 2014 and Peng *et al*., 2003.).

In the present experiment, 12 different genotypes were taken of which, BPT 5204 (77%), MTU 7029 (72%), MTU 1064 (74%) showed more disease incidence over other genotypes. In BPT 5204 culm strength and diameter were very less. MTU 7029 had more no. of tillers and leaf angle facilitating horizontal spread of the disease. The genotypes which produced more number of tillers relatively provide congenial environment for the disease development. As reported by Peng *et al*. (2003), plant compactness significantly correlated with sheath blight susceptibility. MTU 1001(53%) showed less disease incidence than other genotypes due to more culm strength, diameter and less duration.

Table: 1. Morphological characters of rice genotypes evaluated for sheath blight disease development

Genotype	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Leaf angle (^{0})	Culm strength	Culm diameter (mm)	No of tillers	Sheath lengthc (mm)	Duration	Severity (%)	Incidence (%)
MTU 2077	98.54	50.32	1.20	14.46	3.08	4.95	10.84	28.92	150.00	52.59 *(46.46)	58.40 (49.84)
MTU 3626	91.67	48.15	1.21	18.71	2.92	5.00	10.92	30.19	135.00	61.28 (51.53)	72.64 (58.42)
MTU 1001	102.71	46.74	1.04	18.46	5.92	5.83	8.17	29.47	120.00	43.19 (41.85)	53.58 (47.16)
IR 64	80.00	38.41	1.03	23.12	3.00	4.48	9.09	26.19	120.00	66.35 (54.51)	69.26 (56.80)
MTU 1112	107.50	51.44	0.98	14.58	4.58	5.11	8.75	29.95	140.00	53.04 (46.24)	7 0.61 (57.53)
BPT 5204	90.89	44.76	0.94	29.58	2.92	3.84	11.25	24.32	150.00	67.34 (56.77)	77.71 (61.01)
JASMINE	117.71	52.93	1.14	21.12	5.67	5.22	10.50	31.47	125.00	57.61 (49.38)	62.70 (52.28)
MTU 1064	111.63	47.44	1.07	15.75	4.75	6.26	9.04	30.18	170.00	57.7 (49.48)	74.24 (59.00)
PLA 1100	106.42	52.25	1.13	18.75	2.25	6.26	8.17	30.02	160.00	55.20 (47.07)	70.87 (57.94)
MTU 1061	89.79	46.73	0.96	13.91	4.42	5.08	7.34	25.49	120.00	49.75 (44.45)	59.28 (50.14)
MTU 7029	96.96	40.89	0.92	26.41	3.58	4.89	13.71	30.63	150.00	70.44 (57.38)	72.27 (58.43)
MTU 1166	119.08	55.43	1.08	16.37	5.67	5.59	6.84	27.61	130.00	56.23 (48.52)	59.80 (50.23)
SEm	2.19	1.39	0.01	1.59	4.74	0.02	0.08	0.80	1.74	2.70	4.74
CD (Pd”0.05%)	5.79	3.68	0.03	0.54	0.29	0.07	0.35	0.20	4.62	5.30	8.53
CV %	3.51	4.53	2.2	7.91	8.86	1.96	6.76	2.21	1.95	4.35	7.98

***Figures in parentheses are arc sine transformed values** **Every data is mean of three replications**

Table: 2 Correlation between plant characters and rice sheath blight disease severity

Character	Pl. ht	L. L	L. W	L. A	C. St	C. dia	T. tl	S. L	Dur	Sev %
Pl. ht	1	0.8170	0.4764	0.1683	0.3128	0.6348	0.5900	0.8540	0.0973	0.1652
L. L		1	0.5061	-0.0973	0.1253	0.5125	0.4662	0.7410	0.0328	0.1603
L. W			1	0.3512	-0.2493	0.3501	0.5028	0.5970	0.0271	0.3370
L. A				1	-0.0827	0.1829	0.4034	0.3106	-0.3565	0.6419*
C. St					1	0.1350	0.2941	0.2018	-0.1772	0.0383
C. dia						1	0.1243	0.6232	0.3894	-0.0712
T. tl							1	0.5910	-0.3320	0.7804**
S. L								1	-0.0120	0.3587
Dur									1	-0.6314*
Sev %										1

