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CONTENTS

Effect of transplanting date on incidence of insect pests of rice

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ABSTRACT: The current research on effect of planting date on the occurrence of insect pests of rice was conducted during kharif 2020 at the Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar. The damage caused by sucking pests is either more or less similar in normal and late plantings or the most damage was recorded in late planting. It was observed that early planting gives suitable conditions for the crop and manage the insect population, the damage due to sucking pests is either found more or less similar in normal and late plantings or maximum damage was recorded in late planting. It was found that early planting (30 June) reduced the incidence of insect pest in rice as compared to normal (15 July) and late planting (30 July) crops. The incidence of yellow stem borer, leaf folder, rice hispa, whorl maggot, brown plant hopper, white backed plant hopper and gundhi bug was low in early sown crop with the exception of green leaf hopper which had the minimum overall population during normal planting and high damage is seen in early planting as compared to others. The pre-harvest data and yield analysis shows significantly low white ear heads of rice with high yield (42.68 qha^{-1}) in early planted crop as compared to timely (15.38 qha^{-1}) and late sown crop (3.48 qha^{-1}). There was significant difference among the yield recorded in early, normal and late transplanted crop.

Key words: Insect pests, lepidopteran pests, planting date, rice, sucking insect

Even though origin of rice (*Oryza sativa* L., Family Poaceae) is unclear, it is believed that domestication of rice took place in South and Southeast Asia around ten thousand years ago. Rice, wheat, and maize are the three most important food crops in the world, producing 42% of the calories consumed globally (Anonymous, 2013). Most people consume rice on the planet and India, which has the largest cultivable area in the world, is second in terms of production (after China) (NRRI bulletin, 2020). It produces 177.64 MT, or 23.51 percent of the world's total output, over a vast area of 43.78 M ha (FAO, 2020). There are more than 100 insects which cause loss in rice including sap suckers, defoliators, stem borers and grain damaging insects. Among them some causes major loss to the crop like- brown plant hopper 52% (Kaur *et al.,* 2022), white backed plant hopper 35-95% (Dhurwey and Deole, 2021). The yellow stem bores cause losses of 10-30% (Prasad *et al.,* 2014) while another important pest *i.e.,* leaf folder cause 30-80% losses in epidemic conditions (Gangwar, 2015). Similarly, rice hispa causes 28-100% losses (Sharma and Srivastava, 2018).

The only strategy that reduces pest populations without causing harm to the environment or creating any damage to property is integrated pest management (IPM). There are many methods involved under IPM to manage insects and cultural practices are a crucial part of IPM management tactics that prevent or lessen pest infestation and field damage (Dara, 2019). The crop's production can be increased by altering the planting period in response to weather and climatic circumstances (Desiraju *et al.,* 2010), and this can also help with management because it creates a gap between the stage of the crop the insect feeds on and the arrival of insect (Kaur *et al.,* 2020; Baruah and Dutta, 2020; Junior *et al.,* 2021).

MATERIALS AND METHODS

The experiment was carried out at the Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), which is situated at 29°N latitude, 79°30'E longitude, at an elevation of 243.84 m above mean sea level. Rice seed was sown after preparation of puddled seed bed. After 25 days of seeding, the seedlings were transplanted in the main field, which

had already been prepared by irrigation water being applied after puddling.

For the experiment, HKR 47, a rice variety that reaches maturity in 120–135 days (mid-early), was chosen. There were three experimental plots each divided into 24 subplots to maximize area covered in the field for accuracy, each of which had three seeding dates (June 30, July 15 and July 30 in 2020). On the day that was previously specified, 25 days old rice seedlings were transplanted.

Data on the four insects considered in the study were taken beginning on the seventh day after transplanting (DAT) from 10 randomly chosen hills.

