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## CROP ROTATIONAL EFFECTS ON INFESTATION OF STEM BORERS IN RICE

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### ABSTRACT

The present study investigates the impact of crop rotation on the infestation of stem borers in rice crops. This research was carried out in the field at Shaheed Zulfiqar Ali Bhutto Agricultural College Dokri, Sindh, Pakistan. Several rotation practices were tested, including Rice fallow Rice, Rice-Wheat-Rice, Rice-Gram-Rice, Rice-Barseem-Rice, and Rice-Mustard-Rice. The results of the study revealed interesting findings. The lowest infestation rate, approximately 1.92% of rice stem borers, was observed in the Rice-Barseem-Rice rotation. This was followed by Rice-Mustard-Rice at 2.18%, Rice-Gram-Rice at 2.40% and Rice-Wheat-Rice at 3.21%. In contrast, the highest infestation rate, reaching 4.99%, was recorded in the Rice-fallow-Rice rotation system. These findings suggest that incorporating winter rotation crops such as Mustard, Barseem, and Gram into the cropping system can significantly reduce the population density of rice stem borers. On the contrary, mono-cropping, as exemplified by the Rice-fallow-Rice rotation, appears to favor stem borer infestations. In light of these results, it is recommended that further research and understanding be developed to implement cultural control methods and ensure ecological safety within winter crop rotation systems. This study underscores the importance of diversified crop rotation practices in mitigating the infestation of harmful pests like rice stem borers, contributing to sustainable agriculture and higher crop yields.

**Keywords:** infestation, *Oryza sativa*, rice, stem borer

### INTRODUCTION

Rice is technically known as *Oryza sativa* L. and belongs to the *Poaceae* family. Rice is one of the cereal crops that can grow under a wide range of rainfall and temperature conditions. South and South-East Asian countries enjoy the largest rice cultivation areas worldwide, and more than 12,000 different rice varieties are grown across all continents under a broader range of rainfall, climate, soil, and available water conditions (Alam *et al.*, 2001; Babu *et al.*, 2006). Currently, rice supplies food to more than half of the global population and serves as the primary source of nutrition for over 800 different species of insects, from nursery growing to the harvesting of the crop. Among all insects, a few pose a real threat to rice crops, which is why significant attention is given to understanding their behavior (Cramer, 1967; Karim and Riazuddin, 1999). Rice plays a significant role in

the economy of Pakistan, contributing a major share to foreign exchange earnings. After wheat, rice is the staple food, and it also serves as an alternative cash crop after cotton in the country (Shafique and Ashraf, 2007). Approximately 18% of foreign exchange in Pakistan comes from rice crops (Bhutto *et al.*, 2007). In the province of Sindh, there are two special rice agro-ecological areas: one is located in the southern part, including districts Tando Muhammad Khan, Badin, Sijawal and Thatta. The second rice cultivation area is situated in northern Sindh, covering Larkana, Shikarpur, Jacobabad, Kashmore, Kandhkot, Qamber, Shahdad Kot and a significant part of district Dadu, known for the cultivation of non-aromatic rice varieties. This entire region is particularly suitable for rice cultivation, benefiting from available irrigation water. Rice is susceptible to attack by more than a hundred different insect species, with around twenty of them causing major economic losses (Chatterjee and Maiti, 1979). Rice is susceptible to infestation at all

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growth stages (Pathak and Khan, 1994). Rice stem borers can also cause substantial damage, leading to severe economic losses in Pakistan (Mahar and Hakro, 1979). Insect populations are highly influenced by relative humidity and average temperatures in specific areas, favoring stem borer populations in tropical and subtropical Asian countries, including Pakistan. Stem borer attacks manifest differently at various growth stages of the plant, with white heads appearing during the reproductive stage and dead hearts during vegetative growth stages (Sun, *et al.*, 2003). While stem borer attacks occur throughout the year, they are most severe in September (Das, *et al.*, 2008), resulting in widespread impacts on rice crops (Siswanto, 2008). Cultural practices are recognized as powerful tools for managing insect pests (Huffaker, 1980). However, local field conditions and alternative cultural practices can affect population control in rice crops. Moreover, these methods are economically and environmentally viable, reducing the need for pesticides and being friendly to beneficial insects. Cultural practices, such as cleanliness, deep tillage and planting, harvesting, and accurate fertilizer application with proper water management, can effectively address the rising issues of insect pests in agricultural fields. While hand picking and netting are labor-intensive methods, they can reduce the risk of insect attacks, especially in nurseries. Additionally, rotation strategies are used in many agricultural fields, offering environmental, ecological, and economic benefits to local farmers (Litsinger, *et al.*, 1994). These methods play a crucial role in suppressing insect populations and reducing outbreaks (Hilimari, *et al.*, 2011; Ruis *et al.*, 2017).

In this recent study, four different crop rotation techniques were used to assess population diversity and density of rice pests within a winter crop rotation system. There is limited available information on insect pest populations affected by a winter crop rotation system. Therefore, it is highly necessary to conduct further studies to evaluate the effects of a winter crop rotation system on the population density of major insect pests, such as stem borers, in rice crops.