* and ** represent 5 and 1% level of significance, respectively

Pl. Ht - Plant height L. L – Leaf length L. W – Leaf width
L. A – Leaf angle C. St – Culm strength C. dia – Culm diameter
T. tl – Total tillers S. L – Sheath length Dur – Duration of crop
Sev % - Severity percent

Table: 3 Multiple correlation and regression of certain plant characters on sheath blight disease severity

S.No.	Variables	Partial regression coefficient (b)	Standard Error (E)	t values	p values
y	Disease severity				
X1	Plant height	-0.6989	0.1162	-6.0167	0.0265*
X2	Leaf length	1.8818	0.3535	5.3229	0.0335*
X3	Leaf width	10.9433	8.4740	1.2914	0.3256*
X4	Leaf angle	2.5633	0.3814	6.7215	0.0214*
X5	Culm strength	5.8343	0.9833	5.9334	0.0272*
X6	Culm diameter	-9.2458	1.5882	-5.8217	0.0282*
X7	No. of tillers	-1.7298	0.3543	-4.8825	0.0394*
X8	Sheath length	1.0477	0.3837	2.7307	0.1120*
X9	Duration	0.4190	0.0763	5.4933	0.0315*

Coefficient of determination (R^2) = 0.9738 Intercept = 82.41 F value = 8.230
*Significant at 5% LOS N = 10 NS = Non significant

Table: 4 Correlation between plant characters and rice sheath blight disease incidence

Character	Pl. ht	L. L	L. W	L. A	C. St	C. dia	T. tl	S. L	Dur	Inc %
Pl. ht	1	0.8047	0.3161	-0.5844	0.4170	0.5962	0.2601	0.6533	0.3950	-0.2302
L. L		1	0.7142	-0.7291	0.0412	0.7065	0.4163	0.7430	0.7232	-0.1395
L. W			1	-0.5180	-0.3422	0.5033	0.4841	0.4084	0.8375	0.2498
L. A				1	-0.2447	-0.4171	-0.4039	-0.4220	-0.6189	0.7425*
C. St					1	-0.1577	-0.3317	0.0774	-0.3541	-0.0515
C. dia						1	0.2026	0.6170	0.5992	-0.1181
T. tl							1	0.3502	0.5254	0.6557**
S. L								1	0.3796	-0.2643
Dur									1	0.5334
Inc %										1

* and ** represent 5 and 1% level of significance, respectively

Pl. Ht - Plant height L. L – Leaf length L. W – Leaf width
L. A – Leaf angle C. St – Culm strength C. dia – Culm diameter
T. tl – Total tillers S. L – Sheath length Dur – Duration of crop
Inc % - Incidence percent

Table: 5 Multiple correlation and regression of certain plant characters on sheath blight disease incidence

S.No.	Variables	Partial regression coefficient (b)	Standard Error (E)	t values	p values
Y	Disease incidence				
X1	Plant height	-0.0248	0.3688	-0.0671	0.9525^{NS}
X2	Leaf length	0.2723	1.1225	0.2425	0.8309^{NS}
X3	Leaf width	-35.1579	26.9069	-1.3067	0.3213^{NS}
X4	Leaf angle	-0.1052	1.2109	-0.0868	0.9387^{NS}
X5	Culm strength	-1.9304	3.1222	-0.6183	0.5994^{NS}
X6	Culm diameter	-2.1418	5.0428	-0.4247	0.7123^{NS}
X7	No of tillers	0.3727	1.1249	0.3313	0.7719^{NS}
X8	Sheath length	1.0031	1.2182	0.8234	0.4968^{NS}
X9	Duration	0.1207	0.2422	0.4983	0.6676^{NS}

Coefficien of determination (R^2) = 0.8170 Intercept = 47.73 N = 10
F value = 0.9934 *Significant at 5% LOS
NS = Non significant

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