Crop Protection 61 (2014) 16–22

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Relative abundance and damage of some insect pests of wheat under different tillage practices in rice–wheat cropping in India

Beant Singh [a,*], J.S. Kular [b], Hari Ram [a], M.S. Mahal [c]

[a] Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana 141004, Punjab, India
[b] Department of Entomology, Punjab Agricultural University, Ludhiana 141004, Punjab, India
[c] Punjab Agricultural Management and Extension Training Institute, Punjab Agricultural University, Ludhiana 141004, Punjab, India

ARTICLE INFO

Article history:
Received 19 August 2013
Received in revised form
3 March 2014
Accepted 7 March 2014

Keywords:
Relative abundance
Damage
Some insect pest
Wheat
Insecticide
Tillage conditions

ABSTRACT

Tillage changes the physical and chemical properties of soil and can also inhibit or enhance useful and harmful fauna. In agriculture, different tillage technologies are being tried to enhance crop productivity, but little concrete information seems to exist on their effects on pest abundance and damage. To address this lack of information, sowing of wheat was investigated under different tillage systems. In order to monitor pest abundance and damage in altered tillage systems, the present studies on the relative abundance and damage due to insect pests viz. pink stem borer (PSB, *Sesamia inferens* Walker), termites (*Microtermes obesi* Holmgren and *Odontotermes obesus* Rambur) and root aphid (*Rhopalosiphum rufiabdominalis* Sasaki) were undertaken in a rice–wheat cropping system during 2010–11 and 2011–12. Pest abundance and damage was monitored in four tillage systems i.e. conventional tillage (CT), zero tillage (ZT), ZT + mulch and rotary tillage (RT) under insecticide protected and unprotected conditions. The application of insecticide did not affect root aphid incidence or termite damage. However, significant differences in PSB damage in insecticide protected (0.9%) and unprotected (1.2%) conditions were observed. The investigations demonstrated that in CT, damage by PSB (0.6%) was minimum; however termite damage (2.2%) was maximum as compared to all other tillage conditions. In ZT, PSB damage (1.4%) was maximum and root aphid incidence (3.1 aphids/tiller) was minimum in comparison to other tillage conditions. ZT + mulch resulted in inter-mediate insect pest incidence/damage; however, RT was the least effective practice which showed relatively high incidence/damage of these three insects (1.2% PSB damage, 1.9% termite damage and 5.1 aphids/tiller). The insecticide × tillage interaction indicated that insecticide application is needed only in ZT and RT for PSB management.

1. Introduction

Wheat (93.90 metric tonnes production during 2011–12) is the second most important food crop after rice in India (Anonymous, 2012). Its production is severely constrained owing to damage inflicted by pests and diseases with annual monetary loss due to insect pests amounting to Rs. 413.68 billion. Of the various insect pests, termites (*Microtermes obesi* Holmgren and *Odontotermes obesus* Rambur) are well-established pests of wheat while pink stem borer (PSB, *Sesamia inferens* Walker) and root aphid (*Rhopalosiphum rufiabdominalis* Sasaki) are considered as emerging ones (Dhaliwal et al., 2010). In the case of termites, many influences such as high polyphagy, wide host-range, migratory potential and ability to survive in adverse climatic conditions have strongly contributed to their pest status (Ijaz and Aslam, 2003). PSB is originally a pest of rice crops but in the recent past, it has emerged as a serious pest in wheat too (Ram et al., 2011; Singh and Kular, 2012; Lina et al., 2012). Similarly, as the name indicates, rice root aphid was also first described on rice (Doncaster, 1956) but lately is shifting to wheat (Sandhu and Deol, 1976; Singh et al., 1994). Generally, termite damage is observed initially at the seedling stage i.e. 3–5 weeks after sowing (WAS) and then at the earhead stage while PSB damage is observed in late December to mid-February (4–10 WAS) (Singh, 2012). The pinkish caterpillar of *S. inferens* bores into the stem and kills central shoots forming 'dead hearts' (Deol, 2002) while termite cuts the roots and underground stem portion of plants (Sharma et al., 2004a). The root aphid sucks sap from the roots and crown region of the stem at the seedling stage (3–5 WAS) and growth of the effected plant remains stunted (Singh, 2008). These symptoms are similar to those of termite damage but the difference is that here roots remain intact with the plant.

* Corresponding author.
E-mail address: beant19@yahoo.com (B. Singh).

http://dx.doi.org/10.1016/j.cropro.2014.03.005
0261-2194/

Tillage is known to alter the physical and chemical environment of the crop and also affects soil dwelling insect fauna. The reports of Musick (1970), Edward (1975) and All and Gallaher (1976) are amongst the earliest records of the effects of tillage on arthropods. Later Stinner and House (1990) and Kladivko (2001) extensively reviewed the subject and also suggested that knowledge on the impact of tillage on soil arthropods in different wheat tillage systems is lacking. According to Anonymous (2004), the frequency, depth and nature of tillage in wheat determine its effect on soil fauna. Conventional tillage (CT) is regarded as a highly disturbed cropping system while rotary tillage (RT) as intermediate and reduced tillage is an example of minimum disturbage tillage. Mehla et al. (2000) considered reduced/minimum tillage to be an attractive resource conservation technology, which is being actively promoted in rice–wheat cropping in India. According to Singh et al. (2001), sowing of wheat in residual moisture after harvest of rice without pre-sowing irrigation is also becoming a common feature in the North- western plains of India. It reduced the time gap between rice and wheat crops, which is favourable for the carry over of PSB from rice to wheat (Singh, 2012). To break the yield plateau in wheat, long duration varieties are an important option for which early planting has to be practiced which again will reduce the time gap between rice and wheat. Above all, climate change has resulted in late onset of winters providing greater opportunities for proliferation and damage by PSB. As a futuristic projection, introduction of *Bt* rice and corn may strengthen the probability of increased PSB incidence in wheat crops (Van den berg and Wyk, 2006; Gao et al., 2010).

