EFFECT OF ROW SPACING ON BROWN PLANTHOPPERINCIDENCE IN BASMATI RICE UNDER PUNJAB CONDITIONS

Abstract

The field experiment was conducted at the Research Farm, Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana during *Kharif* 2018. Pusa Basmati variety was transplanted on 5th July (D_1) and 15th July (D_2) under three spacing (25 cm x12 cm, 20 cm x 15 cm and 30 cm x 10 cm). The brown planthopper incidence data from 2014 to 2016 and 2018 indicated that the highest incidence at Ludhiana was observed in 2016 and the lowest in 2018.Regression analysis was carried out between different meteorological parameters and brown planthopper incidence. According to present study, the favourable temperature for brown planthopper incidence was 30.2-33.4 ^{o}C (maximum temperature) and 20.6-22.5 ^{o}C (minimum temperature) while relative humidity was 86-90 per cent in the morning and 48-60 per cent in the evening. Hot, cloudy and humid conditions are conducive for brown planthopper multiplication.The micrometeorological data on relative humidity was recorded at different phenological stages. The higher relative humidity was recorded in closer spacing (25 cm x 12 cm) than wider spacing (20 cm x 15 cm and 30 cm x 10 cm). The peak incidence of brown planthopper was also observed in 25 cm x 12 cm spacing (3.1 brown planthopper population/hill) as compared to 20 cm x 15 cm spacing (2.9 brown planthopper population/hill) and 30 cm x 10 cm (2.4 brown planthopper population/hill) during 2018.Hence, microclimate modification through spacing is cost effective measure for brown planthopper management in basmati rice.

Key words: Brown planthopper, microclimate, wider row spacing,closer row spacing, regression models

Introduction

Rice (*Oryza sativa* L.) is a short-day plant and is mostly grown in regions of high temperature, high humidity, long sunshine hours and assured rainfall.In Punjab, it covers 31.45 lakh hectares area with total paddy production of 203.71 lakh tonnesduring 2021-22. The average yield of paddy recorded was 64.78 quintals per hectare during 2021-22. Like semi-dwarf rice varieties, basmati varieties require prolonged sunshine, high humidity and assured water supply. Under Punjab conditions, the crop requires a temperature range of 20 to 37.5^{o}C for its optimum growth. The humidity range is 83 to 85 per cent and 67 to 68 per cent for the early and late sown varieties respectively (Anonymous 2023). Insect incidence during different seasons depend on weather conditions. The growth and survival of insects are influenced by the prevailing weather conditions at different phenological stages of crop. Higher relative humidity combined with moderately low range of temperature is highly conducive for insect occurrence and their multiplication. Under these conditions, if the expected weather conditions are favourable, then serious outbreaks of insects may occur. The rice plant is attacked by more than 100 species of insects and 20 of them can cause economic damage. The brown planthopper (*Nilparvatalugens*) is one of the important insects of rice crop. The seasonal abundance of rice brown planthopper is severely affected by weather conditions. Among different weather parameters, air temperature and atmospheric humidity are the most important factors influencing the brown planthopper incidence. The favourable mean temperature for brown planthopper incidence is 26^{o}C to 28^{o}C while mean relative humidity is 66 to 75 per cent and total weekly rainfall should be less than 25 mm (Venilla *et al* 2016).Climate change affects BPH immigration patterns and breeding cycles by altering weather patterns and temperature conditions. Specifically, the northward shift of overwintering boundaries and temperature increases impact BPH survival and breeding cycles. While warmer temperatures may expand the overwintering range of BPH, it may also limit their breeding potential due to temperature constraints. A decrease in tropical cyclones in the western North Pacific due to increased stability from global warming, while certain weather patterns favoring BPH immigration whichincreased with higher greenhouse gas concentrations (Oishi *et al* 2024).

Planting geometry of a crop affects the interception of solar radiation, crop canopy coverage, dry matter accumulation and crop growth rate (Anwar *et al* 2011). Compact seedling transplanting affect rice plant growth which inturn generates microclimatic environment, conducive for brown planthopper multiplication (Teetes 1981). Dense seedling plantation is favourable for brown planthopper incidence. Seedling spacing extensively modifies the microclimate for brown planthopper development (Prasad-Ram*et al* 2003). Under wider spacing (20 cm x 20 cm), incidence of brown planthopper was less as compared to narrow spacing (20 cm x 15 cm). The brown planthopper population was comparatively higher in 20 cm x 15 cm spacing (2.38 individuals/hill) than 20 cm x 20 cm spacing (1.83 individuals/hill) (Satpathi*et al* 2012). So, plant spacing should be optimized by keeping in mind different aspects of crop and pest management techniques (Miah *et al* 1990). Keeping this in view the present study was carried out to investigate the influence of plant spacing on brown planthopper abundance in basmati rice

Materials and methods

The field experiments were conducted at the Research Farm, Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana during *kharif* 2018. Pusa Basmati variety was transplanted on 5th July (D_1) and 15th July (D_2) under three spacing (25 cm x12 cm, 20 cm x 15 cm and 30 cm x 10 cm). The experiment was laid out in Factorial Randomised Complete Block Design with four replications.Psychron (Model 566 series) was used to measure diurnal cycles of relative humidity from 1000 hours to 1600 hours at different phenological phases.Brown planthopper population data was recorded at weekly intervals. Historical field data on brown planthopper population (BPH) was obtained from theDepartment of Entomology, PAU, Ludhiana from 2014 to 2016. Corresponding meteorological data (maximum temperature, minimum temperature, relative humidity (morning and evening), sunshine hours and total rainfall) from 2014 to 2016 and 2018 of Ludhiana were collected from the Agrometeorological Observatory, Department of Climate Change and Agricultural Meteorology, PAU, Ludhiana. From historical data, regression analysis was conducted between brown planthopper population and different meteorological parameters during different years.

Results and discussion

Relative humidity profiles

The plant-water relations are greatly influenced by relative humidity. It affects leaf growth, photosynthesis, occurrence of diseases, incidence of insect pests and finally economic yield. Relative humidity and temperature have aninverse relation with each other. In morning hours, relative humidity is high because of low temperature whereas the rise in temperature during noon, decreases the relative humidity percentage. The dry matter production is reduced due to saturation deficit which affects leaf water potential, stomatal control, internal water potential of plants and transpiration. Relative humidity in crop canopy is affected by row spacing. Lower relative humidity is usually recorded in wider spacing as compared to narrow spacing as air circulation is more in wider spacing as compared to narrow spacing (Biswas 2006).