For yellow stem borer:

$$DH(\%) = \frac{\text{Total no.of dead hearts in 10 hills}}{\text{Total no.of tillers in 10 hills}} \times 100$$

$$WE(\%) = \frac{\text{Total no. of white ear in 10 hills}}{\text{Total no. of panicles in 10 hills}} \times 100$$

For leaf folder, rice hispa and whorl maggot:

$$\% \text{ leaf damage} = \frac{\text{Total no. of damaged leaves in 10 hills}}{\text{Total no. of leaves in 10 hills}} \times 100$$

Incidence of GLH = Total no. of GLH per 10 hills
Incidence of BPH = Total no. of BPH per 10 hills
Incidence of WBPH = Total no. of WBPH per 10 hills
Incidence of bug = Total no. of bug per 10 hills

RESULTS AND DISCUSSION

The observations were taken from standard meteorological week 27 to standard meteorological week 42 in *kharif* 2020 in early, normal and late planting rice. During the course of study, the insect pests mentioned in Table 1 were found in the field and their infestation levels are recorded.

Effect of Planting dates on the incidence of yellow stem borer (*Scirpophaga incertulas*) during *kharif* 2020

The effect of different planting dates on per cent damage by yellow stem borer was observed and tabulated in Table 2. It was seen that the infestation of yellow stem borer started from early planting in rice and goes till late planting. The highest infestation of yellow stem borer was recorded in late plantings followed by normal planting whereas early planting recorded the least infestation. In early planting the maximum stem borer infestation was seen during standard meteorological week 34 while in normal planting it was seen during week 36. In late planting, however the peak infesting period was found to be standard week 40 followed by 41 and 38. Remaining weeks had comparatively less infestation. This information can be useful in the timely management of yellow stem borer.

The effect of different abiotic factors on population of yellow stem borer was also seen in three planting dates. The positive correlation was seen with minimum temperature (0.41), evening relative humidity (0.49), rainfall (0.23), no. of rainy days (0.51), wind velocity (0.02) and evaporation (0.15) in early planting and negative correlation with maximum temperature (0.65), morning relative humidity (0.01) and sunshine hours (0.31). In normal planting positive correlation was seen with maximum temperature (0.32), minimum temperature (0.22), morning relative humidity (0.15), wind velocity (0.02), sunshine hours (0.36) and evaporation (0.21) and negative with evening relative humidity (0.02), rainfall (0.22) and no. of rainy days (0.14). In late planting the positive correlation was seen with maximum temperature (0.71) and sunshine hours (0.69) and negative with minimum temperature (0.70), morning relative humidity (0.20), evening relative humidity (0.76), rainfall (0.48), no. of rainy days (0.66), wind velocity (0.38) and evaporation (0.47).

The present findings were in accordance to the findings of Korat *et al.* (1999), Saha *et al.* (2005), Prasad *et al.* (2006), Sarwar (2012), Chaudhari *et al.* (2018), Baruah and Dutta (2020) and Taha *et al.* (2021) with similar reporting of early planting being the best for the control of yellow stem borer.

Effect of planting dates on the incidence of leaf folder (*Cnaphalocorcis medinalis*) during *kharif* 2020

The incidence of leaf folder in three different planting dates was observed (Table 3). The maximum incidence of leaf folder was seen in standard week 35 for early

planted crop whereas it was week 39 and 42 for normal and late planted crops respectively. The maximum damage was seen in normal planted crop followed by late and least in early planted. The leaf folder damage can be reduced either by planting the crop early or late, though early planting was most suitable.

The effect of different abiotic factors on population of leaf folder was also seen in three planting dates. The positive correlation was seen with minimum temperature (0.39), morning relative humidity (0.14), evening relative humidity (0.54), rainfall (0.39), no. of rainy days (0.61), and evaporation (0.21) in early planting and negative correlation with maximum temperature (-0.67), sunshine hours (-0.34) and wind velocity (-0.03). In normal planting positive correlation was seen with maximum temperature (0.19), minimum temperature (0.12), morning relative humidity (0.30), wind velocity (0.17), sunshine hours (0.21) and evaporation (0.00) and negative with evening relative humidity (-0.03), rainfall (-0.29) and no. of rainy days (-0.19). In late planting the positive correlation was seen with maximum temperature (0.53), morning relative humidity (-0.05) and sunshine hours (0.57) and negative with minimum temperature (-0.67), evening relative humidity (-0.69), rainfall (-0.50), no. of rainy days (-0.65), wind velocity (-0.13) and evaporation (-0.52).

