Interaction of Weed Density and Standing Water Level on Rodent Damage in Rice Fields of Low Country Intermediate Zone of Sri Lanka

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Abstract

Rice is a staple crop in Sri Lanka, where rodent damage is an increasing threat. This study examined the effect of weed density and standing water level on rodent damage in rice fields. The experiment was conducted in selected farmer fields in Kurunegala district with four replicates following a standard statistical procedure. For the study of weed density, three experimental plots were demarcated, each measuring 50×50 m. Three treatments were weed-free, conventional farmer weed management practice, and un-weeded. For the study of standing water level, four separate experimental plots were demarcated each measuring 50×50 m, and treatments were no standing water, farmer practice (based on water availability), 5 cm of standing water, and 10 cm of standing water. Damaged and undamaged tillers were recorded in two-week interval before harvesting. Accordingly, un-weeded (minor season – 20.56%, major season - 52.51%) and no standing water (minor - 15.33%, major -16.00%) treatments were given the highest rodent damage, while weed-free (minor - 1.81%, major – 1.48%) and 10 cm of standing water (minor - 0.67%, major – 1.00%) treatments were given the lowest damage. Meanwhile, weeds were collected from each transect by using a quadrate (36×36 cm), and their dry weight was measured. A positive linear relationship was observed between rodent damage and weed dry weight. Data were arcsine-transformed and analyzed using ANOVA (SAS 9.1.3), with means compared using the LSD test at P < 0.05. These studies indicate that effective weed management and adequate water availability reduce rodent damage in rice fields.

Keywords: Rice, Rodent damage, Standing water level, Weed density

I. INTRODUCTION

Rice serves as the primary dietary source for more than half of the people in the world, contributing approximately 27% of daily energy intake and 20% of protein consumption in low-income countries. Rice is widely cultivated across at least 114 countries, predominantly in the developing world, and serves as the main livelihood and employment source for over 100 million families across Asia and Africa. (FAO, 2004). Rodents are a leading group of mammals belonging to the family Muridae, and they damage rice crops at every stage of growth. Rodents have three foremost impacts. First is the significant damage to the rice plants at any time during their growth. Second is the post-harvest losses to grain and vegetables under stored conditions. Third, frequently neglected, consequence is the impact on the health status of subsistence farmers, as rodents transmit more than 20 serious human infections (Meerburg et al., 2009). Slight or moderate rodent injury on a growing rice crop is not easily detectable unless the plants are observed closely. The distribution of damage is greatly inconsistent. Sometimes, patches of severe damage are visible within the fields, while some fields may appear to be unaffected but with uniformly scattered damage (Manilal, 1984).

Weeds are often seen as a biological obstacle that shrinks the yield potential of cultivating fields by causing several issues to the farming system, including attracting pests. The amount of weeds in rice fields is a major factor that can make pest damage worse by providing foodstuff, shelter, etc., while creating a promising environment for pests in the cultivating areas (Sadof et al., 2014). According to Wilson and Whisson (1993), grass

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seeds are a source of protein for rodents, which is important for their breeding cycle. Also, it was found that a rigid reproductive seasonality is shown by African multi-mammate mice, which was thoroughly correlated to rain periods and almost certainly happens through the stimulating result of growing grasses (Leirs et al., 1994). Controlling weeds in crop lands is mandatory to limit the food and habitat accessibility for the reproduction and growth of rodents (Wilson and Whisson, 1993). White et al. (2003), stated that habitat exploitation is an applicable controlling method for the suppression of rodent damage. A similar study found that changing large, stable nearby non-crop areas from thick, weed-filled places with a lot of vertical structure to big, greatly changed grasslands with little structure has negative effects on rodents. According to Htwe et al. (2019), repeatedly catching rodents during the tillering and ripening stages, along with keeping weeds under control around the rice fields, is a better way to manage rodent damage in rice fields.

Some previous studies revealed that weeds can affect how much damage rodent pests cause to crops like rice. However, in Sri Lanka, there hasn't been any research looking into how weeds and rodent attacks are connected. Understanding this link could help create better ways to manage rodent problems, which will be beneficial in making an Ecologically Based Rodent Management (EBRM) system to lessen the injury to crops. According to Htwe et al. (2019), systematic trapping through the management of weeds was a better way of reducing the damage done by rodents in rice cultivation in Myanmar.

Water availability in rice fields is an environmental factor that contributes both gains and drawbacks to diverse pests found in the paddy field, including rats and mice. Therefore, the aforementioned experiment was conducted to assess the effects of weed density and standing water level on rodent damage in rice fields, to develop improved rodent control methods and minimize yield loss from rodent attacks (Sarathchandra et al., 2022).

