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# Relative Susceptibility of Rice Genotypes to Lesser Grain Weevil *Sitophilus oryzae* (L.)

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***Abstract***: A total of 11 rice genotypes were screened for their relative susceptibility to the lesser grain weevil *Sitophilus oryzae* (L.), under no-choice and free-choice conditions at Post-harvest Technology Centre, Bapatla during 2022-23. Under free-choice conditions on rough rice, the variety *Teja* recorded the highest adult population (61.33) of *S. oryzae,* while the advanced culture BPT 3111 recorded the lowest (18.0) at 60 days after release (DAR). In milled rice, BPT 2841 was the most susceptible genotype, recording the highest weevil populations under both free-choice (110.33) and no-choice (112.67) conditions. In contrast, the genotypes *Bapatla Mahsuri* and BPT 3111 were least preferred, with significantly lower adult weevil populations in milled rice under free-choice (12.33 and 13.33, respectively) and no-choice (49.67 and 47.67, respectively) conditions. The high susceptibility of BPT rice 2841 was further confirmed in the dual choice test, where it supported the maximum progeny emergence (327.50 adults), higher percent grain weight loss (2.40) and a slightly shorter development period (47.17 days) compared with *Bapatla Mahsuri* that recorded fewer progeny (56.67 adults), lower weight loss (0.49 %) and a longer development period (48.37 days). Overall, both rough and milled rice grains of BPT 3111 were consistently less susceptible to rice weevil, indicating its potential as a relatively resistant genotype under storage conditions.

***Keywords***: Rice genotypes, Rice weevil, Rough rice, Milled rice, Stored grain insects

Rice (*Oryza sativa* L.) is a staple food for more than half of the global population and its safe storage is vital for ensuring food and nutritional security (Kumar et al., 2020). To meet consumer demand, rice is stored in various forms *i.e.*, rough rice, milled rice, and parboiled rice at multiple levels including farmers, traders, processors, and public agencies. However, stored grains are highly vulnerable to both biotic and abiotic stresses, among which insect pests are the most serious biotic factor causing significant quantitative and qualitative losses (Rees 2004, Geeta and Yadu 2022). The lesser grain weevil or rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae), is one of the most destructive and cosmopolitan primary pests of stored grains (Padin et al., 2002). Unlike secondary pests, it can penetrate intact grains, oviposit within kernels, and complete its larval development internally, making infestations difficult to detect and manage (Hagstrum et al., 2012). Both adults and larvae feed on grain contents, leading to reductions in grain weight, milling recovery, nutritional value, and marketability, while also predisposing grains to moulds and secondary pest infestations (Arannilewa et al., 2002, Singh and Sharma 2024).

The extent of susceptibility of rice genotypes to grain insects varies widely depending on grain form (rough rice/milled rice) and physicochemical characteristics such as husk thickness, kernel hardness, starch composition, and nutrient content (Farzana 2007, Rizwana et al., 2011, Swamy et al., 2022). Resistant cultivars negatively affect insect survival, growth and reproduction thereby offering an eco-friendly and sustainable option for managing stored-product pests (Nawrot et al., 2010, Borzoui and Naseri, 2016, Barzin et al., 2019). Although several studies have examined varietal resistance in rice to stored-grain pests (Ashamo and Khanna, 2006, Rashid et al., 2009, Astuti, 2019, Swamy et al., 2019, Ethan et al., 2023), information on the relative susceptibility of newly released or advanced rice genotypes is scanty, particularly under both rough and milled grain conditions. With increasing interest in specialty rice varieties such as pigmented black and red rice for their nutritional and health benefits, understanding their resistance to storage pests has also become more relevant. In this context, certain rice genotypes were evaluated for their susceptibility to rice weevil. The study aimed to identify promising genotypes with less susceptibility that may serve as safer storage options and contribute to integrated stored-grain pest management strategies.