Previous studies on the effects of different tillage systems on insect pests of wheat yielded conflicting results; some researchers documented the higher incidence/damage of some insect pests in minimum tillage, viz. PSB (Mann et al., 2008; Singh, 2012) while others demonstrated little or no effect, viz. termites (Sharma et al., 2004b). Therefore, concrete information on the incidence/damage of insect pests in wheat under different tillage in rice–wheat cropping is still lacking. In this study, the relative abundance and damage due to soil insect pests was compared in a popularly grown wheat variety PBW 550 under different tillage practices in insecticide protected versus unprotected conditions.

2. Materials and methods

2.1. Experimental site and material

This study was conducted at the Experimental area of the Department of Plant Breeding and Genetics, Punjab Agricultural University (PAU), Ludhiana (30° 55′ N and 75° 54′ E, 247 m above the sea level) during 2010–11 and 2011–12. The soil was *Typic Ustochrept* having low organic carbon (4–4.5 g C/Kg at 0–15 cm). The wheat variety PBW 550 was used in this study and its seed was procured from the Wheat Breeding Laboratory, Department of Plant Breeding and Genetics, PAU Ludhiana. Various equipment, viz. zero till drill (11 rows PZTD, Punjab Engineering Works, Ludhiana), rotavator (1.81 m wide G P, Punjab Engineering Works, Ludhiana) etc. used for sowing of wheat under different tillage conditions were procured from Department of Agronomy, PAU Ludhiana.

The experiments were conducted in rice fields where no insecticide had been applied in the preceding crop to control stem borers and the crop was manually harvested leaving 3–6 inch long rice stubble. The seeds of wheat variety PBW 550 were sown under four tillage systems, viz. conventional tillage (CT), zero tillage (ZT), ZT + mulch and rotary tillage (RT). For CT, the field was prepared by undertaking two operations of disc harrows, followed by one each of cultivator and planking. In ZT, direct sowing with a zero till drill was done without any tillage operation. A single tractor operation with rotary till drill was performed to sow the crop in the RT system. The seed was broadcast on the field and a rotary tiller was run over it. The direct seeding of the crop without any tillage operation was done in ZT + mulch sown crop. Paddy straw @ 5 tonnes/ha, as is usually found in combine-harvested crops, was left in this sowing practice. The crop was sown on 20th November in 2010–11 and 23rd November in 2011–12, using 112.5 kg seed/ha. Quinalphos 25 EC @ 2 l per hectare was applied 4 WAS in insecticide protected plots while it was not used in unprotected plots. No other insecticide was applied for the control of any other pest in the experiment.

2.2. Environmental conditions

The region has a sub-tropical climate with hot, wet summers and cool, dry winters. The weather conditions did not differ substantially during the two years of study. The total rainfall was 53.7 mm during 2010–11 and 44.4 mm during 2011–12. Well distributed rainfall along with a greater number of rainy days was recorded in 2010–11 as compared to 2011–12. The average sunshine hours per day were less in 2010–11 (6.4 h) compared to 2011–12 (6.9 h) during the course of study (Fig. 1). The higher rainfall in 2010–11 also resulted in higher average relative humidity i.e. 73.8% as compared to 68.4% in 2011–12 (Fig. 2). There was not much difference in maximum, minimum and average temperature during both the years. Maximum, minimum and average temperature ranged from 15 to 33 °C, 5 to 15 °C and 10 to 24 °C, respectively, during the course of investigations.

2.3. Experimental design and sampling methods

The relative abundance and damage by insect pests in wheat was compared in four tillages under insecticide protected and unprotected conditions in an experiment using randomized complete block, split-plot experiment design. PSB protection with insecticide was the main plot treatment, while tillage condition was the sub-plot treatment. There were three replicate for each treatment and size of the sub-plot was $8 \times 2 = 16$ m^2. A plot-to-plot spacing of 0.75 m was used to avoid insecticide drift and insect movement between the plots. The crop was grown by following the recommendations of PAU Ludhiana (Anonymous, 2010), except for the usage of insecticide. Insect density and damage was recorded from five randomly selected spots (of one-metre row length) in each plot for the following insect pests; PSB, termites and root aphid.

First of all, to confirm the stem borer species, twenty dead hearts from different locations in non-experimental plots were collected and excised with a sharp knife and the larvae were collected in the

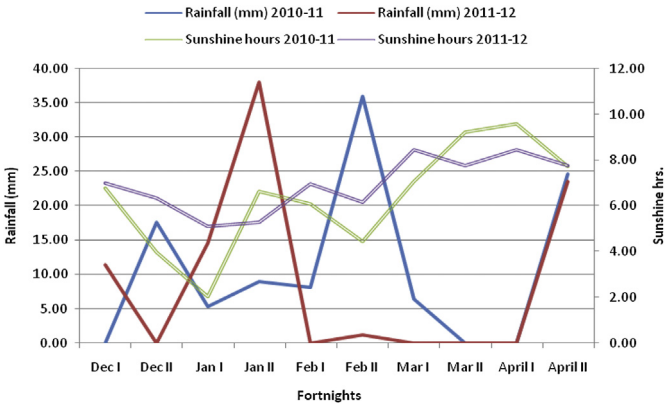

Fig. 1. Rainfall and sunshine hours during wheat growing season in 2010–11 and 2011–12.