II. MATERIALS AND METHODS

A. Influence of weed density on rodent damage

1) Location of the study

The experiment was implemented in a selected farmer field in Kahapathwala (7023’47.2” N, 80028’05.8” E), Kurunegala district, Sri Lanka (Intermediate zone) during 2018 minor (*Yala* season), and 2018/19 major season (*Maha* season) under normal field conditions. Coordinates recorded using a handheld GPS device.

2) Field establishment

The designated field was split into 3 experimental units by 50 × 50 m. and each plots were separated by a 20 m border on all sides. Three treatments (Table 01) were assigned according to the following standard design (Htwe et al., 2019). Weed-free fields were continued through manual weeding. According to Aplin et al. (2003), to establish the sampling layout, a baseline was demarcated along the long axis of the field. Four transects were demarcated from each treatment unit and treated as replicates. These replicates were positioned perpendicular to the baseline, running in from the edge of the field. They were spaced at 13 m intervals, located at distances of 1 m, 14 m, 27 m, and 40 m starting at the field margin (Figure 01). Each transect was divided into 3 strata, which were perpendicular to each transect at 5 m, 15 m and 25 m along the transect (Figure 01).

Table 01: Treatments applied in the experiment of weed density on rodent damage

Treatment number	**Treatment**
T1	Weeds-free field
T2	Field with conventional farmer weed management practice
T3	Un-weeded (Control) field

3) Data collection

According to the International Rice Research Institute (IRRI, 1988), rat damage was assessed through observing symptoms such as cutting down or chopping down of rice plants. The damaged and undamaged tillers were counted two weeks prior to crop harvest. stage by assessing every three hills along each stratum of each transect, up to 10 sampling points were noted. Data collection was repeatedly done in the same orientation (Aplin et al., 2003). Following counts were recorded;

(i) Total number of tillers/hill

(ii) Damaged tillers/hill -both freshly damaged tillers and regenerated tillers

The level of damage caused by rats was estimated using the following formula;

$$Damage\ \% = \frac{Number\ of\ damaged\ tillers}{Total\ number\ of\ tillers}\ x\ 100$$

In the meantime, weeds present within the rice field were sampled from each transect using a quadrate (36 × 36 cm), and the dry weight (DW) of each weed sample was measured for each replicate by drying the sample at 70 °C for 72 h until reaching a constant weight (Anwar et al., 2012).

4) Statistical analysis

The recorded data were transformed into arcsin values and analyzed according to the ANOVA procedure using SAS statistical software (SAS 9.1.3, 2003-2008) and means were compared with LSD test where P< 0.05.
A regression analysis was done to determine the correlation between dry weight of weeds and rat damage percentage via SAS 9.1.3 (SAS Institute, 2003- 2008).

B. Influence of standing water level on Rodent damage

1) Location of the study

The study was carried out in farmer fields in selected area located at Kahapathwala (7023'40.6" N, 80027'58.7" E) in Kurunegala district Sri Lanka during 2019 minor and 2019/20 major season.

2) Field establishment

The selected field was split into 4 experimental units, each having 50 × 50 m, with each unit separated by a 20 m border on all sides. Field preparation and crop establishment were done according to the recommended standards (Department of Agriculture, 2025). Conventional water level as farmer practice was maintained until tillering stage which is vulnerable for rodent damage. From the beginning of the tillering stage, four treatments were conducted to distinct plots. The tested standing water levels (Table 02) were assigned according to the same standard design (Aplin et al., 2003).

Table 02: Treatments applied in the experiment of sanding water levels on rodent damage

Treatment number	Treatment
T1	No standing water (control)
T2	Farmer practice (based on the availability of water)
T3	5 cm standing water level
T4	10 cm standing water level

3) Data collection

Observed damaged and undamaged tillers for rat damage assessment, followed a similar procedure to the study on weed density and rodent damage. The sampling layout was given in Figure 01.

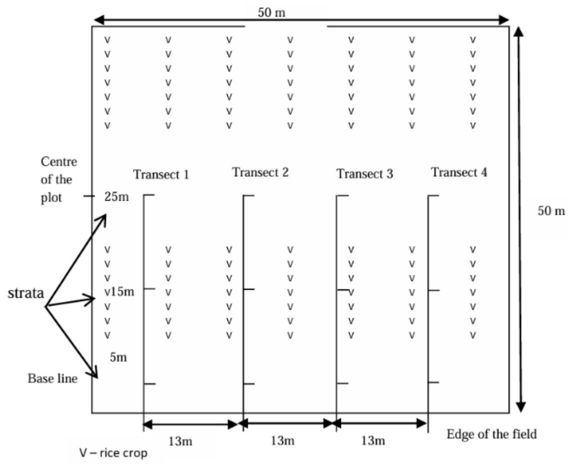

Figure 01: Layout of transects to measure the damage caused by rats in a plot (Aplin et al., 2003)

4) Statistical analysis

The recorded data were transformed into arcsin values and analyzed according to the ANOVA procedure via SAS 9.1.3 (SAS Institute, 2003-2008). Means were compared with LSD test, where P< 0.05.

