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ANTIBIOSIS IN RICE TO WHITE BACKED PLANT HOPPER AS INFLUENCED BY ZINC APPLICATION

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ABSTRACT

The induced effect of Zn on white backed plant hopper infesting rice was studied during kharif, 2017 through application of Zn in form of $ZnSO_4$ and Zn EDTA either as basal or foliar spray method. The pot culture study revealed that application of Zn EDTA as basal @ 40 kg/ha along with foliar spray of Zn EDTA @ 0.8 % twice at 30 and 45 days after transplanting (T_6) significantly reduced the growth and development parameters like nymphal survival, growth index, adult longevity, population build up, weight gain and feeding potential. Also, the nymphal period got prolonged. Such impaired growth and development with reduced feeding in Zn EDTA treated plants denotes the induced antibiosis effect of Zn on WBPH.

Key words: White backed plant hopper, rice, Zn EDTA, basal, foliar spray, pot culture, life stages, developmental period, induced antibiosis

Rice crop suffers from yield loss due to a number of biotic stresses, and notable of them is insect pests. A recent report from IRRI (2012) estimated that white backed plant hopper (WBPH) cause losses between 1 to 2 million tons of paddy rice annually in China. Chemical control has become a futile, rather has compounded the WBPH problem (Mishra, 2006). To contain its damage in rice, utilization of either constitutive resistance or induced resistance can be considered. Unfortunately, no true resistance variety is available against WBPH, necessitating induction of defence mechanism through exogenous application of abiotic elicitors. Zn is one such elicitor which is micronutrient and known to regulate more than 300 enzymes in plants resulting in synthesis of a wide array of secondary metabolites having induced defensive effects against herbivores. Keeping this in view, an attempt was made in a pot culture to study the possible induced antibiosis effect of Zn on WBPH.

MATERIALS AND METHODS

Experiments to ascertain antibiosis in rice were done in the green house of the Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar (20^0 15' N, 85^0 52' E). TN 1, a susceptible rice variety was used, and 21 days old seedlings were transplanted in pots with 10 kg soil. These pots contained good quality soil treated with calculated amount of fertilizers and basal treatment Zn fertilizers. After transplanting, all the potted plants were covered by mylar cages with top end wrapped by fine mesh muslin cloth. At 30 and 45 days after transplanting (DAT) foliar application of Zn fertilizers was made. At 46 DAT, the required numbers of WBPH were released into the cages as per the requirement of the study.

For nymphal survival study, ten numbers of one day old first instar nymphs collected from rearing cages were released through aspirator into each cage at 46 DAT. Each treatment had five replications. The plants were observed daily and the number of adults counted after emergence and removed from the plant. The number of nymphs that survived and developed into adults indicated the % nymphal survival (Heinrichs et al., 1985).

Nymphal development period study was made by releasing ten number of first instar nymphs of WBPH and observing the nymphs daily for ecdysis. Each treatment was replicated five times and the number of days to reach the adult stage in each treatment was recorded in all the replications (Pongprasert and Weeraput, 1979). The adults which were obtained from nymphal development study, were observed to derive the sex ratio (female: male). The growth index of WBPH was calculated as the ratio of mean nymphal survival percentage and mean nymphal duration in days (Panda and Heinrichs, 1983). Ten pairs of freshly emerged adults were released on potted plants of each treatment replication wise on 46^{th} DAT. The adults were observed for their longevity (Rodriguez- Rivera, 1972).

The population build up study was undertaken by releasing 3 day old adult female in five numbers on treated pots at 46 DAT. After one month of release of adults, the number of insects in each pot replicationwise was counted (Heinrichs et al., 1985). Feeding potential of WBPH in relation to various treatments was evaluated in terms of honey dew excretion as suggested by Sogawa and Pathak (1970). Honey dew excretion was computed in terms of mm^2 area coverage and this experiment had three replications. Weight gain by female adults of WBPH fed on treated plants at 46 DAT was computed as the difference in initial weight of the adults and final weight of adults after 48h of feeding (Ramulamma, 2014). This experiment also had three replications.

The data were analysed as per Completely Randomized Block Design (CRBD) procedure (Gomez and Gomez, 1984). The treatment variations were tested for significance by 'F' test. The standard error of means (SE(m)±) and critical difference (CD) at p= 0.05 level of significance were calculated.

