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The Effect of Different Dosages of Nitrogen Fertilizer on Rice Growth and Leafroller Populations

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Abstract
Rice (*Oryza sativa* L.) is an essential cereal grain crop, cultivated in tropical and subtropical areas, particularly in Asia. Several insect species are known to infest rice plants, both in open fields and in storage rooms. However, higher amounts of nitrogen fertilizer can increase plant growth, they may be responsible for initially attracting these insects to the plants. The field experiment for this study measured the effects of different nitrogen application rates on leafroller populations and rice crop growth. Five doses of nitrogen fertilizer were applied at three different times, with insect populations recorded after each application in leaf samples from six randomly selected spots on each plot. The results indicated that an optimum fertilizer dose of 75kg of urea per acre can minimize leafroller infestations and maximize plant growth. Moreover, this optimum application of fertilizer might also help plants develop resistance against invasive pest populations.
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Introduction

Cultivated in tropical and subtropical areas, rice (*Oryza sativa* L.) is one of the most important cereal crops in Asia (Molina et al. 2011). Ninety percent of the world's rice is grown in Asia (Virk et al. 2004), and rice is the primary food of 50 percent of Asian people (Virk et al. 2004). Although the rice plant is native to Asia and some parts of Africa, however, it can be grown almost anywhere with the use of water-controlling terrace systems (Khush 2005), and it provides more than one-fifth of the calories consumed worldwide (Smith 1998). The yields of rice crops can be increased by improving irrigation management and fertilization, and by controlling diseases, insects, and other pests (Alamet et al. 2008). Several insect species can infest rice plants from germination to harvest, even causing damage in storage rooms. The most common species include stem borers in the genera *Scirpophaga* and *Chilo* (IRRI 2014), brown planthoppers (Preap et al. 2006), rice bugs (Jahn et al. 2004), rice leafrollers, rice grasshoppers, and rice weevils.

Fertilizer application is necessary to achieve optimum crop yields. It has been found that high fertilizer dosages can result in higher yields compared to low dosages (Khush et al. 1990). However, increased use of synthetic fertilizers, especially nitrogen (N), can lead to a significant increase in the number of herbivorous pests, particularly sap-feeding insects (Jahn et al. 2005; Ha Bi et al. 2001). And also the high cost of inputs contributes the scarcity of financial resources, a low yield per hectare, and ultimately decreasing the benefits (Hassan 1991). Better plant growth and crop yield depend on balanced fertilization, which in turn has an indirect effect on pest populations. With this idea in mind, the present study was designed to investigate the effects of different doses of nitrogen fertilizer (Urea) on rice leafroller populations.

Materials and Method

The field experiment was conducted in the fields that alternate crop cycles between rice and wheat in Dokri, Pakistan, situated at 27.3743° north latitude, 68.0967° east longitude, with an altitude of 39 meters (131 feet) above sea level. Specimens of rice cultivar IRRI-6 were first grown in 15x15-meter nursery beds. Healthy and uniform 30-day-old nursery plants were then transplanted to the experimental fields, with row-to-row spacing of 20 centimeters and plant-to-plant spacing of 30 centimeters. The field was divided into five areas, each treated with different doses of nitrogen fertilizer (urea), as follows:

Treatment-1 (T1) 50 kilograms per acre
Treatment-2 (T2) 75 kilograms per acre
Treatment-3 (T3) 100 kilograms per acre
Treatment-4 (T4) 125 kilograms per acre
Treatment-5 (T5) 150 kilograms per acre

Fertilizers were applied at three different times, i.e. 30 days after transplanting (DAT), at the flowering stage, and at the milky stage of the crop. The crop was irrigated whenever necessary and weeded regularly to keep the field clean and healthy.

Data Recording

Data on insect populations was recorded 10 days after each fertilizer application. For each data observation, leaves were sampled from six randomly selected spots on each plot of experimental field, and the number of leafrollers per plant was counted and recorded. Each plant was further observed for agronomic data such as plant height, number of leaves per plant, and number of tillers. The mean numbers of treatments were compared and analyzed using statistical program for social sciences (SPSS). All data figures were prepared using Microsoft Office Excel 2010.