The experiments conducted by Kumar *et al.* (2003), Prasad *et al.* (2006), Chaudhari *et al.* (2018) and Rautaray *et al.* (2019) showed similar results indicating the maximum population of leaf folder in late plantings as compared to early and normal plantings.

Effect of Planting dates in the incidence of rice hispa (*Dicladispa armigera*) during *kharif* 2020

The maximum incidence and damage by rice hispa was seen in standard week 33 in early and normal planting and 35 in late planted crop. The pest appeared in 3rd week after transplanting in early and normal planting but appeared in 2nd week in late planting but the maximum rice hispa damage was seen in normal planting (Table 4).

The effect of different abiotic factors on population of rice hispa was also seen in three planting dates. The positive correlation was seen with minimum temperature (0.48), morning relative humidity (0.45), evening relative humidity (0.63), rainfall (0.28), no. of rainy days (0.47) and wind velocity (0.05) in early planting and negative correlation with maximum temperature (-0.54), sunshine hours (-0.72), and evaporation (0.01). In normal planting positive correlation was seen with minimum temperature (0.28), morning relative humidity (0.17), evening relative humidity (0.21) and no. of rainy days (0.11) and negative with maximum temperature (-0.29), rainfall (-0.07), wind velocity (0.02), sunshine hours (0.08) and evaporation (0.13). In late planting the positive

Table 1: Insect pests found in the field along with their infestation level

S. No.	Common Name	Scientific Name	Order	Family	Infestation or insect population*
1.	Yellow stem borer	*Scirpophaga incertulas* (Walker)	Lepidoptera	Pyralidae	+++
2.	Leaf folder	*Cnaphalocrocis medinalis* (Guenée)	Lepidoptera	Pyralidae	++
3.	Rice hispa	*Dicladispa armigera* (Oliver)	Coleoptera	Chrysomelidae	++
4.	Whorl maggot	*Hydrellia philippina* (Ferino)	Diptera	Ephydridae	++
5.	Green leaf hopper	*Nephotettix virescens* (Distant)	Homoptera	Cicadellidae	++
6.	Brown plant hopper	*Nilaparvata lugens* (Stål)	Homoptera	Delphaeidae	+++
7.	White Backed plant hopper	*Sogatella furcifera* (Horvath)	Homoptera	Delphacidae	+
8.	Gundhi bug	*Leptocorisa acuta* (Thunberg)	Hemiptera	Alydidae	++
9.	Golden tortoise beetle	*Aspidimorpha* sp. (Hope)	Coleoptera	Chrysomelidae	+
10.	White leaf hopper	*Cofana spectra* (Distant)	Hemiptera	Cicadelidae	+
11.	Grasshopper	*Hieroglyphus banian* (Fabricius)	Orthoptera	Acrididae	+

*(+++) represents major infestation/ population of insect in the field, (++) represents moderate infestation and (+) represents minor infestation or population

Table 2: Effect of planting dates and their correlation with weather parameters on the incidence of yellow stem borer (*Scirpophaga incertulas*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Temperature(°C) Min.	Relative Humidity(%) 712 am	Relative Humidity(%) 1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart: Early Planting	Per cent dead heart: Normal Planting	Per cent dead heart: Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0.92	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	5.96	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	4.52	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	7.54	4.76	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	10.42	3.64	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	16.73	8.52	0.13
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	10.61	17.48	0.62
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	26.38	5.57
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	15.28	6.72
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	18.45	24.9
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	13.81	15.83
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	38
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	29.39
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	12
Correlation coefficient (r)		EP	-0.65	0.41	-0.01	0.49	0.23	0.51	-0.31	0.02	0.15		Mean	
between weather		NP	0.32	0.22	0.15	-0.02	-0.22	-0.14	0.36	0.02	0.21	6.30	9.85	13.32
parameters separately		LP	0.71	-0.70	-0.20	-0.76	-0.48	-0.66	0.69	-0.38	-0.47			
with each planting date														

correlation was seen with maximum temperature (0.02), minimum temperature (-0.16), morning relative humidity (-0.00) sunshine hours (0.38) wind velocity (-0.14) and evaporation (-0.21) and negative with evening relative humidity (-0.01), rainfall (-0.18) and no. of rainy days (-0.01).