## MATERIAL AND METHODS

A total of 11 genotypes of rice including one advanced culture BPT 3111 (red rice), three pre-released cultures (BPT 2776, BPT 2858 and BPT 3082), and seven released varieties (*Bapatla Mahsuri, Sasya, Teja, Bhavathi*, BPT rice 2841 (black rice), BPT rice 2846 and *Samba Mahsuri*) were screened for their susceptibility to rice weevil under both no-choice and free-choice conditions at Post-harvest Technology Centre, Bapatla during 2022-23. The grains were obtained from the *kharif* crop produced at Agricultural Research Station, Bapatla during 2022. The grain moisture content was ranged from 11 to 12% (wet basis).

**Insect bioassays:** The initial mother culture of *S. oryzae* was established in the laboratory on rough rice (variety, *Samba Mahsuri*), using a small number of adults obtained from a local warehouse and later they were sub-cultured to ensure continuous supply of adult insects in sufficient numbers required for the experiments. For free-choice test, rough rice grain (50 g) of each genotype was placed in a plastic plate (10 cm diameter and 2 cm height) and arranged in a circular fashion inside a round plastic opaque tray (60 cm diameter and 9 cm height). A total of 50 mixed-age adult population of test insects were released in the center of the tray, giving equal opportunity to secure the host grains of their choice. It was closed with another tray of the same size by keeping in reverse position and secured tightly with binder clips and the setup was left for three days under ambient conditions. Thereafter, the number of adults that moved into each variety of grain was recorded and the respective grains along with insects were transferred individually into plastic jars (250 ml). Since rice weevil is an internal feeder, only adult insects that came out of the grains up on gentle agitation were counted at 40 days after release (DAR) and put them back into respective containers. Final adult counts were recorded again at 60 DAR in the similar manner and for analysis, only total adult population was taken into consideration. A similar free-choice test was conducted with milled rice, wherein 40 g sample of each variety was placed in the plates and 50 adult insects were released at the center. Milled rice was obtained by milling rough rice of above varieties using a lab model dehuller at Post-harvest Technology Centre, Bapatla. For no-choice test, insects (10 adults) were released into each grain sample (40 g), and data on progeny adult emergence were recorded at 40 and 60 DAR as described above. Both no-choice and free-choice experiments were conducted in three replications with completely randomized block design. Insect bioassays were conducted with both rough rice and milled rice in completely randomized block design replicating thrice.

In addition, a dual -choice test was conducted to assess relative growth and development of rice weevil on a resistant variety comparing with a susceptible one. For this 40 g of milled grain of both varieties were taken and 20 adult insects were placed between the two. There were six replications. Data on the number of insects moved into grain, adult emergence at 40 DAR at 60 DAR, egg to adult development period, and percent weight loss were recorded and compared.

**Statistical analysis:** The data obtained were subjected to one-way analysis of variance (ANOVA) after transforming the values. Differences among the means were tested for significance by the Tukey test at $P<0.05$ level.

## RESULTS AND DISCUSSION

There were significant differences among the test rice genotypes in their susceptibility to *S. oryzae* under storage (Table 1). Under free-choice conditions on rough rice, significantly higher numbers of adult insects moved into grain of *Bhavathi* (5.33) and BPT rice 2846 (5.0) followed by *Bapatla Mahsuri* and BPT 2858 (4.0 each) while the lowest number was recorded in BPT 2776 (0.67). However, the population buildup at 60 DAR was lowest in red rice culture BPT 3111 (18.0 adults) followed by BPT 2776 (23.0 adults) and *Samba Mahsuri* (23.0 adults). In contrast, BPT rice 2846 and *Teja* varieties recorded the maximum adult populations (63.33 and 61.33, respectively). The results corroborate Swamy et al. (2025) who reported that *Teja* (BPT 2595) (in the form of rough rice) was the most susceptible variety to Angoumois grain moth, *Sitotroga cerealella* (Olivier) with maximum adult emergence and grain damage (362 moths and 14%, respectively), while the variety BPT Rice 2841 showed lower susceptibility with minimum values for the same.