Results

Leafroller Population

The minimum and maximum doses of fertilizer resulted in the highest leafroller populations. In the first data observation, the lowest numbers of insects were found in T2 (1.50 ± 0.24), followed by T1 (1.75 ± 0.32), T3 (3.38 ± 0.33), T4 (3.63 ± 0.33), and T5 (4.00 ± 0.41). At the second observation, the leafroller population remained the lowest in T2 (1.63 ± 0.33), followed by T1 (1.75 ± 0.21), T3 (3.50 ± 0.34), T4 (4.63 ± 0.41), and T5 (5.38 ± 0.23). T2 (1.63 ± 0.33) retained the lowest pest population in the last measurement, followed by T1 (2.63 ± 0.23), T3 (4.50 ± 0.34), T4 (4.75 ± 0.78), and T5 (6.00 ± 0.59). Results from the ANOVA analysis showed significant differences between all treatments at first ($F = 19.02$; df = 4, 35; $P < 0.00$), second ($F = 46.11$; df = 4, 35; $P < 0.00$), and third ($F = 19.90$; df = 4, 35; $P < 0.00$) data observations (Fig. 1).

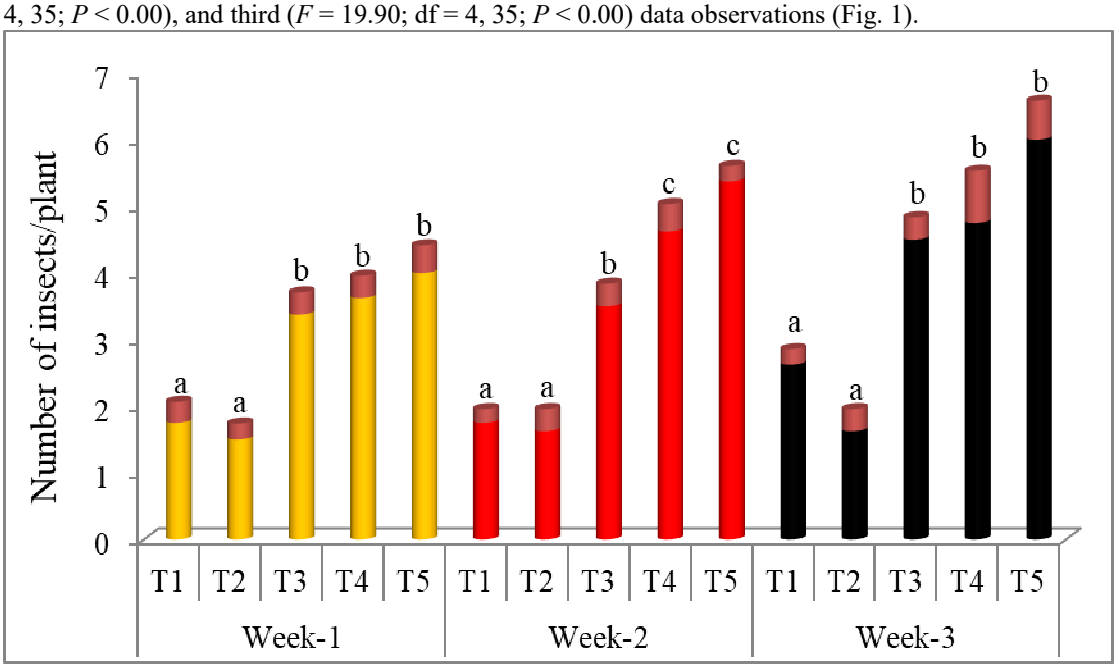

Fig 1. Leafroller population (mean + SE) per plant in five different treatment of urea application. Values are the means of eight replications.

Plant Height

Plant height increased regularly with an increased level of urea; the maximum application of urea resulted in the greatest height increased (Fig. 2). The greatest height across the entire study was recorded in the third data observation in T5 (121.88 ± 4.44), followed by T4 (116.63 ± 2.75), T3 (111.88 ± 2.61), T2 (104.63 ± 3.20), and T1 (94.75 ± 3.17). The first and second data were respectively lower in height. The results of the ANOVA analysis showed significant difference between treatments at the first ($F = 11.67$; df = 4, 35; $P < 0.00$), second ($F = 15.46$; df = 4, 35; $P < 0.00$), and third ($F = 16.56$; df = 4, 35; $P < 0.00$) observations (Fig. 2).