At themaximum tillering stage, relative humidity was higher in 5th July transplanting under 25 cm x 12 cm spacing (90 per cent) than 30 cm x 10 cm spacing (88 per cent) and 20 x 15 cm spacing (89 per cent) spacing as compared to 15thJuly(Fig. 1). Karuna (2019) also reported higher relative humidity in 20 cm x 15 cm and 25 cm x 12 cm spacings as compared to wider spacing (30 cm x 10 cm).Due to higher leaf area, the relative humidity was higher at panicle initiation stage than maximum tillering stage. The relative humidity during panicleinitiation stagein 5th July transplanting under 25 cm x 12 cm (92 per cent) as compared to 15th July transplanted crop (90 per cent) (Fig. 2). Sharma *et al* (2011) also reported that relative humidity was higher in case of closer spacing (20 cm x 15 cm) as compared to wider spacing (30 cm x 10 cm). Biswas (2006) also reported higher relative humidity under closer spacing (20 cm x 15 cm) than wider spacing (20 cm x 20 cm).Higher relative humidity was recorded in 25 cm x12 cm spacing followed by 30 cm x10 cm and 20 cm x15 cm spacing due to more circulation of air within crop canopy in wider spacing. At grain filling stage relative humidity was higher for 5th July transplanting under 25 cm x 12 cm spacing (81 per cent) followed by 20 cm x 15 cm (80 per cent) and 30 cm x 10 cm (77 per cent) as compared to 15th July transplanting (Fig. 3). Thus, relative humidity decreased with an increase in row spacing (West *et al* 2008).

Effect of row spacing on brown planthopper incidence

The air flow and sunlight penetration and consequently moisture and humidity levels are affected by thespace between plants. Thus, generating conducive microclimate conditions for pest development.Low pest incidence is often observed under wider spacing. In narrow spacing, plants are closer to each other than inwider spacing. Thus, relative humidity in case of closer spacing will be more and insect development will be high under humid conditions.

In Pusa Basmati 1121, the brown planthopper incidence was observed more in 25 cm x 12 cm spacing as compared to 20 cm x 15 cm and 30 cm x 10 cm spacings (Fig. 4). Due to wider spacing, air circulation was more in case of 30 cm x 10 cm spacing. Also, delayed transplanting (15th July) recorded more brown planthopper population ascomparedtoearlytransplanting (5th July). The firstincidence was reported during the38th SMW(Standard Meteorological Week) in all the spacings. The highest peak was recorded under 25 cm x 12 cm spacing (3.68 brown planthoppers/ hill) followed by 20 cm x 15 cm spacing (3.44 brown planthoppers/ hill) and 30 cm x 10 cm spacing (2.76 brown planthoppers/ hill) under 5th July transplanting in Pusa basmati 1121. However, under 15th July transplanting, the highest peak was observed in 25 cm x 12 cm spacing (8.4 brown planthoppers/ hill) as compared to 20 cm x 15 cm spacing (7.2 brown planthoppers/ hill) and 30 cm x 10 cm spacing (4.6 brown planthoppers/ hill). Satpathi*et al* (2012) also found that under wider spacing (20 cm x 20 cm), theincidence of brown planthopper was less as compared to narrow spacing (20 cm x 15 cm). The brown planthopper population was comparatively higher in 20 cm x 15 cm spacing (2.38 individuals/hill) than in20 cm x 20 cm spacing (1.83 individuals/hill). Teetes (1981) reported that compact seedling transplanting affectsthe growth of rice plantwhich inturn generates microclimatic environment, conducive for brown planthopper multiplication. Prasad-Ram*et al* (2003) also suggested that dense seedling plantation has positive influence on brown planthopper incidence. Seedling spacing extensively modifies the microclimate for brown planthopper development. Kanno *etal* 1977 and Katayama (1975) reported similar results.

Meteorological parameters and brown planthopperpopulation during different years

Insect abundance is generally dependent on the weather conditions prevailing during the crop season. Accordingly, there are variations in insect abundance during different years. Thus, the number of insects attacking a particular crop will be affected by the weather conditions during that season which may or may not be suitable for its growth and development. The different meteorological parameters *viz.* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and total rainfall greatly influence thebrown planthopperpopulation. The effect of above stated meteorological parameters during different years (2014, 2015, 2016 and 2018) was studied.

Maximum temperature

During 2014, the maximum temperature ranged from 28.7°C to 41.7°C from 24th to 45th SMW. Initially the brown planthopper population was less due to high temperature (36.1°C to 41.4°C) later, it started increasing when temperature range was in range of30.4°C to 34.1°C (34th SMW onwards)(Fig.5a).Win *et al* (2011) reported that brown planthopper population was negatively correlated with temperature. The peak brown planthopper population (10.4 brown planthoppers/hill) was observed during 42nd SMW and thereafter it started declining. The maximum temperature ranged from 26.8°C to 38.7°C during 2015 (Fig.5b). The brown planthopper population was initiallylow due to high temperature (35.6°C to 38.6°C) but it showed an increasing trend when temperature range was from30.9°C to 34.6 °C i.e. 34th SMW onwards. During 42nd SMW, the peak brown planthopper population (20.8 brown planthoppers/hill) was observed and later it started declining. During 2016, the maximum temperature ranged from 28.7°C to 39.1°C. Initially the brown planthopper population was low due to high temperature (36.2°C to 39.1°C) and later, it started increasing when temperature range was from31.5°C to 34.5°C i.e. 34th SMW onwards (Fig.5c). The peak brown planthopper population (21.4 brown planthoppers/hill) was observed during 43rd SMW and later it started declining. The maximum temperature ranged from 28.2°C to 38.3°C during 2018. The brown planthopper was observed during 38th SMW and then it started increasing when thetemperature range was from29.9°C to 32.5°C. During 41st SMW, the peak brown planthopper population (6.6 brown planthoppers/hill) was observed and later it started declining as shown in Fig.5d. The maximum temperature mostly remained above normal from38th SMW onwards which was peak brown planthopper multiplication period during 2014,2015 and 2016 unlike 2018.

Minimum temperature

The minimum temperature ranged from 14.5°C to 29.4°C from 24th to 45th SMW during 2014. The brown planthopper population was less due to high minimum temperature (26.7°C to 29.4°C) initially but it started increasing when minimum temperature range was 15.7 °C to 23.4 °C i.e. 34th SMW onwards (Fig.6a). During 42nd SMW, the peak brown planthopper population (10.4 brown planthoppers/hill) was observed and later it started declining. During 2015, the minimum temperature ranged from 14.3°C to 27.9°C. Initially the brown planthopper population was low due to high minimum temperature (25.7°C to 27.9°C) but later, it started increasing when minimum temperature range was 19.2°C to 25.3°C i.e. 34th SMW onwards. The peak brown planthopper population (20.8 brownplanthoppers/hill) was observed during 42nd SMW and later it started declining (Fig.6b). The minimum temperature ranged from 12.3°C to 29.2°C during 2016. Initially the brown planthopper population was low due to high minimum temperature (26.1°C to 29.2°C) but later, it started increasing when temperature range was 17.2°C to 24.9°C i.e. 34th SMW onwards (Fig.6c). The peak brown planthopper population (21.4 brownplanthoppers/hill) was observed during 43rd SMW and later it started declining. During 2018, the minimum temperature ranged from 11°C to 28.1°C. The brown planthopper was observed during 38th SMW and then it started increasing when minimum temperature range was 18°C to 20.5°C. During 41st SMW, the peak brown planthopper population (6.6 Brown planthoppers/hill) was observed and later it started declining (Fig.6d).