On milled rice under free-choice conditions, maximum numbers of adults moved into grain of *Teja* (5.33) followed by *Bhavathi* and BPT rice 2841 (3.67 each), while it was minimum in BPT 2776 and *Bapatla Mahsuri* (1.0 each). Consistent with this, black rice variety BPT rice 2841 significantly recorded the maximum population of adults (110.33) followed by *Teja* (96.33), while *Bapatla Mahsuri* (12.33) and BPT 3111 (13.33) recorded in lower numbers at 60 DAR. Under no-choice conditions on milled rice, the adult population buildup recorded was minimum in BPT 3111 (47.67) and *Bapatla Mahsuri* (49.67), whereas BPT rice 2841 had maximum adult population (112.67) followed by *Bhavathi* (99.0), BPT 2776 (89.0) and *Teja* (85.0) at 60 DAR.

On perusal of data, it was evident that rough rice as well as milled rice grains of BPT 3111 consistently exhibited lower insect preference and adult emergence compared to other genotypes, suggesting that it is relatively less susceptible to *S. oryzae*. In contrast, BPT rice 2846 and *Teja* were highly susceptible to rice weevil, as evidenced by higher insect preference and progeny development with maximum adult populations of 63.33 and 61.33, respectively. The susceptibility of milled grains of different genotypes exhibited a different trend compared to rough rice, as the protective husk acting as a physical barrier was removed. Among the genotypes, *Bapatla Mahsuri* and BPT 3111 consistently recorded the lowest weevil populations in milled rice under both free-choice (12.33 and 13.33 adults, respectively) and no-choice (49.67 and 47.67 adults, respectively) conditions, thereby categorizing them as less susceptible. In contrast, BPT rice 2841 supported the highest weevil populations in milled rice under both free-choice (110.33) and no-choice (112.67) conditions, indicating its high susceptibility.

The pronounced susceptibility of BPT rice 2841 was further validated in dual-choice test which revealed significantly higher progeny adult emergence (327.50) with higher grain weight loss (2.40%) and a slightly shorter development period (47.17 days) compared with *Bapatla Mahsuri* that recorded lower progeny emergence (56.67 adults), minimal weight loss (0.49%) and a slightly longer development period (48.37 days). Irrespective of form of grain *i.e.*, rough rice or milled rice of the variety BPT 3111 (red rice variety) consistently demonstrated reduced susceptibility to *S. oryzae*.

The morphological and biochemical composition of the rice grain was the most important factor in determining resistant or preferred rice varieties to *S. oryzae* (Kamal et al., 2024). Sathiyaseelan and Balaji (2025) studied the behavioral responses of *S. oryzae* to volatiles from different grain commodities which can be useful in effective monitoring of the pest in storage environments. The variation in susceptibility among the rice genotypes may be attributed to the thickness of the husk in rough rice (Kamiyo and Adetumbi 2017, Swamy et al., 2019), and to kernel hardness and nutrient composition in milled rice (Swamy et al., 2022). Thus, indicated that hard, thick, and intact hulls serve as physical resistance factors that hinder insect penetration into rice kernels. Among the various physical characteristics, grain hardness was found to have a significant and negative correlation with alive insect, grain weight loss, and preference index (Kamal et al., 2024). Similarly, Zahra et al. (2024) linked grain resistance to rice weevil infestation with physical and biochemical properties and noted that shorter, wider, and harder seeds with lower starch content were less susceptible to stored product insects. True to this, fine grain rice varieties with thinner husks were found more prone to Angoumois grain moth, *Sitotroga cerealella* infestation compared to those with bold grains with thicker husks (Swamy et al., 2019). Mahdi et al. (2021) further suggested that the cultivar Neda was unsuitable for development of *S. oryzae* as it negatively affected the amylolytic and proteolytic enzyme activity of the pest.

Notably, BPT rice 2841 which was found moderately susceptible to *S. oryzae* in the form of rough rice became highly susceptible when offered in the form of milled rice. (Meaning), This indicates that while in the form of rough rice the resistance offered was majorly by the outer hulls. Hasaranga et al. (2018) concluded that rice stored as un-milled paddy provides better protection from *S. oryzae* than milled rice. In addition, unlike *S. cerealella* which deposits its eggs on the grain surface, the female *S. oryzae* oviposits directly into the seeds, on hatching larvae complete their