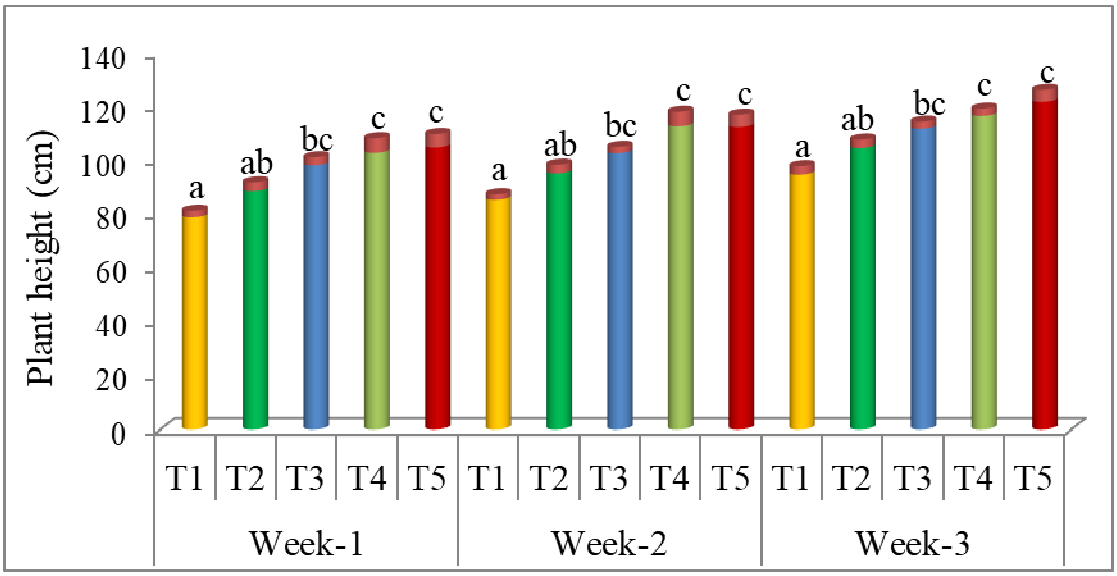

Fig 2. Plant height (mean + SE) in five different treatment of urea fertilizer. Values are the means of eight replications.

Plant Leaves

It has been recorded that with increase amount of urea, the number of leaves also increased. All treatments showed significant different at first ($F = 21.88$; df = 4, 35; $P < 0.00$), second ($F = 20.02$; df = 4, 35; $P < 0.00$) and third ($F = 11.15$; df = 4, 35; $P < 0.00$) observation. The maximum number of leaves were recorded in the third data observation in T5 (121.88 ± 2.74), followed by T4 (119.63 ± 3.63), T3 (114.63 ± 3.41), T2 (111.38 ± 2.32) and T1 (101.63 ± 2.81); while the first and second data were respectively lower in leaf numbers (Fig. 3).

Number of Tillers

Result from the ANOVA analysis showed significant differences between all the treatments at first ($F = 6.91$; df = 4, 35; $P < 0.00$), second ($F = 5.74$; df = 4, 35; $P < 0.00$) and third ($F = 5.57$; df = 4, 35; $P < 0.00$) observations. In the first observation, the maximum number tiller were recorded in T5 (29.38 ± 1.01), T4 (28.25 ± 1.45), T3 (26.25 ± 1.56), T2 (24.63 ± 1.09), and T1 (22.88 ± 1.13), the number of tiller were increased with increase of crop age as on Second and third recording times (Fig. 4).

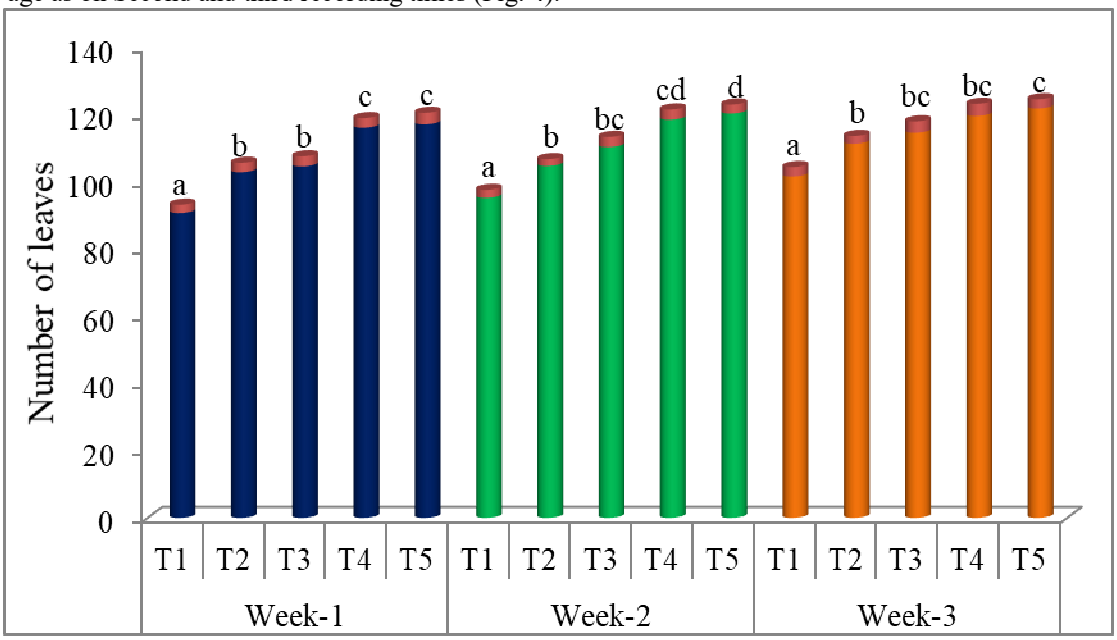

Fig 3. Number of leaves per plant (mean + SE) in five treatments of urea fertilizer. Values are the means of eight replications.