Morning relative humidity

During 2014, morning relative humidity ranged from 55.6 per cent to 91.3 per cent during the entire crop season. Morning relative humidity was low (55.6-80 per cent) and mostly below normal during initial crop stages (Fig.7a). It increased 34th SMW onwards and simultaneously, anincrease in brown planthopper population was also observed. During peak brown planthopper population (42nd SMW), it ranged from 86.9-91.3 per cent. Chander and Palta (2010) reported that higher relative humidity conditions due to early commencement of rainfall in summer with more number of rainy days contribute to brown planthopperoutbreaks. During 2015, relative humidity (morning) ranged from 56.1 per cent to 94 per cent(Fig.7b). High brown planthopper population was observed when relative humidity (morning) ranged from 92.1 per cent to 94 per cent. Relative humidity (morning) during

2016 was between 55 per cent and 92.3 per cent. Low brown planthopper population was observed when morning relative humidity was 55-78.6 per cent while peak brown planthopper population was observed under high relative humidity conditions (89.2-92.3 per cent) (Fig.7c). During 2018, morning relative humidity was 60 per cent to 93 per cent and comparatively lower brown planthopper population was observed during this year. The peak brown planthopper population was observed when morning relative humidity was 87-92.3 per cent (Fig.7d).

Evening relative humidity

During 2014, evening relative humidity ranged from 29.6 per cent to 78.9 per cent. Evening relative humidity was low (29.6-64.4 per cent) during initial stages. It increased 34th SMW onwards and started decreasing after 36th SMW (Fig.8a). During peak brown planthopper population, it ranged between 40.4 to 55.6 per cent. During 2015, evening relative humidity ranged from 31.7 to 81.7 per cent. High brown planthopper population was observed when evening relative humidity ranged from 45.9-60.4 per cent (Fig.8b). Evening relative humidity during 2016 was ranged between 28.7-73.6 per cent. The peak brown planthopper population was observed when it was 29.6-55.1 per cent (Fig.8c). During 2018, it ranged from 33 per cent to 76 per cent and comparatively lower brown planthopper population was observed during this year (Fig.8d). The peak brown planthopper population was observed when evening relative humidity was 47-65 per cent.

Total rainfall

The total rainfall (as recorded 24th SMW onwards) was higher (807.6 mm) in year 2018 followed by 2015 (535.4 mm), 2014 (420.7 mm) and 2016 (237.3 mm). Low brown planthopper was recorded during high rainfall year 2018.During 2014, brown planthopper population was found to increase with decreaseinrainfallfrom30thSMWonwards. Later duringdry conditions, its populationincreased up to 36th SMW and again became constant during rainfall period. In the succeeding weeks, brown planthopper population increased during dry period (Fig.9a). During 2015, brown planthopper population remained low during rainfall period and started increasing later (34th SMW onwards) as shown in Fig.9b. The brown planthopper population showed an increasing trend with decrease in rainfall 30th SMW onwards in year 2016 (Fig.9c). The first incidence of brown planthopper was recorded during 38th SMW during 2018. The dry period after 39th SMW showed increase in brown planthopper population (Fig.9d).During 2016, total rainfall (409.3 mm) was below normal (606.4 mm) while in (2018, it was 845.4 mmfrom 22nd to 45th SMW. High amount of rainfall was received at 29th SMW (167.8 mm) and 38thSMW (146.2 mm) in year 2018which may be responsible for lower BPH incidence (Anand *et al* 2023). Chaudhary *et al* (2014) reporteda negative correlation between brown planthopperpopulation and rainfall.Jeyarani (2004) also reported a negative correlation between brown planthopperpopulation and rainfall.

Regression analysis

Regression models are widely used to study the relationship of different meteorological parameters with insect abundance or disease incidence. The variability between observed and predicted values of insect or disease can be studied through regression models. Shekhar *et al* (2018) developed regression models for per cent damage of leaf folder and meteorological parameters that gave significant R^2 value (0.75). Dhaliwal *et al* (2019) also developed models for brown leaf spot disease of rice and relationship between observed and predicted values gave significant R^2 value (0.89). Anand *et al* (2020) developed agroclimatic indices-based regression models for forewarning of rice brown planthopper. Regression models were developed to study the relationship of different meteorological parameters with the brown planthopper population in field for years2014,2015,2016 and 2018as shown in Table 1. The pooled data regression equation is as follows:

Y= -26.82- 0.1 Tmax+ 0.22 Tmin+ 0.43 RHm- 0.29 RHe+ 0.91 SSH+ 0.04 RF (R^2= 0.75)

The maximum temperature was negatively correlated with brown planthopperpopulation while minimum temperature showed a positive correlation with brown planthopperpopulation. Morning relative humidity, sunshine hours were positively correlated with brown planthopper population. Total rainfall was found to have weak positivecorrelation with brown planthopperpopulation. Evening relative humidity showed a negative correlation with brown planthopper population. All the factors together showed 75 per cent variation in brown planthopper population.

Conclusions

Thefavourable temperature for brown planthopper incidence was 30.2-33.4 ^{o}C (maximum temperature) and 20.6-22.5 ^{o}C (minimum temperature) while morning relative humidity was 86-90 per cent and evening relative humidity was 48-60 per cent. Hot, cloudy and humid conditions are conducive for brown planthopper multiplication.Closer spacing (25 cm x 12 cm) hada higher BPH population than wider spacing (20 cm x 15 cm and 30 cm x 10 cm) due to changes in micrometeorological parameters. Hence, microclimate modification through spacing is cost-effective measure for brown planthopper management in basmati rice.

