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Investigation of morphological indices of different rice varieties (*oryza sativa*) in relation to insect-pest attack under shallow and semi-deep land condition during *Kharif* Season

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Totally 23 different rice cultivars were analyzed for pest attack and varying morphological studies from Chinsurah, West Bengal, India. The individual rice cultivars were planted in both shallow and semi-deep conditions, maintaining the two replicated yield trail (RYT) with randomized block design (RBD) pattern. It was observed that the dead heart (DH) disease caused by *Scirpophaga incertulas* affects mostly NDR 8027 rice cultivar, which had maximum tillers in both shallow and semi deep conditions. The OR 2329-2 was less affected by DH, having minimum tillers in both shallow and semi deep conditions. The dead heart damages were directly proportional to the tillering stage and reproductive stage of rice plant. The mean value of pest attack in semi-deep land situation (SDW) (6.62%) was lesser than the mean value of pest attack in a shallow land situation (SHW) (6.68%). When compared the plant height of all 23 rice cultivars in shallow land was shorter than semi-deep land. From statistical analysis, it was understood that the rice cultivars of semi-deep land areas are less affected by insect-pest damage than the rice varieties of the shallow land area during the *Kharif* season. The rice cultivars grown in semi-deep land with high water depth were less damaged by pest and the plant heights of semi-deep land area is higher than the plants of the shallow land area. From this study, we concluded that the rice cultivation in semi- deep land condition is more beneficial than shallow land condition.

Key words: Rice cultivar, *Scirpophaga incertulas*, plant morphology, *Kharif* season, insect-pest damage.

INTRODUCTION

Rice (*Oryza sativa*) is a plant of Asian origin and native formers account for 87% of the world's total rice production (MacLean et al., 2002). Rice is the major food for half of the world's population and it supplies about 27% of dietary energy and 20% of dietary protein in the developing countries (WRS, 2010). In India, totally 44.3 million hectares of land are used for rice cultivation and stands second in rice production of around 89.09 million tons/ year (MacLean et al., 2002). The genus *Oryza* includes twenty wild species and two cultivated species

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such as *O. sativa* (Asian rice) and *Oryza glaberrima* (African rice). Among this rice variety, *Oryza sativa* is the most commonly grown species throughout the world today (Parvez et al., 2006). Food shortages in developing countries are aggravated by rapid population growth. This rising population has made it more necessary to go in for increased agricultural production. The increase in rice production depends on the condition of the land where it is cultivated (Anusha and Sourik, 2014). On the other hand the insect pest attacks are the major biotic constraints in rice production. It is estimated that 25% of rice yield loss in India was reported due to the pest attack (Neeraj et al., 2013). Specifically, the rice variety *O. sativa* is attacked by Yellow stem borer (dead heart) by *Scirpophaga incertulas* (Anusha and Sourik, 2014). The level of many pests attacks significantly rises due to increased nitrogen levels and water may also influence the growth of some pest species (Rao et al., 1987). It has become a notable challenge to overcome the issues of pest attack to meet the increasing demand for rice. Hence, effective insect pest management strategies for rice plants are needed to be developed and implemented. So, the present study is to analyze the morphological indices of different rice plant varieties and their relationship with the insect-pest attack in different cultivation systems during *kharif* season.

MATERIALS AND METHODS

The field experiments are conducted during *Kharif* season in rice research station, Chinsurah, Hooghly, West Bengal. Latitude: 22°52' N. Longitude: 88°24' E. Elevation: 8.62 m above mean sea level (AMSL).

Rice cultivation systems

Totally 23 individual rice cultivars were planted in both shallow land condition (with water stagnation from 20 to 40 cm water depth, with capacity to tolerate sudden submergence for 7 to 10 days) and semi-deep condition (water stagnation from 40 to 75 cm water depth, with capacity to tolerate sudden submergence for 7 to 10 days) maintaining the two replicated yield trial (RYT) with randomized block design (RBD) pattern. All the 23 varieties of rice cultivars were planted in three rows with 20 cm spacing between each plant. All the rice varieties growth was observed and noted in both land conditions. All the varieties were observed their pest attack with a hand lens after trans-planting date (DAT) of 60^{th}, 75^{th}, 90^{th} day respectively. A standard formula was used to calculate the dead heart damage percentages caused by *S. incertulas*.

$$\text{Dead Heart (DH\%)} = \frac{\text{No. of DH in 10 hills}}{\text{Total No. of tillers in 10 hills}} \times 100$$

Comparisons were made between damages observed in rice cultivars due to pest attack along with morphological changes, viz., a) Total No. of tillers, b) Flag leaf length (cm), c) Flag leaf breath (cm), d) Plant height (cm), e) Total No. of Panicle bearing tillers f) Leaf length (cm), g) Leaf breath (cm), h) Panicle length (cm). The data was collected for calculating levels of pest damage caused by various pests during growth of the rice cultivar at 60^{th}, 75^{th}, 90^{th}, 105^{th} day's respectively from the date of transplanting (DAT).

