RESEARCH ARTICLE

Incidence of Brown Plant Hopper in the Rice Field with the Use of Different Doses of Fertilizers

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Abstract

The rice brown planthopper is a rice pest, which one is very harmful when the nitrogen fertilizer is applied at a higher rate. To evaluate the effect of brown plant hopper by using different fertilizers on transplanted basmati rice, a field experiment was conducted at the experimental farm of School of Agriculture, in Lovely Professional University, Punjab during Kharif season 2015–2016. The different fertilizer doses were used, and the experiment comprised of 15 treatments. The results showed that the nitrogen fertilizer did not harm to rice crop, but the attack of brown planthopper was increased due to more succulent tissues of a rice plant. The nitrogen increased the photosynthesis effect and ratio in the plant due to more production of chlorophyll. In case of another fertilizer P and K (P_2O_5 and K_2O) are not promoting but also nor affecting to insect/pests attack. Zinc sulfate proved that its effect was much positive towards crop because the zinc sulfate making less susceptibility of plants to pest attack at all doses. The rice crop was showed highest brown plant hopper attack at 50 kg ha^{-1} of nitrogen and also showed maximum plant height, number of tillers, panicles/plant, and 1000 grain weight. Maximum grain and straw yield (7093 kg/ha, 8753 kg/ha) was recorded in T9 where N- 50, P-40 kg ha^{-1} was applied. The grain yield and straw yield was recorded maximum in treated plots as compared to the control.

Keywords: Brown plant hopper, Fertilizer, Grain yield , Straw yield, Treatments.

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Introduction

Rice is a leading crop in the global level, and half of the world's population always depends upon the cereal crops to maintain the daily diet (Ali, 2014). In Asia, Rice crop is a mostly eatable crop (Bewke *et al.,* 2018). Its family is Gramineae, and it is also self-pollinated crop where the full flower are emerged (means male and female parts are grown together). Rice crop providing food to 50% of the world's population (Bottrell *et al.,* 2012), the second largest producer of rice in India (Cao *et al.,* 2013). Basmati rice is a different variety by itself from all other dwarf varieties by grains, Indian country they want to eat *basmati* rice (Darrvath *et al.,* 2017). The *basmati* rice also considered as fragrance queen (Agriculture produce export and development agency). *Basmati* rice has very good characteristics like enlarged grains, smooth surface, good in meal, good in taste, easy to digest). The Sanskrit language has given the name to this crop as *basmati.* After this having a particular number of the crop is 1121 and the combined name is Pusa *Basmati* 1121, the life cycle is of 138 days, and the grain production is 14.3q $acre^{-1}$. The Pusa *Basmati* 1121 originates from or belonged to Punjab state but in these days the main crop was rice during Kharif season up-to 1965. The area of Punjab under Pusa *basmati* 1121 was 7.30 lakh acres in Punjab (De Bruyne *et al.,* 2014). In 1965 the yield and production were 6.2 q $acre^{-1}$ and 44.7 lakh quintals, but with the comparison of 2014–2015, the cultivated area, yield and production were 73 lakh quintal, 26 q $acre^{-1}$ and 1750 lakh quintals. According to this, there was a big enhancement of production by 5–50 times in the last 52 years. Punjab is also famous as a 'rice bowl' of Indian country. According to the data in 2014–2015 Punjab has 9.60 lakh hectares of area and 26.50 lakh tone production. In India, the area under cultivation is 27 lakh hectare, and production was 84 lakh tones (De Vleesschauwer *et al.,* 2016).

Along with the rice production, the insects/pests attack is also increased and loss of rice is continuously going on. These attacks always demand more care for the rice plant (Horgan *et al.,* 2018). Due to the insects/ pests at the global level the rice yield has decreased (Horgan *et al.,* 2007). Different species are affecting the rice crop. Among the rice pests, rice stem borer, BPH (Brown planthopper) and leaf folder are economically important causing heavy losses in economic importance (Barley and Butter,2008). This was observed that these pests cause substantial damage up to 25-55% (Horgan *et al.,* 2016) which forms one of the major problems for the productivity of Indian soil (Huangfu *et al.,* 2016). Up to the 60% crops damaged is done by just single pests' i.e BPH *Nilaparvata Lugens* (Li *et al.,* 2015). Due to using of the high input of fertilizer and narrow spacing the pest

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status has increased in India (Lu *et al.,* 2015) From the phloem cells the nymphs and adults of BPH suck more plant sap and leaves then turn to brown giving the burnt appearance to crop known as hopper burn effect.