RESULTS AND DISCUSSION

Mean nymphal survival was observed to be 44.00% in treatment T_6 which was significantly different from rest of the treatments. The treatment T_5 was the next better treatment which resulted in 51.00% survival, whereas, in control treatment, nymphal survival was to the tune of 92.00%. In other treatments, nymphal survival ranged from 56.00% in T_8 to 73.00% in T_2. Thus, it was clearly observed that the treatments T_6 and T_5 supported nearly half the nymphs to survive when compared against the control treatment. Hence, reduced nymphal survival in T_6 and T_5 treatment was attributable to the Zn application. Therefore, it can be inferred that rice plants treated with Zn application must have been physiologically influenced as a result the nymphs could not survive as has been observed in control. Poor nymphl survival in T_6 and T_5 can be attributable to poor nutritional quality in treated rice plant. Similar finding has also been made by Pati (2002).

The treatment T_6 also caused prolonged nymphal duration (17.30 days) which was at par with T_7 (17.00 days). The treatment T_5 caused a nymphal period of 16.50 days, whereas, the nymphal duration was lowest in T_9 (control) (13.90 days). Enhancement of nymphal period in resistant variety is attributable to poor nutrition of the plant which causes poor assimilation and poor growth. Thus, Zn application in rice might have influenced the plants' nutrition and as a result, nymphs feeding on these plants took longer period to become adults. Similar observation had been made earlier by Pati (2002) and Rath (2004).

The data in Table 1 on sex ratio (female: male) indicated that the treatment T_6 had a sex ratio 0.88 which otherwise revealed development of more male forms than females. Some other Zn treatments like T_7 (0.93), T_8 (1.01), T_5 (1.06), T_4 (1.19) and T_3 (1.23) also caused a female: male ratio of 0.93 to 1.23 without any significant difference between themselves and with T_6. But T_1 and T_2 treatments favoured more female forms. The control treatment (T_9) had significantly high value of sex ratio (1.92). Kumar (2015) have reported that male to female ratio of WBPH adult was 1:78 indicating the preponderance of males. The dominance of males has also been observed by Win et al. (2009) with a sex ratio of 1:88. Production of more males on resistant rice accessions might be attributable to poor nutritional quality of host.

The adult longevity data reveal that male adults lived for 9.00 days in T_6 and 9.30 days in T_7, respectively. The other treatments caused the male duration of 10.00 to 12.40 days, whereas, in control treatment, the adult males lived for 13.80 days. As regards to the female adult duration, the treatment T_7 caused the lowest longevity of females (12.50) which was almost equal to T_6 (12.90 days). Female duration was observed to be 18.10 days. Adult longevity (both male and female) was observed to be more in all the Zn treatments; spectacular being in T_6 and T_7 when compared with the control treatment. Thus, control rice plants were nutritionally suitable for which the life cycle of WBPH was completed relatively quickly with reduced nymphal and adult duration. Hence, it is perhaps the Zn supplementation which definitely might have altered the nutritional status of rice plants treated with Zn fertilizers, for which the adult life span of both male and female WBPH was more including the nymphal duration. Lower adult longevity of WBPH on resistant varieties has been visualized by Gunathilagaraj and Chelliah (1991) and particularly shortening of adult life span in WBPH on rice under Zn umbrella has been reported by Rath (1995) and therefore, the present finding is well supported by the above findings.

It is indicated from Table 1 that the treatment T_6 favoured only 31.40 insects, whereas, the treatment T_7 resulted in 38.30 insects. The treatment T_8 supported only 41.50 insects during this period. The control treatment at this period supported 79.30 insects. Preference/ non-preference of a variety by the insect