Conflict of interest statement

The authors involved in this research declare no conflict of interest. They affirm that there are no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Authors' contribution:

Conceptualization of research work and designing of experiments (SA, LKD);

Execution of field/lab experiments and data collection (SA, LKD, KSS);

Analysis of data and interpretation (SA);

Preparation of manuscript (SA, LKD)

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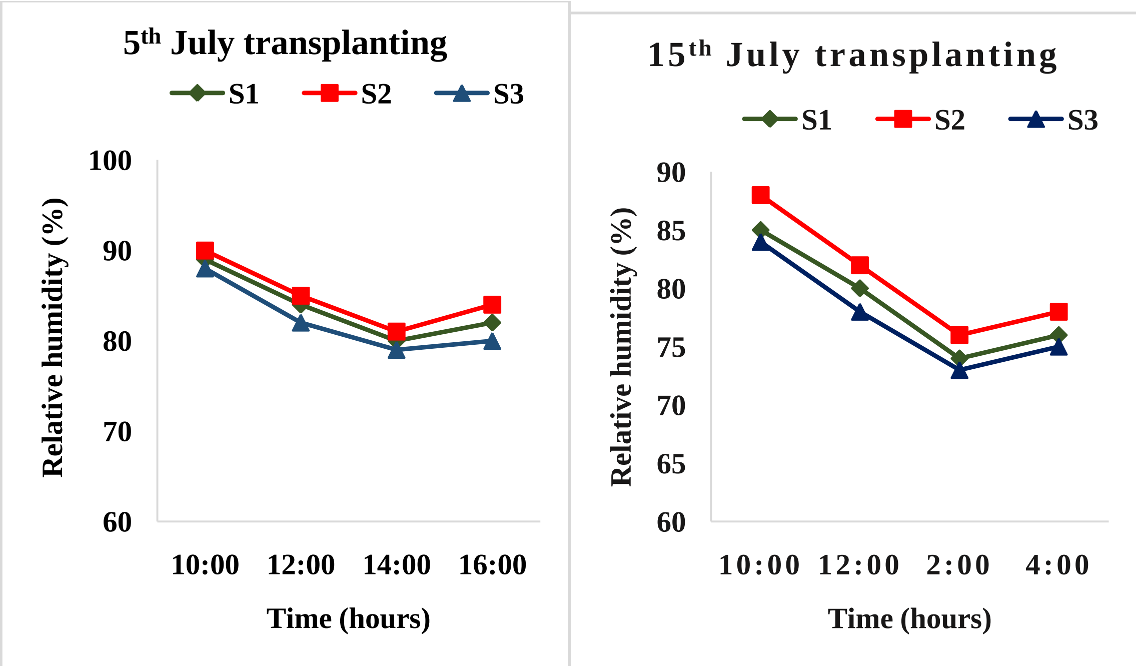
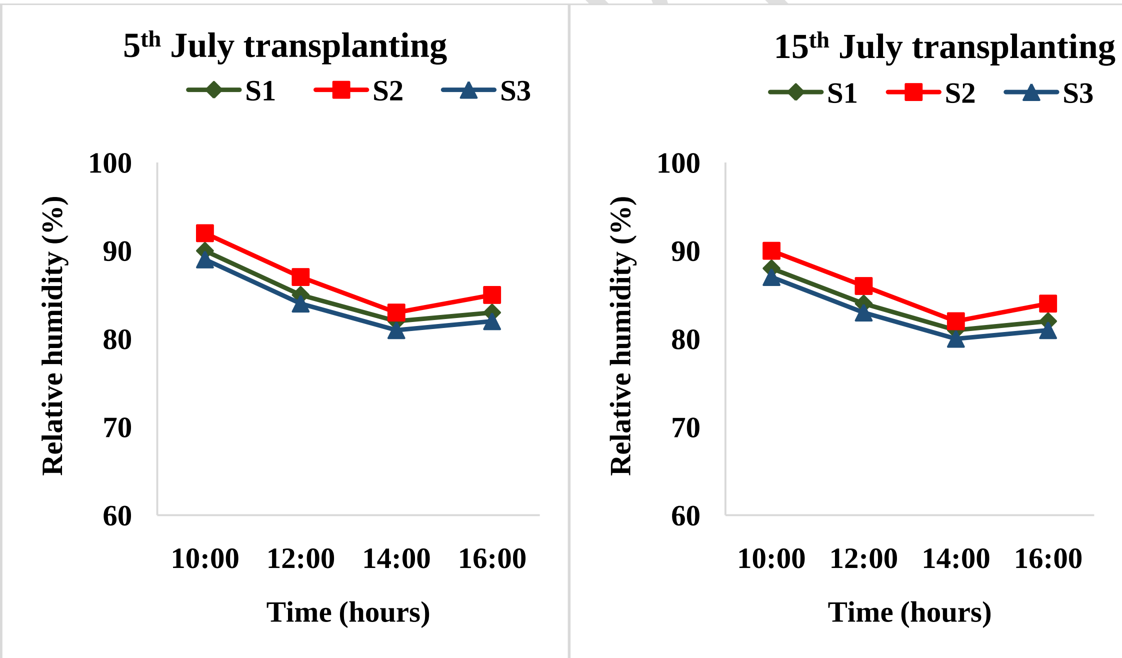


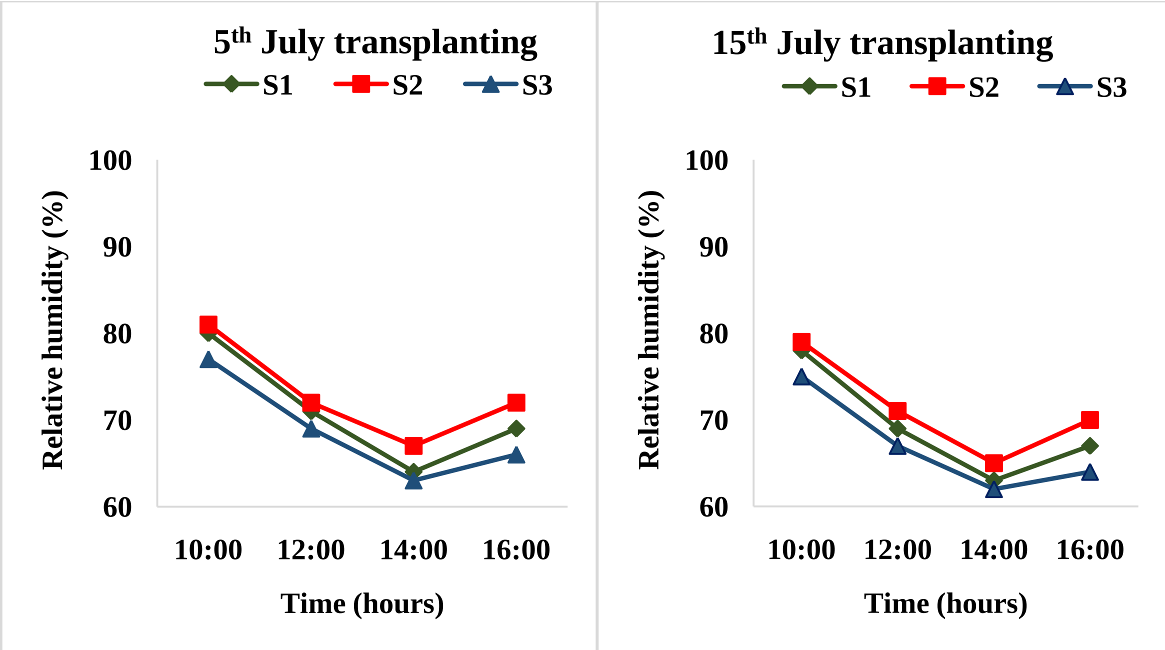
S_1 = 20 cm × 15 cm, S_2 = 25 cm × 12 cm, S_3 = 30 cm × 10 cm