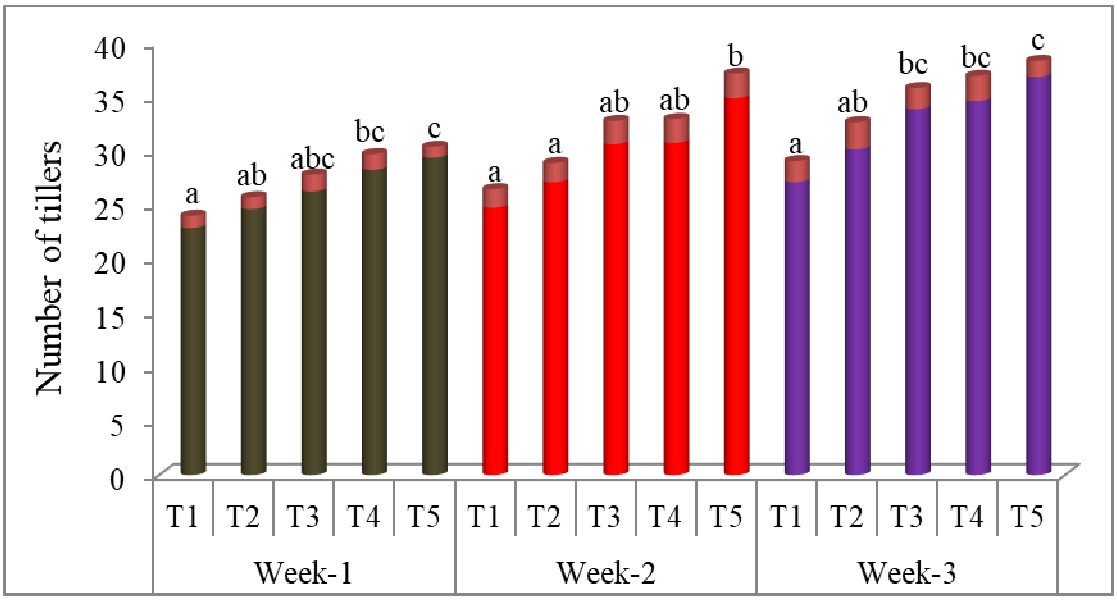

Fig 4. Number of tillers per plant (mean + SE) in five different treatment of urea fertilizer. Values are the means of eight replications.

Discussion

We observed from our results that the maximum use of urea fertilizer results the greenish crop and increase plant growth, while the lush green crop attract insect pest which are the reasons of losses grain quantity and quality. The similar results of fertilizer effects on pest population was described by Sohail et al. (2007) that the unnecessary and high doses of nitrogen fertilizer yielded lush green plants, which is the responsible for insect attraction; moreover higher doses of fertilizer might be affect the crop maturity. High dose of nitrogen fertilizer resulted maximum pest population, as compared to minimum dose rates, therefore appropriate management of nitrogen is important to obtain high yield (Wagan et al. 2015). In our study, each fertilizer dose showed positive effect on plant growth. Maximum fertilizer gives maximum plant growth as compared to minimum does rates of nitrogen. Similar results of fertilizers effect on plant growth were defined by Khalifa *et al.* (2012) that frequently application of nitrogen fertilizers in the field will improve the plant ability to high uptake of nitrogen. Nitrogen application can be effective if it is applied on time when the plant demand is high (Setatou and Simonis 1995). Balanced and timely application of plant nutrients can increase plant growth and its final yield (Dhaunroo et al. 2018). Grain weight and crop yield can be improved with increasing of fertilizer doses, however application methods of fertilizers not effecting the yield (Sami and Yassin 2012). It has been concluded from our results, that high or very low dose of urea fertilizer attract leaf roller populations. However, an optimum fertilizer dose of 75kg of urea per acre can minimize leafroller infestations and maximize plant growth. Moreover, this optimum application of fertilizer might also help plants develop resistance against invasive pest populations.

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