BPH is a severe pest in rice crop, which is harming to rice plant with heavy damage (Madhuri *et al.,* 2017). Most of the researchers have opined that the attack of BPH always increased with the miss use and overuses of nitrogenous fertilizer which leads to more excretion of honeydew by BPH (Rashid *et al.,* 2017), the plants become more vulnerable to BPH by using more amount of nitrogen. There is a need to increase nutrient use efficiency by providing particular or optimum doses of fertilizers. The import of fertilizers of value Rs 34,600 crores in 2012–13 and India faced 2900 crores rupees loss due to miss use or overuses of nitrogen fertilizers, by using just 1% increase in NUE in N and P will save 10,056 million rupees and also controlling health issues in Punjab and Haryana which one is spreading by the groundwater samples had nitrate –N of > 22 mg/L. The soil health is degrading by the over and misses use of fertilizers. To reduce the bad effects of the overuses of fertilizers, we need to introduce the NUE (Nutrients use efficiency) now in these days.

Materials and methods

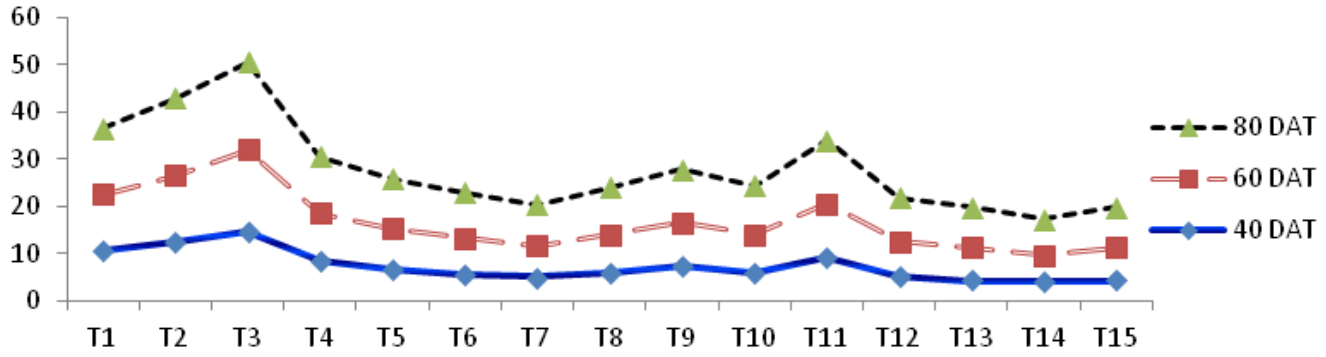
In order to find the effect of various fertilizer doses on the incidence of brown planthopper, the experiment was conducted in randomized complete block design in three replications with a plot size of 5 m x 4 m at the experimental farm of School of Agriculture. The variety used for the experiment was Pusa basmati1121. The soil was sandy loam in texture having a medium in available nitrogen, high in available phosphorus and potassium. Soils were sufficient in all micronutrients. The experimental site enjoys the sub-tropical type of weather conditions with cool winter and hot summer. The nursery was raised before one month of transplanting. The seedlings were raised in two seedbeds, the size of each seedbed is 10m x 2m= 20m2. A distance of 50 cm in the form of the drain was maintained between the beds. The area was well prepared with a spade and by plowing. All kinds of weeds, stubbles and crop residues were removed from the field. The soil was mixed with cow dung, 520g urea, and 250g $ZnSO_4$ at last puddling. Pre-germinated seeds @ 1 kg/ 20m2 were sown by broadcasting on before sowing the seeds were treated with 1 g Baviston for 8–10 hours. After sowing the plots were irrigated frequently. The main field was prepared by 2-3 plowing, harrowing's and leveling before one week of transplanting. Weeding, irrigation, and fertilization were done from time to time. One to two seedlings were transplanted per hill at a spacing of 20X10cm from row to row and plant to plant. The treatments viz. T1-N-38 kg ha^{-1}, T2- N-43 kg ha^{-1}, T3- N-48 kg ha^{-1}, T4-P-25 kg ha^{-1}, T5-P-30 kg ha^{-1}, T6-K-25 kg ha^{-1}, T7- K-30 kg ha-1, T8-N+P-43+25 kg ha-1, T9- N+P- 48+30 kg ha^{-1}, T10- N+P+K-43+25+25 kg ha^{-1}, T11-N+P+K-48+30+30 kg ha^{-1}, T12-ZnSO4- 20 kg ha^{-1}, T13-$ZnSO_4$-25 kg ha^{-1}, T14- $ZnSO_4$-30 kg ha^{-1}, T15-control. All the recommended agronomic practices, except the application of fertilizer, were followed. A full dose of phosphorous and potash was applied as a basal dose through SSP and MOP. Nitrogen was supplied in the form of urea at 21 and 42 DAT. One month after transplanting the observations on the incidence of leaf folder and brown planthopper were recorded at regular intervals. The leaves which are damaged by 2/3rd portion and more than 2/3rd portion were considered as damaged leaves. The motile stages of brown planthopper were counted on ten randomly selected hills in each treatment plot and expressed as per hill basis. The data recorded at three intervals 40, 60 and 80 DAT. The crop parameters were also recorded at different intervals like plant height, tillers, and panicles per plant, filled grains per panicle, grain yield, straw yield and test weight. The weeds were removed by hand weeding at 20 and 40 DAT. The data obtained on various observations were tabulated and subjected to the analysis by using analysis of variance and treatments were tested by using f-test.