III. RESULTS AND DISCUSSION

A. Influence of weed density on rodent damage

During 2019 minor season (*Yala* season, from April to September), a statistically significant positive ($p \leq 0.002$, $r^2 = 0.629$) correlation was observed between the percentage of rodent damage in rice fields and the dry weight of weeds (Figure 02). Equation of Rodent damage% = 3.20 + 0.192 Dry weight of weed shows that the

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coefficient for the dry weight of weeds (in grams) is 0.192, indicating that for every additional gram of dry weight of weeds, the rodent damage percentage increases by 0.192%.

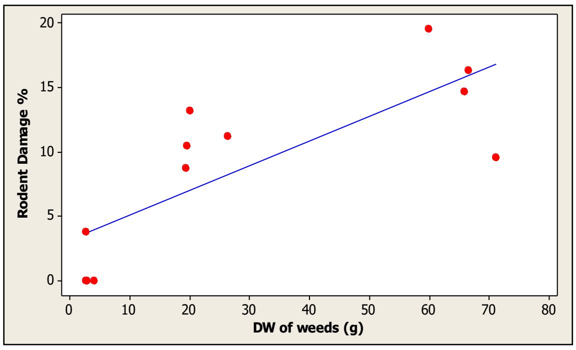


Figure 02: Relationship between rodent damage percentage and dry weight of weeds (g) caused by rodents under weedy conditions, 2019 minor season, DW-Dry weight

During 2019/20 major season (*Maha* season, from September to March), a significant positive ($p \leq 0.002$, $r^2 = 0.821$) correlation was observed between the percentage of rodent damage in rice fields and the dry weight of weeds (Figure 03).

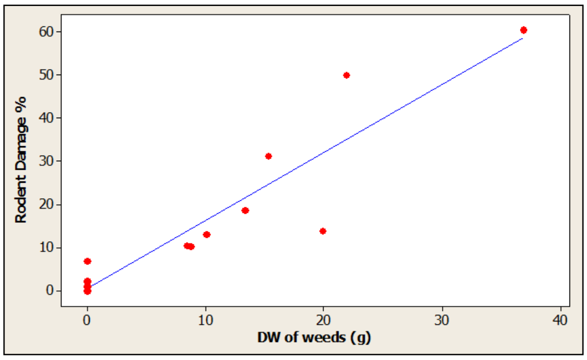
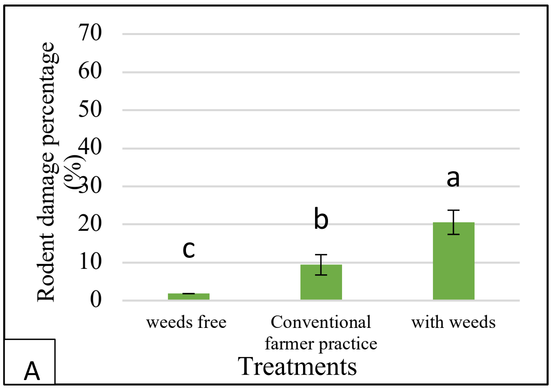


Figure 03: Relationship between rodent damage percentage and dry weight of weeds (g) caused by rodents under weedy conditions, 2019/20 major season, DW-Dry weight

The equation of Rodent damage% = 0.44 + 1.58 dry weight of weeds shows that the coefficient for the dry weight of weeds (in grams) is 1.58, indicating that for every additional gram of dry weight of weeds, the rodent damage percentage increases by 1.58%.

In both seasons of major and minor, the highest percentage of rodent destruction was observed in the treatment with weeds (un-weeded) and the lowest percentage of rodent damage was found in weed-free fields (Figure 04). The observations revealed that rodent damage intensified with increasing weed density.



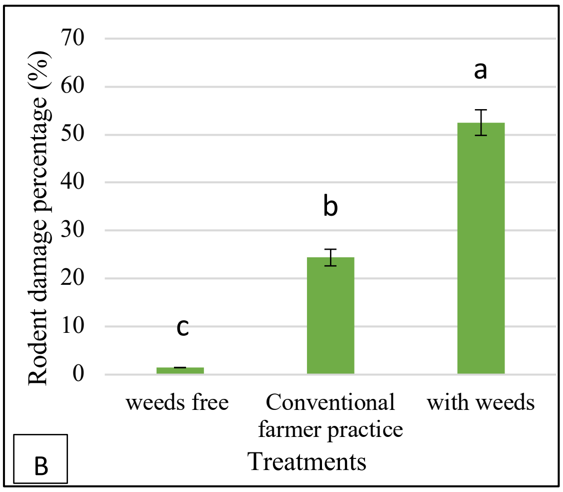


Figure 04: Rodent damage percentage under different weed densities of farmer field in Kahapathwala during A) 2018 minor season (April to September) B) 2018/19 major season (September to March)

This was proofed by the same study showed in Myanmar on *Cyprus difformix* and *Echinochloa crus-galli* weeds, indicating the highest rodent damage in dry season compared to the wet season (Htwe et al., 2019). Conversely, Leirs et al. (1994) find that the breeding seasonality of African multimammate mice (*Mastomys* spp.) was closely linked to rainfall periods.