RESULT AND DISCUSSION

In the present study, two different land conditions were used to investigate the level of growth and pest damage on 23 different rice cultivars. The rice varieties grown in semi-deep land conditions (SDW) showed better growth under water stagnation from 40 to 75 cm water depth and had the capacity to tolerate submergence for 7 to 10 days than shallow land condition with 20 to 40 cm of water stagnation (Table 1). The varieties grown in this condition (SDW) had prominent submergence tolerance and elongation ability. Similarly, the rice cultivation in semi-deep land condition was found to be more fruitful than shallow land condition (Anusha and Sourik, 2014).

The field investigation against pest damage was carried out during the *kharif* season. Studies showed that the NDR 8027 rice variety was highly affected with dead heart disease caused by *S. incertulas* (Figure 1) in the mean average range of 7.47% in SHW and 7.41% in SDW and the OR 2329-2 showed a minimum of 5.93% in SHW and 5.87% in SDW (Table 2). Similarly, the rice plants from the seedling to maximum tillering stages were attacked at the base of the stem had dead hearts attack (Tripathi et al., 1997). In the present study, less number of tillers were observed in both shallow and semi deep conditions. The mean average percentage of pest attack in SDW is less than the mean average percentage of pest attack in SHW was recorded. The earlier study reported that critical infestation of the stem borer occurred during vegetative and panicle stages of the *kharif* season (Parwez et al., 2006). It was also observed that the plant height of individual 23 rice cultivars in SHW land condition was shorter than SDW land condition. On a comparison analysis between dead heart damage of 23 rice cultivars in both shallow and semi-deep conditions the mean damaging average percentage of shallow land was 6.68% and semi-deep land was 6.62% (Table 2). So, the damaging effect of DH% in shallow land was higher (0.06%) than semi-deep land. Studies also revealed that higher water depth was reason for the lesser pest attack in semi-deep land conditions.

All the 23 rice cultivars grown in shallow condition, the parameters such as plant height, Total no. of tillers, leaf length, leaf breath, flag leaf length, flag leaf breath, panicle length and total number of panicle bearing tillers ware analyzed. Among this, the highest plant height was observed as 138.0 cm in RAU 1407-7-1-3-4 rice variety and the lowest was observed as 95.4 cm in Swarma-Sub1. The NDR 8027 has the highest (133) number of tillers and OR 2329-2 has the lowest number (96) of tillers. The highest leaf length was observed in LPR 1131 (20.5 cm) and the lowest was observed in NDR 9460 (13.8 cm). The highest leaf breath was observed in RAU 1407-7-1-3-4 (1.38 cm) and the lowered in Swarna-Sub1

Table 1. Rice cultivars planted in semi-deep condition and shallow land condition with different level of water stagnation.

S/N	Rice varieties	Plant height (avg.) in cm	
		Shallow land condition (20 to 40 cm water depth)	Semi-deep condition (40 to 75 cm water depth)
1	OR 2329-2	104.0	109.0
2	OR 2165-5	117.0	122.0
3	NDR 8027	105.7	110.7
4	NDR 8692	106.0	111.0
5	NDR 9460	105.6	110.6
6	NDR 9467	128.7	133.7
7	NDR 8850	128.1	133.1
8	NDR 9440	132.0	137.0
9	RAU 1407-7-1-3-3	115.0	120.0
10	RAU 1407-7-1-3-4	138.0	143.0
11	IR 70153-11-TTB 1-5	120.0	125.0
12	IR 70153-11-TTB 1-6	109.4	114.4
13	LPR 1112	107.0	112.0
14	LPR 1130	132.4	137.4
15	LPR 1131	117.9	122.9
16	CR 2415-3-2-1-1-1-1	130.0	135.0
17	CR 2754-18-6	105.4	110.4
18	CR 2750-6-2	129.0	134.0
19	Swarna Swarna-	97.0	102.0
20	sub1 Savitri	95.4	100.4
21	Savitri-sub1	107.6	112.6
22		108.8	114.8
23	CN 1039-9	103.3	108.3

Figure 1. Dead heart damage caused by *S. incertulas.*

Table 2. Comparison of dead heart damage between shallow (SHW) and semi-deep land (SDW) during *kharif* season.