Fig.1 Relative humidity profiles at maximum tillering stage under different spacing in variety Pusa Basmati 1121 transplanted on 5th July and 15th July



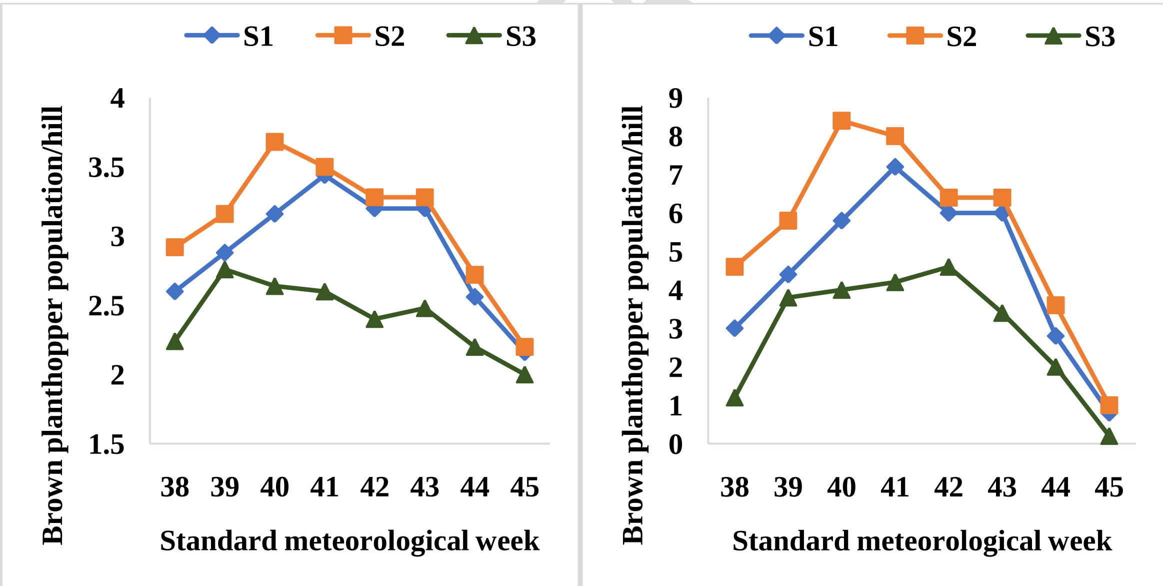
S_1 = 20 cm × 15 cm, S_2 = 25 cm × 12 cm, S_3 = 30 cm × 10 cm

Fig.2 Relative humidity profiles at panicle initiation stage under different spacing in variety Pusa Basmati 1121 transplanted on 5thJuly and 15th July



S_1 = 20 cm × 15 cm, S_2 = 25 cm × 12 cm, S_3 = 30 cm × 10 cm

Fig. 3 Relative humidity profiles at grain filling stage under different spacing in variety Pusa Basmati 1121 transplanted on 5th July and 15th July



S_1 = 20 cm × 15 cm, S_2 = 25 cm × 12 cm, S_3 = 30 cm × 10 cm

Fig.4Brown planthopper incidence under different spacingin variety Pusa Basmati 1121 transplanted on 5thJuly and 15th July

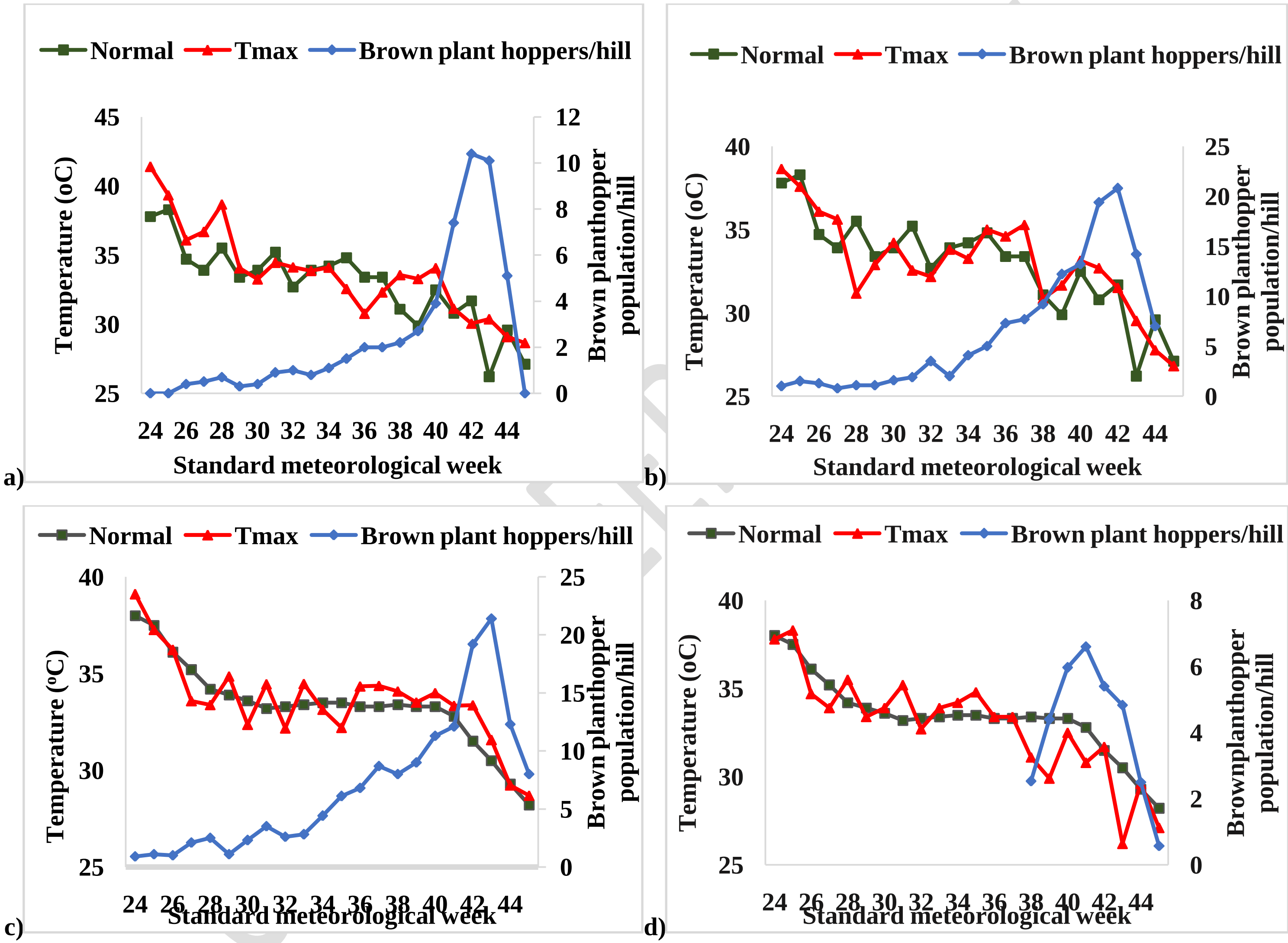


Fig. 5 Comparison of maximum temperature and brown planthopperpopulation during 2014 (a), 2015 (b), 2016 (c) and 2018 (d)