Results

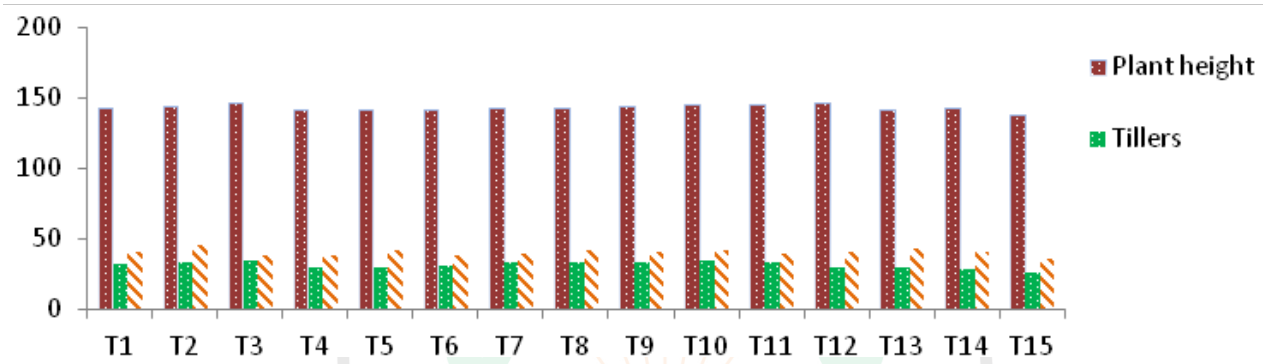
In order to evaluate the relative impact of different dosages of fertilizers (N, P, and K) on the occurrence of brown planthopper (BPH) and yield parameters of paddy a field experiment was conducted. The results are presented and discussed below.