Table 1. Effect of Zn on growth and development of WBPH in rice

Treatment	Nymphal survival** (%)	Nymphal period** (Days)	Sex ratio** (Female : Male)	Growth index**	Adult longevity** (Days)		Population build up**	Area of honey dew excreted* (mm^2)	Mean weight gain by adult* (mg)	
					Male	Female			Female	Male
T_1: $ZnSO_4$ basal (25kg/ha)	71.00 (57.43)	14.00	1.54	5.07	12.40	16.50	53.60	255.80	0.05	0.005
T_2: ZnEDTA basal (40kg/ha)	73.00 (58.68)	14.30	1.62	5.10	11.80	15.70	51.20	262.20	0.05	0.006
T_3: $ZnSO_4$ FS (0.5%) (30 & 45 DAT)	67.00 (54.95)	15.60	1.23	4.29	11.00	14.80	49.80	256.60	0.05	0.004
T_4: Zn EDTA FS (0.8%) (30 & 45 DAT)	69.00 (56.29)	15.20	1.19	4.54	11.40	15.30	49.00	254.00	0.03	0.003
T_5: $T_1 + T_3$	55.00 (47.86)	16.50	1.06	3.33	10.30	13.90	45.10	226.60	0.04	0.004
T_6: $T_2 + T_4$	44.00 (41.53)	17.30	0.88	2.32	9.00	12.90	31.40	167.20	0.02	0.003
T_7: $T_1 + T_4$	51.00 (45.56)	17.00	0.93	2.95	9.30	12.50	38.30	185.80	0.03	0.004
T_8: $T_2 + T_3$	56.00 (48.43)	16.00	1.01	3.50	10.00	14.10	41.50	191.60	0.03	0.004
T_9: Control	92.00 (74.01)	13.90	1.93	7.48	13.80	18.10	79.30	285.40	0.07	0.010
SE_m(±)	1.213	0.156	0.161	0.128	0.236	0.311	0.740	0.519	0.006	0.001
C.D.(p= 0.05)	3.49	0.45	0.46	0.37	0.68	0.89	2.12	1.49	0.018	0.003

*Mean of three replications, ** Mean of five replications; Figures in parentheses angular transformed values; FS- Foliar Spray are greatly strengthened by the population load of the insect on the variety within a stipulated time along with the reaction of the insect on a susceptible host. While susceptibility (more insect population) is the degree of suitability of the variety by insect, there resistance of other comparable varieties is the degree of unsuitability by same insect. In the present study, population buildup of WBPH was found to be highest in the control treatment (79.3 per hill) and the population was less in all other treatments. Even the treatment T_6 supported nearly 60 % less population when compared with control. Earlier workers *viz.,* Rath and Misra (1998) and Rath (2004) also have witnessed low population of WBPH on rice being subjected to Zn application.

The data on feeding potential in terms of honey dew excretion depicted in Table 1, reveal tha the least honey dew excretion was observed in T_6 (167.20 mm^2). The treatments T_7 and T_8 revealed that honey dew excretion was within 200 mm^2, whereas, in T_1 to T_5 it was >200 mm^2 and could reach an area of 262.20 mm^2 in T_2. However, highest amount of honey dew excretion was marked in T_9 (285.40 mm^2). The feeding potential study observed more feeding by females on control plants as the amount of honey dew secreted was maximum. More feeding is the indication of balanced nutritional status of the plant and therefore, less feeding by WBPH on treated rice plants indicated a definite nutritional imbalance. Thus, it is clear that nutritional imbalance resulted due to different graded doses of Zn and subsequent differential uptake of Zn by rice plants. Gunathilagaraj and Chelliah (1985) and Chandrasekar et al., (2017) have also noticed reduced feeding potential of WBPH females on resistant rice accessions than on susceptible ones.

The data on weight gain due to feeding for 48 hours of exposure both in female and male WBPH is presented in Table 1. It can be seen that minimum weight gain by adult female was obtained in T_6 (0.02 mg), whereas, the corresponding values for T_8, T_7 and T_4 was 0.03. The treatments T_1 to T_3 caused 0.05 mg weight gain. However, the weight gain by female was highest in T_9 (0.07 mg). Similarly, the weight gain by males was reported to be minimum in T_4 and T_6 (0.003) followed by T_3, T_5, T_7 and T_8 in which the weight gain was 0.004 mg. The control treatment was responsible for higher weight gain in males (0.010 mg). However, the weight gain in females was more than males irrespective of the treatments studied. Weight gain in feeding insect is also considered as an important antibiosis factor of the host plant. Weight is directly correlated to feeding and assimilation. In the present study, we noticed that weight gained by both WBPH male and female adults was highest in control treatment, whereas, the adults feeding on Zn treated rice plants suffered. Though there was gain in weight of all the individuals exposed to different treatments, yet, the rate of weight gain was poor in all the treatments as compared to control treatment. Again, it was also visualised that the rate of weight gain was more in female adults than in males. Similar studies have been reported by Sogawa (1973) and Ramulamma (2014).

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