S/N	Rice varieties	Mean DH% of RYT-SHW	Mean Avg. (%)	Mean DH% of RYT-SHW	Mean Avg. (%)
1	OR 2329-2	5.93		5.87	
2	OR 2165-5	6.83		6.77	
3	NDR 8027	7.47		7.41	
4	NDR 8692	7.31		7.25	
5	NDR 9460	5.94		5.88	
6	NDR 9467	6.29		6.23	
7	NDR 8850	6.49		6.43	
8	NDR 9440	6.30		6.24	
9	RAU 1407-7-1-3-3	6.81		6.75	
10	RAU 1407-7-1-3-4	6.91		6.85	
11	IR 70153-11-TTB 1-5	6.04		5.98	
12	IR 70153-11-TTB 1-6	6.55	**6.68**	6.49	**6.62**
13	LPR 1112	6.95		6.89	
14	LPR 1130	6.85		6.79	
15	LPR 1131	6.83		6.77	
16	CR 2415-3-2-1-1-1-1	5.95		5.89	
17	CR 2754-18-6	7.21		7.15	
18	CR 2750-6-2	7.33		7.27	
19	Swarna Swarna-	6.74		6.68	
20	sub1 Savitri	6.32		6.23	
21	Savitri-sub1	7.01		6.95	
22		6.72		6.66	
23	CN 1039-9	7.04		6.98	

(1.0 cm). The highest flag leaf length (18.5 cm) was observed in LPR 1131 and lowest in NDR 9460 (11.8 cm). The highest flag leaf breath was observed in RAU 1407-7-1-3-4 (1.36 cm) and lowered in Swarna-Sub1 (0.98 cm). The RAU 1407–7–1–3–4 has the longest panicle length (17.73 cm) and shortest panicle length in NDR 8027 (12.93 cm). The highest number of panicle bearing tillers (34) was observed in RAU 1407–7–1–3–4 and lowered in NDR8027 (Table 3). The range of parameters was differed from season to season (Anusha and Sourik Ghosh, 2014).

In semi-deep condition, among all 23 cultivates the highest plant height was observed in RAU 1407-7-1-3-4 (143.0 cm) and lowered in Swarna-Sub1 (100.4 cm). The highest total No. of tillers was observed in NDR 8027 (131) and lowered in 2329-2 (94). The highest leaf length was observed in LPR 1131 (20.2 cm) and lowered in NDR 9460 (13.5 cm). The highest leaf breath was observed in 1.36 cm of RAU 1407-7-1-3-4 and the lowest is 0.97 cm of Swarna-Sub1. The highest flag leaf length was observed in LPR 1131 (18.2cm) and lowest in NDR 9460 (11.5 cm). The highest flag leaf breath was observed in RAU 1407-7-1-3-4 (1.34 cm) and lowered in Swarna-Sub1 (0.95 cm). The longest panicle length was observed in RAU 1407–7–1–3–4 (17.70 cm) and it was lowered in NDR 8027 (12.90 cm). The highest total number of panicle bearing tillers was observed in RAU 1407–7–1–3–4 (31) and the lowest number was in NDR 8027 (4) (Table 4). Similarly, the previous study reported that the yellow stem borer *S. incertulas* produced two broods, with the first peaking during the last week of September and the second peaking during the second week of November which coincided with the dough stage of rice (Tripathi et al*.,* 1997).

Conclusion

Apart from being a staple food, rice has a historical significance and cultural relevance in the state of West Bengal. The results of the present study focus on the research and development initiatives, specifically on insect-pest management and growth. From the field investigation, it showed that the dead heart (*S. incertulas*) damages are directly proportional to the tillering stage and reproductive stage of rice plant. The rice cultivars of semi-deep land is less affected by insect-pest damage than the rice varieties of shallow land during the *Kharif* season. It also stated that due to high water depth, the cultivars of semi-deep land were less damaged by pest and also the plant heights of shallow land were shorter than the plants of semi-deep land. So, it was concluded

Table 3. Measurements of plant height, total No. of tillers, leaf length, leaf breath, flag leaf length, flag leaf breath, Panicle length, total No. of panicle bearing tillers in shallow condition.