Effect of N, PK and Zn on the Incidence of BPH

BPH is one of the most important insect pests of rice in India, and it has been a major pest of rice. The result indicated that change of fertilizer inputs to rice plants significantly affected BPH population. The BPH population recorded at three different duration (40, 60 and 80 DAT) during the experiment**.** An infestation of BPH population varied statistically in relation to the applied doses of N. The highest BPH incidence (14.6, 17.3 and 18.6 $hill^{-1}$) was noted at (40, 60 and 80 DAT) with the application of 49 kg N/ha. This was followed by 44 kg N/ha (12.3, 14.3 and 16.3 $hill^{-1}$). The lowest (10.6, 12 and 14.0 $hill^{-1}$) was being observed when 40 kg N/ha was applied. BPH population was negatively affected by the applied P dose, more the applied dose of P lower would be the incidence. BPH population infestation was highest when P applied @25 kg/ha (8.3, 10.3 and 12 $hill^{-1}$). BPH population was low when P applied @ 30 kg P/ha (6.6, 8.7 and10.6 $hill^{-1}$). Incidence of BPH varied in consideration of plant growth statistically. But if phosphorus is supplied with higher nitrogen input (49 kg/ha), phosphorus significantly influenced the number of adult BPH. The incidence of BPH population was highest when K was applied @25 kg/ha (5.6, 7.7, 9.6 $hill^{-1}$) and lowest when K was applied @30 kg/ha (5, 6.7 and 8.6 $hill^{-1}$). For the application of Zinc @30 kg/ha, significantly lower the infestation of BPH as compared to the Zn@ 20, 25 kg/ha. Zhang *et al.,* (2017) investigated the effects of Zn on the reproduction of phytophagous insect (Graph 2).



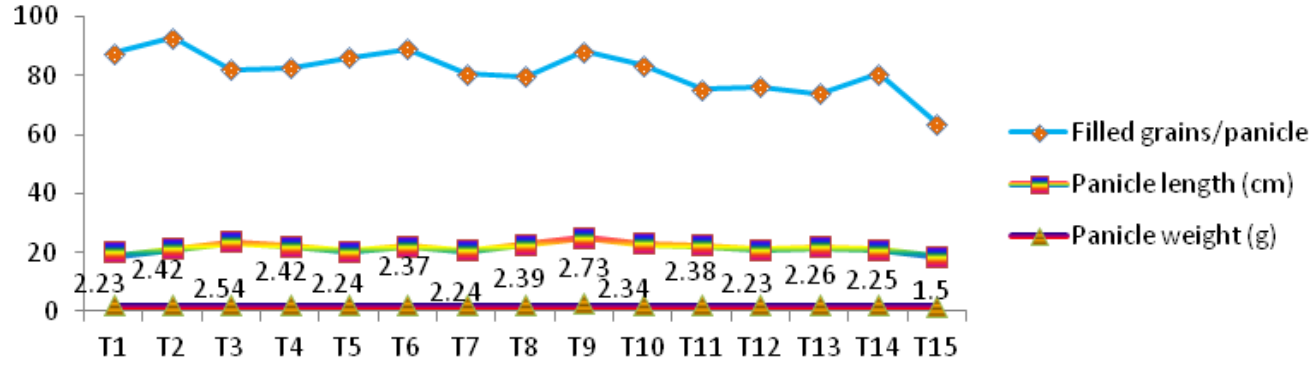
Graph 1: Effect of fertilizers on the incidence of brown planthopper/hill



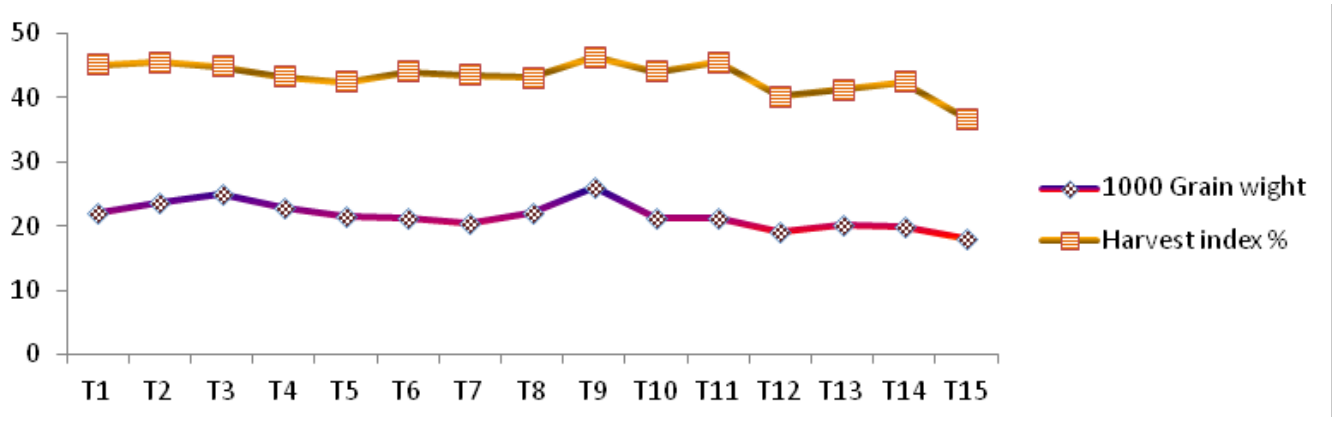
Graph 2: Effect of fertilizers on plant growth