## MATERIALS AND METHODS

The present research work conducted over two successive seasons rabi and kharif from October 2017 to October 2018 at the experimental area of Shaheed Zulfiqar Ali Bhutto

Agriculture at SZABAC Dokri, Sindh, Pakistan. The Rice based on winter crop rotation, the pattern that followed was based on Rice-Fallow-Rice, Rice-Wheat-Rice, Rice-Barseem-Rice, Rice-Gram-Rice and Rice-Mustard-Rice. The objective of study was to evaluate research and monitor the infestation of stem borers on rice crop. The trial was conducted in (RCBD) with four replication and five treatments.

All of the replications were spread over 20 square meter (20 m<sup>2</sup>) area. The distance between plots was maintained at one meter. Moreover, all experimental plots were based on rotational crops in a year, but major focus was used on the direct and subtends effects of different Rabi crops on the rice stem borer's population density. During first year of study (In Kharif) all plots were prepared and sown with transplanted rice on recommended agronomical practices, After harvesting of the crop, the rabi season started from the 15<sup>th</sup> October, in that season we arranged different winter crops like Wheat, Barseem, Gram and Mustard, were sown in designed experimental plots. When these crops were sickle harvested, then in same designed area the rice seed lings were transplanted at the recommended agronomical practices to investigate the impacts of rotational crops on the population density of Rice Stem Borers. The observations of the rice stem borers incidents were recorded randomly within each of one meter square (1 m<sup>2</sup>) thus the entire sample comprised of twenty plots and totally eight observations were carried out during the crop period. Moreover, the observations were carried out on fort nightly basis from month of July to October. All the healthy/ infested plants within each sample were counted and percentage of Rice Stem Borer infestations worked out.

## RESULTS AND DISCUSSION

The result of the present studies indicates that total 8 observation were taken from rice fields to investigate the infestation of stem borers under different crop rotational practices. All collected data was analyses through percentage shown in Figure 1. The result indicates that during the first observation from all rotational practices the maximum infestation of stem borers 2.59% was recorded on the R-F-R rotational practice.

Similarly in second observation the infestation of stem borers was about 3.44%. In 3<sup>rd</sup> observation 4.73%. In the 4<sup>th</sup> observation 5.61%, In the 6<sup>th</sup> observation 6.95% were recorded and also Same way in the 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> observation stem borers infestation were

remained 6.24 %, 5.83% and 4.54% respectively. The results shown in Figure 2 indicate that infestation of rice stem borers under the rotational practice Rice-Wheat-Rice was 1.81% in first observation followed by 2.00%, 2.60%, 3.10%, 4.52%, 4.85%, 3.50%, and 3.64% were received in all remaining observations.

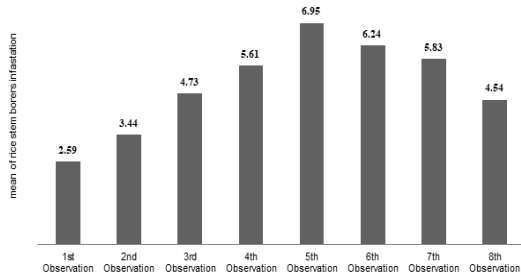


Figure 1. Mean infestation of stem borers under the rotational practice of sowing Rice after Rice

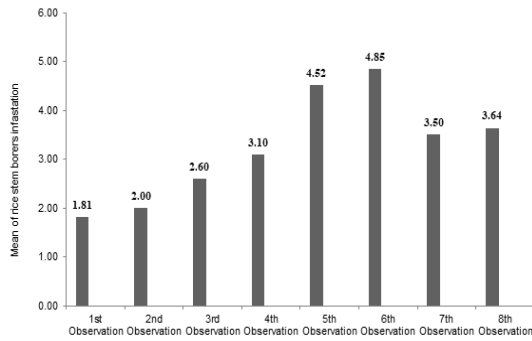


Figure 2. Mean infestation of stem borers under the rotational practice of sowing Rice-Wheat-Rice

Figure 3 shown that Rice stem borer infestations under the cropping scheme of R-M-R were 1.40%, 1.65%, 1.90%, 2.50%, 2.80%, 2.20%, 2.65% and 2.38% in the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> observations respectively.

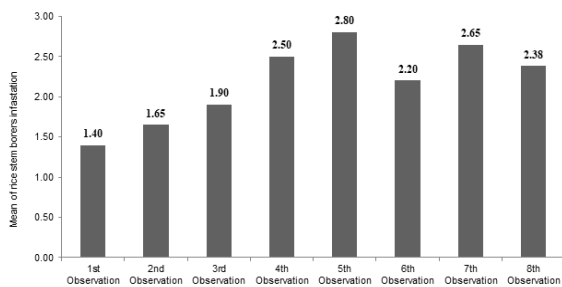


Figure 3. Mean infestation of stem borers under the rotational practice of sowing Rice-Mustard-Rice