According to Mwanjabe (1993), referenced in Massawe et al. (2007), rodents are becoming more prevalent in crop fields with a high weed density for specific reasons. A combination of minimal land preparation and following weed growth can improve the favorable conditions for opportunistic and abundant rodent species like *Mastomys* *natalensis*, ultimately leading to more damaged crops.

In other hand, the lowest percentage of Rodent damage was observed in fields where weeds were effectively controlled. Wilson and Whisson (1993) state that grass seeds afford a protein source for rats and mice essential for their breeding. With the results obtained, it is revealed that when there is no considerable amount of weeds in the field during the different stages of tillering, rice field rodents cannot approach the rice plants.

B. Influence of standing water level on rodent damage

In both seasons, the highest percentage of rodent damage was observed in the treatment with no standing water (T1), where no standing water levels were maintained (Figure 05 and 06). Also in both seasons, the lowest percentage of rodent damage was observed in the treatment with 10 cm standing water (T4).

During 2019/20 major season (Figure 06), these results indicating the higher water standing level did not allow to colonize the Rodent in rice fields. Extensive standing water during rice crop stages is associated with reduced rodent colonization and local abundance in many systems (Ghersi et al. 2021).

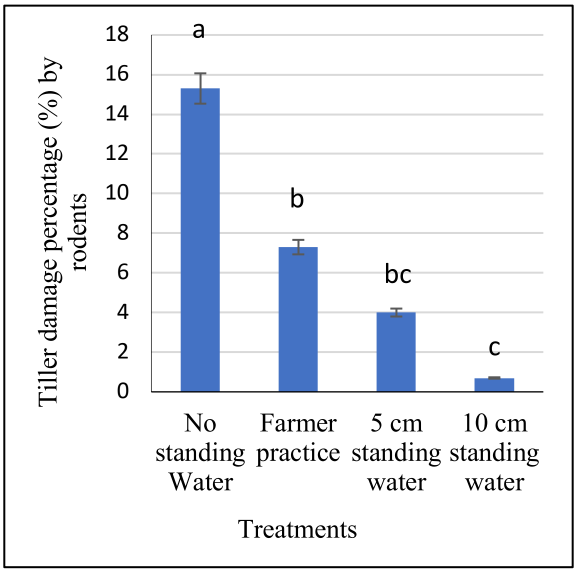


Figure 05: Tiller damage percentage (%) by rodents in rice field at Kahapathwala during 2019 minor season with different levels of standing water

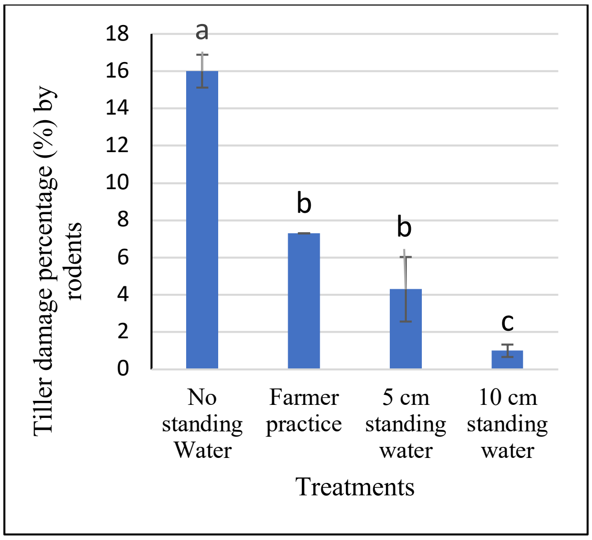


Figure 06: Tiller damage percentage (%) by rodents in rice field at Kahapathwala during 2019/20 Major season with different levels of standing water

IV. CONCLUSION

The study demonstrated that weed density has a positive correlation with rodent damage in rice fields, with the highest losses occurring in un-weeded plots and the lowest in weed-free plots. This emphasizes the necessity of proper weed management tactics to reduce losses by rodents in rice fields. Furthermore, standing water level was found to have a significant effect on rodent activity, indicating that water management practices can also play a role in minimizing rodent-induced yield losses. Overall, following appropriate weed and standing water level management practices provides a practical approach to reducing rodent damage in rice cultivation.

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