Effect of Different Fertilizers on Yield Parameters of Rice

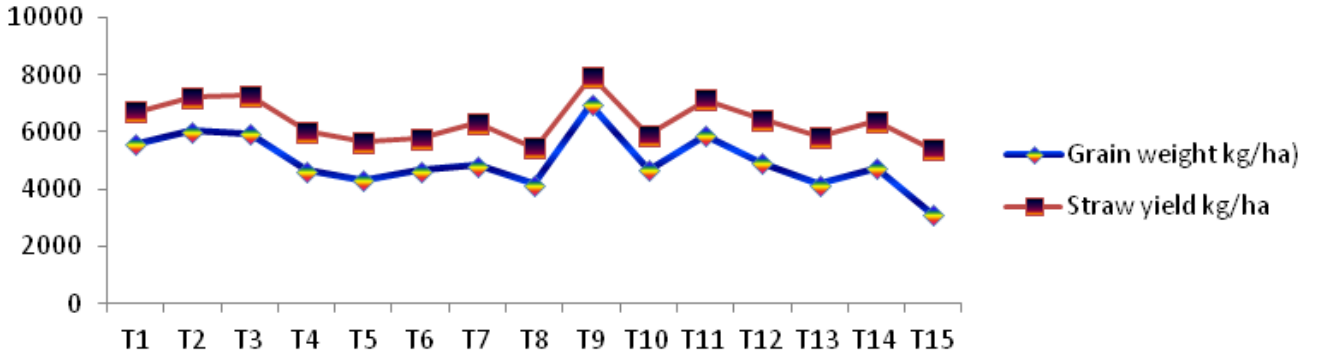
Application of fertilizer enhanced the plant height of rice as compared to control. Application of N more than recommended leads to increased plant height. Especially in cereal crops plant height is not a yield component, but it indicated that the influence of various nutrients on plant metabolism. Plant height increased significantly and progressively with increased levels of nitrogen up-to highest dose tried. Tillers production per plant was significantly affected by levels of nitrogen at all stages. Increase in the number of tillers in rice crop was due to the influence of different fertilizer combination (Graph 3). The panicle length, panicle weight and number of filled grains per panicle were higher in NP-48; 30 kg ha^{-1} treated plots might be due to better N and P ratio of plant during panicle growth period (Graph 4). The significantly maximum 1000 grain weight (26.1 g) was observed in treatment NP-48, 30 kg ha^{-1} which was at par with treatment N-48 kg ha^{-1} (25 g) and statistically similar to each other. All the treatments produced significantly higher grain yield over control. NP- 49, 30 kg ha^{-1} increased the grain yield significantly better than alone N, P, K and Zn (Fig. 5). Maximum harvest index was observed in T9 (NP48, 30 kg ha^{-1}) which was at par with N - 43 kg ha^{-1}, and minimum harvest index was observed in control.