The results found in this experiment were in accordance with Kumar *et al.* (2003) and Prasad *et al.* (2006) who reported similar findings and supported the early planting of rice.

Effect of planting date on the incidence of whorl maggot (*Hydrellia philipina*) during *kharif* 2020

The incidence of whorl maggot in rice was seen in 4[th] week of transplanting in early planted crop with a peak in 34[th] standard week. In normal and late planted crop, the maximum whorl maggot damage was seen in 36 and 37 standard meteorological weeks. The maximum damage was seen in late planted crop followed normal planting and least in early planting (Table 5).

The effect of different abiotic factors on population of whorl maggot was also seen in three planting dates. The positive correlation was seen with minimum temperature (0.41), morning (0.16) and evening (0.55) relative humidity, rainfall (0.31), no. of rainy days (0.55) and evaporation (0.05) in early planting and negative correlation with maximum temperature (-0.69), sunshine hours (-0.46) and wind velocity (-0.03). In normal planting positive correlation was seen with minimum temperature (0.29), evening relative humidity (0.15), rainfall (0.03), no. of rainy days (0.11) and sunshine hours (0.15) and negative with maximum temperature (-0.07), morning relative humidity (-0.02) and wind velocity (-0.19). In late planting the positive correlation was seen maximum temperature (0.48), morning relative humidity (0.19),

Table 3: Effect of planting dates and their correlation with weather parameters on the incidence of leaf folder (*Cnaphalocrocis medinalis*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Temperature(°C) Min.	Relative Humidity(%) 712 am	Relative Humidity(%) 1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart Early Planting	Per cent dead heart Normal Planting	Per cent dead heart Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	1.59	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	1.56	0.1	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	1.02	1.44	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	1.67	0.55	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	1.45	1.23	0.04
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	3.2	1.11	0
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	2.44	1.62
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	2.19	0.91
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	2.32	3.7
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	4.6	3.76
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	2.05
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	1.35
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	3.63
Value of Correlation coefficient (r) weather parameter with each planting date		EP	-0.67	0.39	0.14	0.54	0.39	0.61	-0.34	-0.03	0.21		Mean	
		NP	0.19	0.12	0.30	-0.03	-0.28	-0.19	0.21	0.17	0.00	1.17	1.45	1.71
		LP	0.53	-0.67	0.05	-0.69	-0.50	-0.65	0.57	-0.13	-0.52			

sunshine hours (0.50) and evaporation (0.18) with and negative with minimum temperature (-0.02), evening relative humidity (-0.22), rainfall (-0.24), rainy days (-0.19) and wind velocity (-0.11).

The results shown in Ramesh *et al.,*2015 the damage of insect pest was seen maximum in second fortnight of July.

Effect of planting date on the incidence of green leaf hopper (*Nephotettix virescens*) during year 2020

In early planting, the green leaf hopper infestation in rice was first noticed in standard weeks 32 to 35 *i.e.,* 06th Aug to 02nd Sept. In a typical normal planting, the pest emerged between 36 (03rd Sept) to 39 weeks (30th Sept) and did more crop damage than in an early planting. The pest was more prevalent in late-planted crops, with infestation starting at standard week 37 (10th Sept. to 16th Sept.) and terminating at standard week 42 (15th Oct. to 21st Oct.) (Table 6).