**Table 2.** Development of rice weevil on milled rice of *Bapatla Mahsuri* and BPT rice 2841

| Parameter | *Bapatla Mahsuri* | BPT rice 2841 |
|---|---|---|
| Insects moved (No.) into grain | 5.33 ± 1.03 | 13.33 ± 1.21 |
| Adult population (No.) at 40 DAR | 28.33 ± 3.72 | 111.0 ± 16.07 |
| Adult population (No.) at 60 DAR | 56.67 ± 6.19 | 327.50 ± 19.7 |
| Weight loss (%) | 0.49 ± 0.12 | 2.40 ± 0.07 |
| Egg to adult development period (Days) (Range) | 48.37 ± 7.12 (37 – 65) | 47.17 ± 6.68 (35 – 62) |

**Table 1.** Preference and progeny development of rice weevil on stored rice grain of different genotypes

| Genotype | On rough rice under free-choice | | On milled rice under free-choice | | On milled rice under no-choice |
|---|---|---|---|---|---|
| | Insects moved into grain (no.) | Total adult emergence (no.) | Insects moved into grain (no.) | Total adult emergence (no.) | Total adult emergence (no.) |
| BPT 3111 (Red rice) | $3.67^{abc}$ | $18.0^{f}$ | $2.0^{c}$ | $13.33^{g}$ | $47.67^{f}$ |
| BPT 2776 | $0.67^{e}$ | $23.0^{ef}$ | $1.0^{d}$ | $49.33^{e}$ | $89.0^{bc}$ |
| BPT 2858 | $4.0^{abc}$ | $36.0^{c}$ | $3.33^{b}$ | $81.33^{cd}$ | $56.33^{ef}$ |
| BPT 3082 | $1.67^{cde}$ | $25.33^{de}$ | $2.0^{c}$ | $35.67^{f}$ | $52.0^{f}$ |
| *Bapatla Mahsuri* | $4.0^{ab}$ | $44.67^{b}$ | $1.0^{d}$ | $12.33^{g}$ | $49.67^{f}$ |
| *Sasya* | $2.0^{bcde}$ | $31.0^{cd}$ | $3.33^{b}$ | $93.67^{bc}$ | $69.33^{de}$ |
| *Teja* | $3.0^{abcd}$ | $61.33^{a}$ | $5.33^{a}$ | $96.33^{ab}$ | $85.0^{bc}$ |
| *Bhavathi* | $5.33^{a}$ | $37.33^{bc}$ | $3.67^{b}$ | $77.33^{d}$ | $99.0^{ab}$ |
| BPT rice 2841 (Black rice) | $2.33^{bcd}$ | $34.67^{c}$ | $3.67^{b}$ | $110.33^{a}$ | $112.67^{a}$ |
| BPT rice 2846 | $5.0^{a}$ | $63.33^{a}$ | $2.0^{c}$ | $85.0^{bcd}$ | $81.67^{cd}$ |
| *Samba Mahsuri* | $1.67^{de}$ | $23.0^{ef}$ | $2.67^{bc}$ | $75.67^{d}$ | $52.33^{f}$ |

In each column, values with the same letters do not vary significantly at P=0.05

development internally (and emerge) before emerging as adults (Neha et al., 2025). By this, the influence of outer hull could be nullified in case of milled rice as there is no need of penetration for the larva.

## CONCLUSION

Among the genotypes tested, rough rice of *Teja* and milled rice of BPT 2841 were found as the most susceptible ones, while both rough and milled rice grains of BPT 3111 were less susceptible to rice weevil. Thus, information on the preferences of rice weevil for different rice genotypes and forms, and their level of infestation under storage conditions is useful for formulating effective pest management strategy that enables early detection of insect infestations and facilitates timely implementation of control measures to minimize both quantitative and qualitative losses of stored produce. However, further studies are needed to elucidate the role of specific physico-chemical grain characters in influencing feeding behavior, preference and development of rice weevil.

## AUTHORS' CONTRIBUTION

All authors contributed effectively in this research. S V S Gopala Swamy: Conceptualization, methodology, investigation, data curation, formal analysis, supervision, writing of original draft, review and editing, G V Suneel Kumar: Conceptualization, methodology, supervision, review and editing, B Krishna Veni: Procurement of test material, methodology, review and editing. All authors have read and approved the manuscript.

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