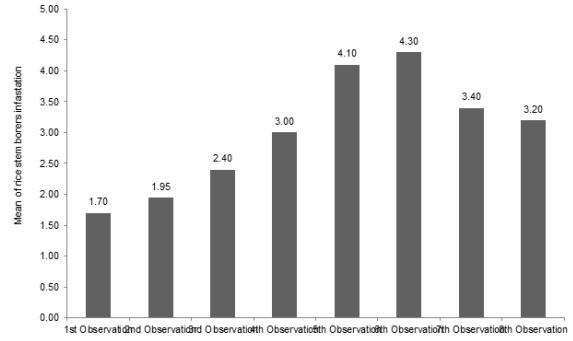


Figure 4. Mean infestation of stem borers under the rotational practice of sowing Rice-Gram-Rice

That infestation of the stem borer under the rotation practice of rice fallow gram fallow rice were 1.70% in first observation, 1.95 were recorded in 2<sup>nd</sup> observation similarly in 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> observation 2.40%, 3.00%, 4.10%, 4.30%, 3.40% and also 3.20% were recorded (Figure 4).

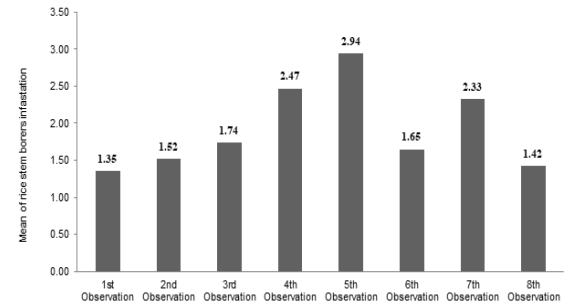


Figure 5. Mean infestation of stem borers under the rotational practice of sowing Rice-Barseem-Rice

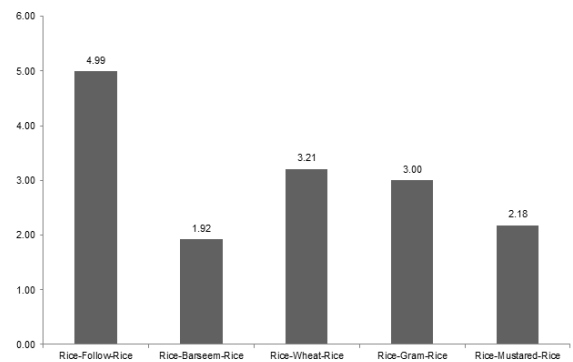


Figure 6. Overall mean infestation of stem borers under the different crop rotational practices

The stem borer infestation during 1<sup>st</sup> observation was 1.35 under the rotational practice R-B-R followed by 1.52%, 1.74%, 2.47%, 2.94%, 1.65%, 2.33% and 1.41% during

the data counted in sequential remaining seven observations (Figure 5). In this study the R-F-R crop rotational practice was found to be most great reason of availability of stem borer's population in the rice fields. But rotational sowing of rabi crops like Mustard, Barseem, Wheat, Grams are good tools of cultural control to reduce the outbreak of stem borer in rice fields.

The overall mean results of stem borers infestation showed in Figure 6 that there is little difference in infestation of stem borers between R-G-R (3.00%) and R-W-R (3.21%) rotation, but 2.18% percent remain infestation of stem borers in case of R-M-R. However lowest pest infestation of 1.92% in case of rotation R-B-R and the highest, 4.99% were recorded in case of R-F-R cultural practice. However, our study results are agreed with (Ramzan *et al.*, 1988) that found maximum survival of larvae of stem borers 28.58% in case of Rice-fallow-Rice cultivation and minimum 5.07% were noticed in Rice-Barseem-Rice rotational system. Especially among Rabi seasonal crops, the use of cover crops in winter season also increases microbial activities and invertebrate population which can enhance the agro-ecosystem sustainability (Balota *et al.*, 2014; Bowels *et al.*, 2017; Isbell *et al.*, 2017). These effects are sustainable in nature and persist in fields for long term and also lead to better yield production (Wyland 1996). These findings are also in accordance with that of Hyder Ali and A. Razzaq (1995) who found that the maximum infestation of 6.49% was noticed in case of Rice-fallow-Rice rotational practice. It is therefore, long term mono-cropping and sequential cropping patterns are becoming wide spread cause of insect infestation and repeated outbreak often leads crop yield reduction. When different kinds of crops are grown in sequence, some insect pests may completely be suppressed due to unavailability of host plant and insect pest survival may be addressed.

## CONCLUSION

In conclusion, rotational crops of winter season such as Mustard, Barseem and Grams have positive effects on increasing population density of rice stem borer. However, their population can also increase many folds under mono-cropping patterns. That's why; there is still great knowledge gap, where further investigation is needed to understand the economic and ecological effects of winter crop (rotational crops) on rice stem borer infestation.

## AUTHOR'S CONTRIBUTION

**M. H. Hullio:** Conducted and managed the experiment and obtained the data.

**S. A. Buriro:** Managed the experimental field and performed necessary cultural practices.

**S. N. Mazari:** Analyzed data and provided technical inputs.

**I. A. Junejo:** Design the research study and conducted the biochemical analysis.

**G. A. Junejo:** Removed plagiarism and statistical work.

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