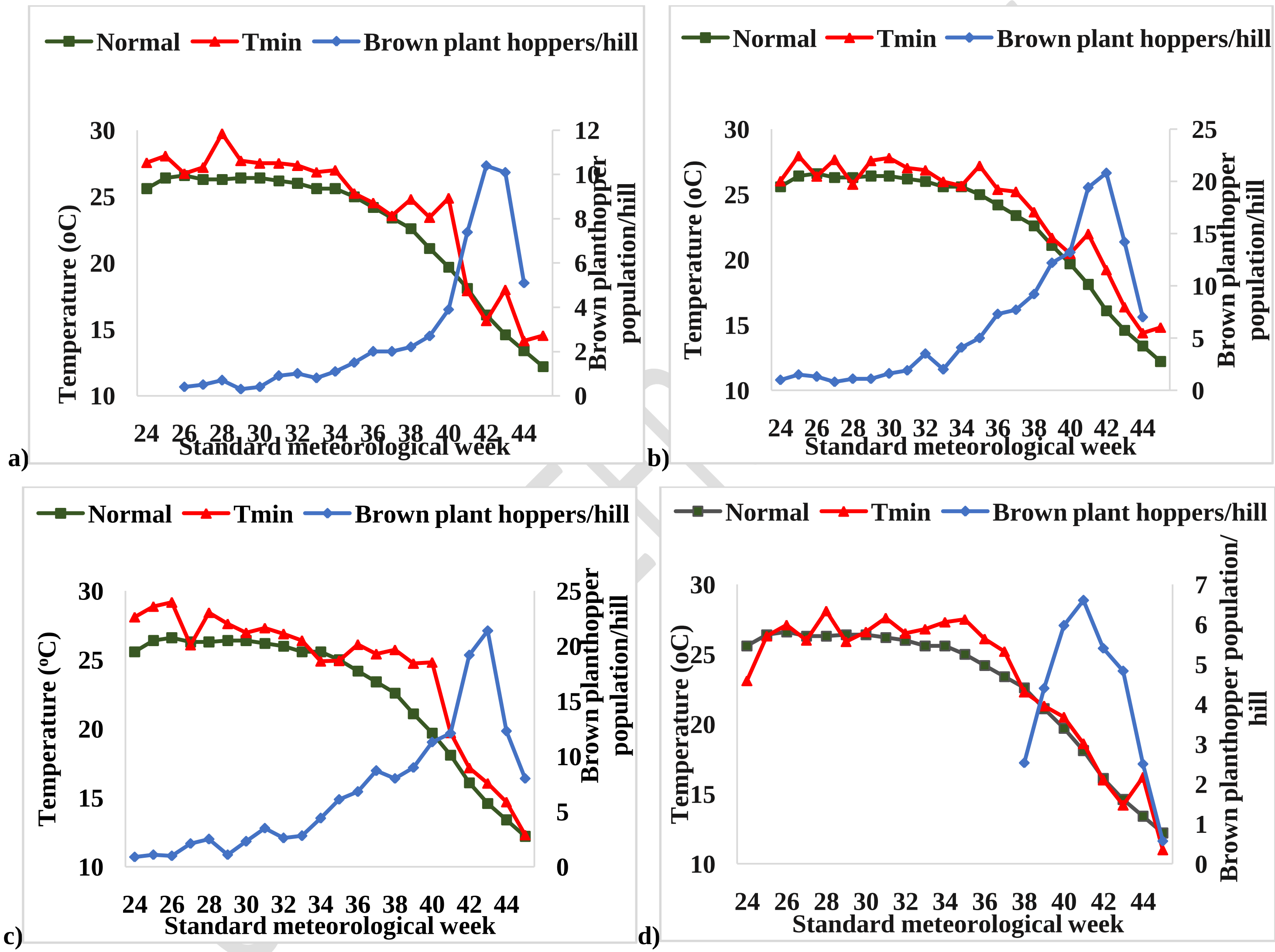


Fig. 6 Comparison of minimum temperature and brown planthopperpopulationduring 2014 (a), 2015 (b), 2016 (c) and 2018 (d)