S/N	Entries of RYT in shallow land condition	Plant height (cm)	Total no. of Tillers	Leaf length (cm)	Leaf breath (cm)	Flag leaf length (cm)	Flag leaf breath (cm)	Panicle length (cm)	Total no. of Panicle bearing tillers
1	OR 2329-2	104.0	96	14.3	1.07	12.3	1.05	13.43	08
2	OR 2165-5	117.0	111	18.3	1.10	16.3	1.08	13.83	10
3	NDR 8027	105.7	133	14.4	1.30	12.4	1.28	12.93	06
4	NDR 8692	106.0	128	17.9	1.04	15.9	1.02	16.73	26
5	NDR 9460	105.6	97	13.8	1.01	11.8	0.99	15.53	19
6	NDR 9467	128.7	101	15.4	1.33	13.4	1.31	14.43	15
7	NDR 8850	128.1	104	19.8	1.18	17.8	1.16	15.63	21
8	NDR 9440	132.0	102	15.0	1.13	13.0	1.11	15.03	13
9	RAU 1407-7-1-3-3	115.0	109	16.2	1.24	14.2	1.22	17.33	31
10	RAU 1407-7-1-3-4	138.0	113	18.2	1.38	16.2	1.36	17.73	34
11	IR 70153-11-TTB 1-5	120.0	99	14.0	1.19	12.0	1.17	17.13	30
12	IR 70153-11-TTB 1-6	109.4	105	14.7	1.05	12.7	1.03	16.93	28
13	LPR 1112	107.0	116	18.0	1.09	16.0	1.07	13.63	09
14	LPR 1130	132.4	112	16.0	1.27	14.0	1.25	14.63	11
15	LPR 1131	117.9	110	20.5	1.12	18.5	1.10	14.83	12
16	CR 2415-3-2-1-1-1-1	130.0	98	18.4	1.11	16.4	1.09	16.33	25
17	CR 2754-18-6	105.4	125	15.6	1.06	13.6	1.04	15.83	22
18	CR 2750-6-2	129.0	130	19.0	1.23	17.0	1.21	16.23	24
19	Swarna Swarna-	97.0	108	17.2	1.03	15.2	1.01	15.13	18
20	sub1 Savitri	95.4	103	14.8	1.00	12.8	0.98	14.73	16
21	Savitri-sub1	107.6	118	17.7	1.02	15.7	1.00	13.13	07
22		108.8	107	18.7	1.17	16.7	1.15	14.93	17
23	CN 1039-9	103.3	120	18.5	1.08	16.5	1.06	15.33	13

Table 4. Measurements of plant height, total No. of tillers, leaf length, leaf breath, flag leaf length, flag leaf breath, total panicle bearing tillers in semi-deep condition.

S/N	Entries of RYT in semi-deep condition	Plant height (cm)	Total No. of tillers	Leaf length (cm)	Leaf breath (cm)	Flag leaf length (cm)	Flag leaf breath (cm)	Panicle length (cm)	Total No. of Panicle bearing tillers
1	OR 2329-2	109.0	94	14.0	1.05	12.0	1.03	13.4	6
2	OR 2165-5	122.0	109	18.0	1.09	16.0	1.07	13.8	8
3	NDR 8027	110.7	131	14.1	1.28	12.1	1.26	12.9	4
4	NDR 8692	111.0	126	17.6	1.02	15.6	1.00	16.7	24
5	NDR 9460	110.6	95	13.5	0.99	11.5	0.97	15.5	17
6	NDR 9467	133.7	99	15.3	1.31	13.3	1.29	14.4	13
7	NDR 8850	133.1	102	19.5	1.16	17.5	1.14	15.6	19
8	NDR 9440	137.0	100	14.7	1.25	12.7	1.23	15.0	11
9	RAU 1407-7-1-3-3	120.0	107	15.9	1.08	13.9	1.06	17.3	30
10	RAU 1407-7-1-3-4	143.0	111	17.9	1.36	15.9	1.34	17.7	31
11	IR 70153-11-TTB 1-5	125.0	97	13.7	1.17	11.7	1.15	17.1	28
12	IR 70153-11-TTB 1-6	114.4	103	14.4	1.03	12.4	1.01	16.9	26
13	LPR 1112	112.0	114	17.7	1.07	15.7	1.05	13.6	7
14	LPR 1130	137.4	110	15.7	1.23	13.7	1.21	14.6	9

Table 4. Contd.

15	LPR 1131	122.9	108	20.2	1.13	18.2	1.11	14.8	10
16	CR 2415-3-2-1-1-1-1	135.0	96	18.1	1.10	16.1	1.08	16.3	23
17	CR 2754-18-6	110.4	123	15.3	1.04	13.3	1.02	15.8	20
18	CR 2750-6-2	134.0	128	18.7	1.21	16.7	1.19	16.2	22
19	Swarna	102.0	106	16.9	1.01	14.9	0.99	15.1	16
20	Swarna-sub1	100.4	101	14.5	0.97	12.5	0.95	14.7	14
21	Savitri	112.6	116	17.4	1.00	15.4	0.98	13.1	5
22	Savitri-sub1	114.8	105	18.4	1.15	16.4	1.13	14.9	15
23	CN 1039-9	108.3	118	18.2	1.06	16.2	1.04	15.3	12

that the rice cultivation in semi-deep land condition is more favorable and may also economically profitable and beneficial than shallow land condition.

Conflict of Interest

We declare that we have no conflict of interest.

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