Graph 3: Effect of fertilizers on yield parameters



Graph 4: Effect of fertilizers on yield contributing characters



Graph 5: Effect of fertilizers on yield parameters

Discussion

From the study, it is clear that nitrogenous fertilizer increases vegetative growth rate and softens the tissues of the plant. N also boosts the tiller formation, which provides the conditions for the outbreak of the planthopper. The nymphs of BPH highly intensified the plants which were fertilized with more dose of N and reproductive rate of progeny is high as compared to those plants which were less fertilized with N. Significant impact of N levels on the incidence of BPH population was also recorded by (Sogawa *et al.,* 2015). With the increase in nitrogen dose the survival rate of BPH from egg–nymph–adult was increased. Phosphorus and potassium fertilizers had no significant effect on BPH. When higher doses of nitrogen fertilizer were applied, plants store higher amounts of nitrogen and soluble protein content in their plant tissue, which influenced herbivore growth and development. If the nitrogen content is more then egg hatchability is also more. BPH reared on plants receiving 49 kg nitrogen ha^{-1} produced three times more eggs than those reared on plants with no nitrogen applied. A higher rate of potassium fertilizer was associated with lower BPH population. This might be due to a decrease in soluble protein and free sugar content in potassium fertilized plants. Zn proved to be a better mode of fertilization for the crop at all levels of application, as it allowed a balanced nutrient blend in soil and reduced the crop damage. Hence, reduced susceptibility of the plant to pests may be a reflection of differences in plant health, as mediated by soil fertility management through Zinc. The soils with good Zinc fertilizer normally exhibited good soil fertility, as well as complex food webs and supported beneficial organisms that prevented pest contamination. These findings are in close conformity with those reported by Horgan *et al.,* (2017), who observed that nutrition imbalance could lower pest resistance. High levels of Zn can stimulate early vegetative growth resulting from increasing the photosynthetic activity leading to a decreased insect pest infestation and elevated crop yield. Further, the indirect effects of Zn fertilization acting through changes in the nutrients composition of the rice crop have influenced plant resistance to borer insect pests. In case of interaction of fertilizers, there was a variation in the incidence of insect pest in case of a combination of fertilizers and with the different levels.

Higher doses of nitrogen being constituent of enzymes and protein which improve the cell expansion and various metabolic processes, like chlorophyll formation and increased plant height. The combined application of fertilizer at higher doses than recommended also showed

a comparable result to others. A number of tillers per hill might be due to more availability of nitrogen which played a vital role in cell division and enhanced cell expansion and various metabolic processes. In case of single supply of nitrogen (N-48 kg ha^{-1}) and combined application of NPK at recommended rate also increased the panicle length because nitrogen is a constituent of enzymes and proteins which enhanced cell expansion and various metabolic processes which lead to more panicles per plant and more panicle length with the application of Zinc, panicle length also increase might be due to its effect on enhancing physiological functions of crop like photosynthesis and translocation of plant nutrients which ultimately increased the number of panicles per plant and also increased panicle length. The minimum panicle length was observed in control due to non-availability of fertilizer. The N+P, combination produced a number of grains per panicle. The nitrogen and phosphorous combination, at higher doses, lead to more dry matter accumulation due to which more straw yield was obtained. Alone N-44 and 49 kg ha^{-1}, showed a comparable result. Nitrogen increased the rate of photosynthesis and is a basic constituent of protoplasm and chloroplast stimulated the meristematic growth and thus increased the growth and dry matter of plants. In case of zinc, the straw yield was also more due to the favorable effect of zinc on the proliferation of roots and increased the uptake of plant nutrients from the soil and supplied it to the aerial parts of the plant ultimately enhanced the vegetative growth of the plant. In control, no fertilizer was applied. So, it gave less straw yield as compared to others. Nitrogen application increased the chlorophyll formation and improved photosynthesis, increased plant height, number of leaves, number of tillers per unit area leaf to the production of higher dry matter

Conclusion

BPH in a rice field is encountered by the use of more fertilizers and insecticides. However, our results also support that higher fertilizer could increase BPH population. So the manipulation of fertilizer inputs, especially of nitrogen may help to optimize agricultural practices by promoting negative effects on herbivorous insects. This could be achieved with little damage to plants and negligible crop yield. Future work should aim at quantifying the trade-off between the negative impact on herbivorous pests and plant yield using sub-optimal, optimal, excessive and limited fertilizer input.

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