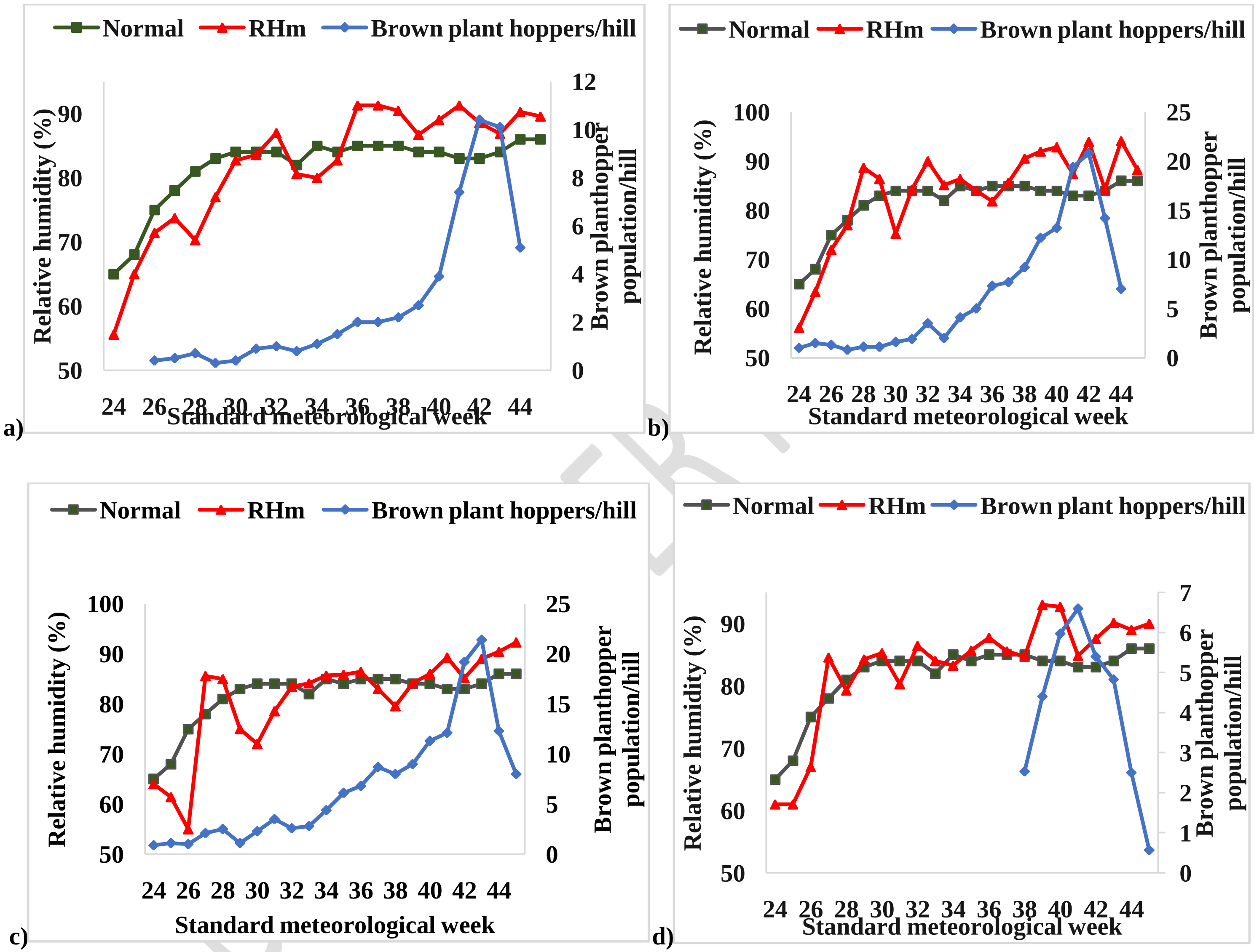


Fig. 7 Comparison of relative humidity and brown planthopperpopulation during 2014 (a), 2015 (b), 2016 (c) and 2018 (d)

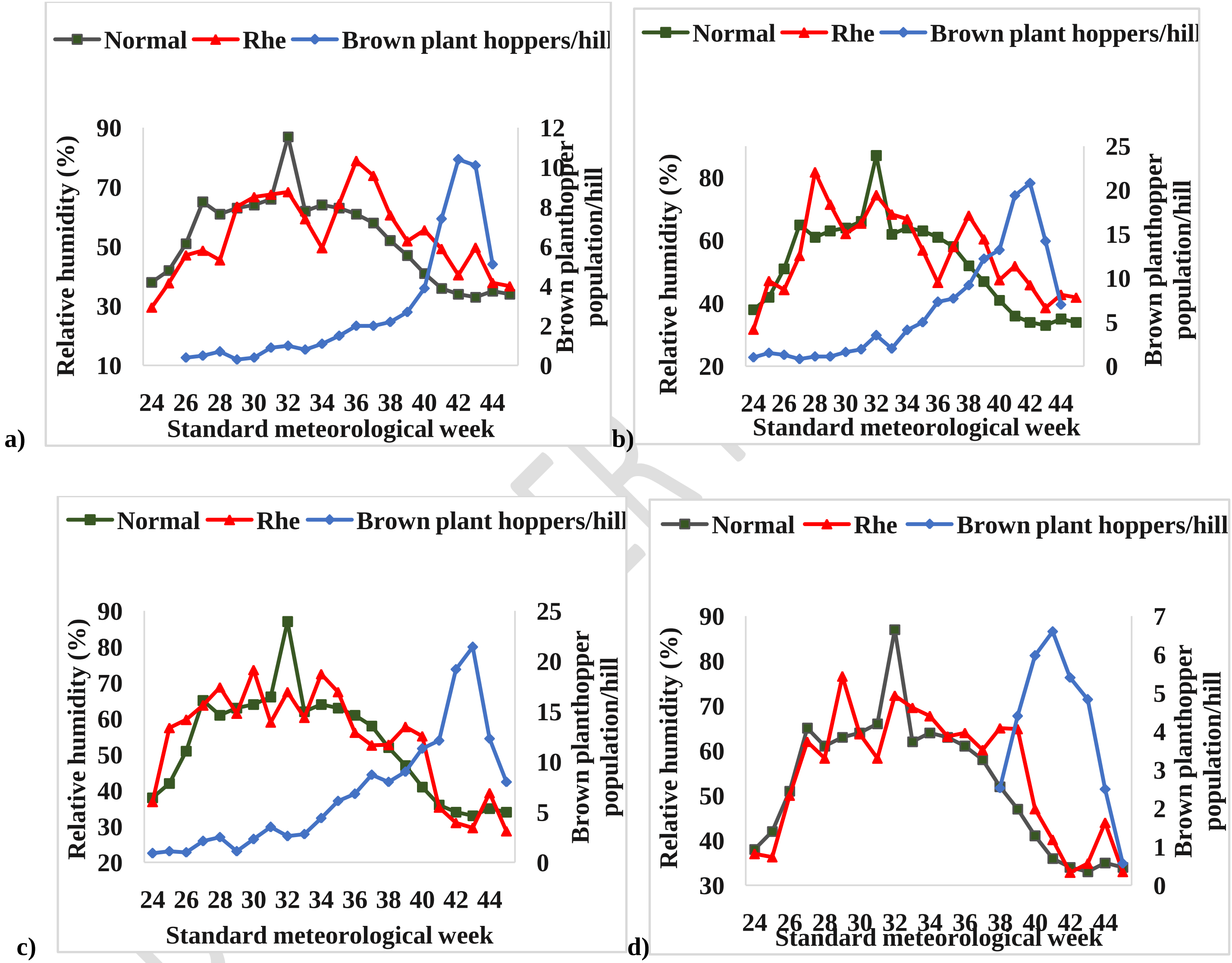


Fig.8 Comparison of evening relative humidity and brown planthopperpopulationduring 2014 (a), 2015 (b), 2016 (c) and 2018 (d)

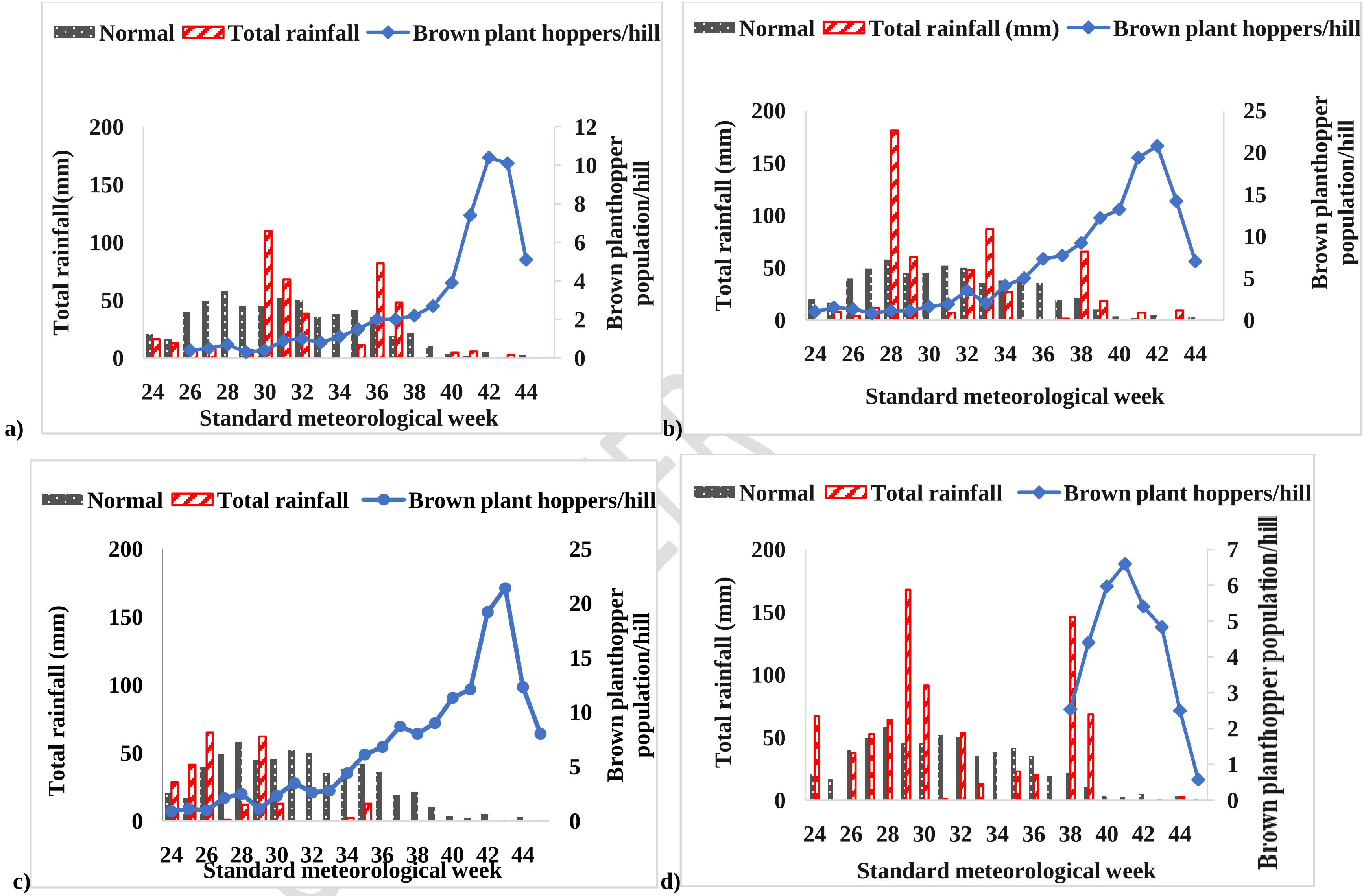


Fig.9 Comparison of total rainfall and brown planthopperpopulationduring 2014, 2015, 2016 and 2018

Table 1. Regression analysis between brown planthopper population (in field) and different meteorological parameters during different years

Year	Regression equations	R^2 value
2014		
	Y= 17.04 - 0.22 Tmax- 0.30 Tmin	0.46
	Y= 17.38-0.44 Tmax- 0.1 RHm	0.33
	Y = 10.89 – 0.47 Tmin +0.05 RHe	0.47
	Y = 24.81 – 0.58 Tmax- 0.05 RHe	0.40
	Y= -16.24 + 0.57 Tmax – 0.60 Tmin + 0.14 RHm + 0.04 RHe	0.53
	Y= -17.28 + 0.70 Tmax – 0.71 Tmin + 0.12 RHm+ 0.09 RHe – 0.14 SSH – 0.16 RF	0.56
2015		
	Y = 32.85 - 0.5 Tmax- 0.45 Tmin	0.27
	Y = -28.23+0.32 Tmax+0.29 RHm	0.34
	Y = 20.36 – 0.89 Tmin+0.12 RHe	0.31
	Y= 39.38-0.92 Tmax -0.06 RHe	0.23
	Y = -73.84 + 1.74 Tmax– 0.89 Tmin + 0.56 RHm-0.06 RHe	0.59
	Y = -68.31 + 1.83 Tmax – 1.27 Tmin + 0.45 RHm + 0.10 RHe+ 0.20 SSH– 0.17 RF	0.61
2016		
	Y= 42.57 – 0.57 Tmax - 0.71 Tmin	0.60
	Y= -5.63-0.19 Tmax+0.23 RHm	0.46
	Y= 27.98 – 1.13 Tmin +0.1 RHe	0.57
	Y= 64.61 – 1.46 Tmax– 0.17 RHe	0.59
	Y = 3.04 – 0.1 Tmax – 0.36 Tmin + 0.25 RHm – 0.09 RHe	0.68
	Y = -4.39 + 0.05 Tmax – 0.33 Tmin + 0.30 RHm – 0.12 RHe – 0.13 SSH+0.09 RF	0.69
2018		
	Y = 6.51 + 0.10 Tmax - 0.33 Tmin	0.50
	Y= 14.75 – 0.41 Tmax+0.1 RHm	0.31
	Y= 8.43 – 0.24 Tmin – 0.03 RHe	0.50
	Y= 15.14 -0.30 Tmax – 0.08 RHe	0.51
	Y = -12.38 +0.14 Tmax + 0.03 Tmin + 0.19 RHm -0.14 RHe	0.65
	Y = - 14.04 +0.1 Tmax + 0.13 Tmin + 0.22 RHm -0.18 RHe + 0.01 SSH + 0.1 RF	0.66
Pooled regression analysis		
	Y= 17.88 + 0.1 Tmax-0.70Tmin	0.52
	Y= 8.81 – 0.50 Tmax + 0.15RHm	0.36
	Y= 19.63-0.69 Tmin+0.02 RHe	0.53
	Y= 38.44 – 0.80 Tmax- 0.14 RHe	0.48
	Y= -50.56+0.71 Tmax+0.11 Tmin+0.54 RHm-0.29 RHe	0.70
	Y= -26.82- 0.1 Tmax+ 0.22 Tmin+ 0.43 RHm- 0.29 RHe+ 0.91 SSH+ 0.04 RF	0.75

Where, Tmax: Maximum temperature (^oC)
Tmin: Minimum temperature (^oC)
RHm: Relative humidity morning (%)
RHe: Relative humidity evening (%)
SSH: Sunshine hours (hours/day)
RF: Total rainfall (mm)