Three planting dates were examined to determine how various abiotic factors affected the population of green leaf hoppers. Early planting showed a positive correlation with the lowest temperature (r = 0.26), evening relative humidity (r = 0.26), rainfall (r = 0.03), the number of rainy days (r = 0.27), and wind speed (r = 0.02), while negative correlation was observed with maximum temperature (r = -0.44), morning relative humidity (r = -0.06), sunshine hours (r = -0.16), and evaporation (r = -0.16). In a normal planting, the maximum temperature (r = 0.39), minimum temperature (r = 0.00), morning relative humidity (r = 0.39), sunshine hours (r = 0.25), wind velocity (r = 0.17), and evening relative humidity (r = -0.15), rainfall (r = -0.29, number of rainy days (r = -0.27), and evaporation (r = -0.27) all showed positive correlations (r = -0.04).

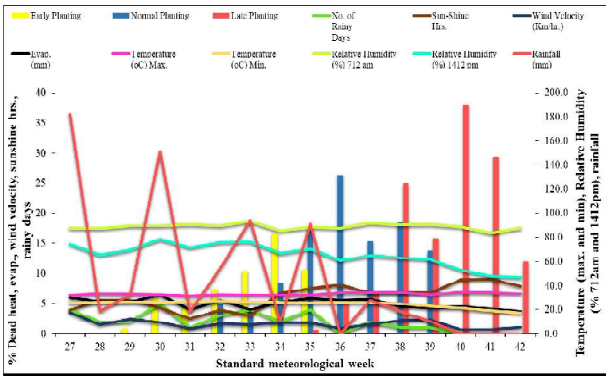

Fig. 1: Effect of weather parameters on the population of yellow stem borer in three planting dates

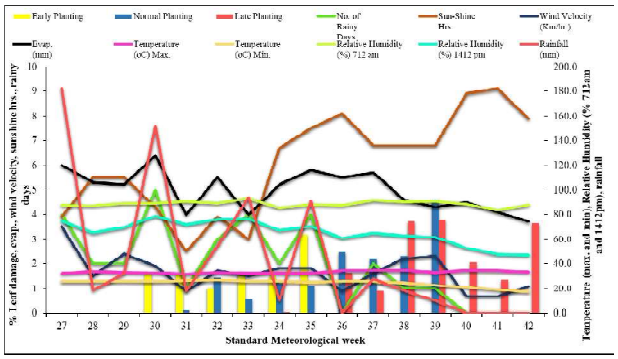

Fig. 2: Effect of weather parameters on the population of leaf folder in three planting dates

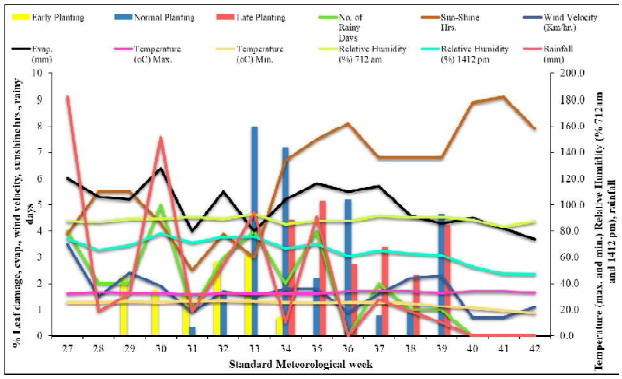

Fig. 3: Effect of weather parameters on the population of rice hispa in three planting dates

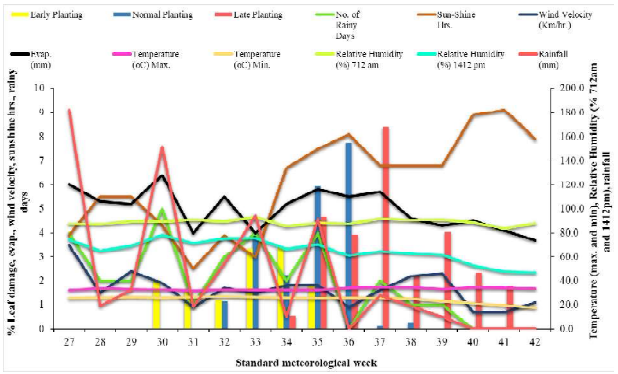

Fig. 4: Effect of weather parameters on the population of whorl maggot in three planting dates

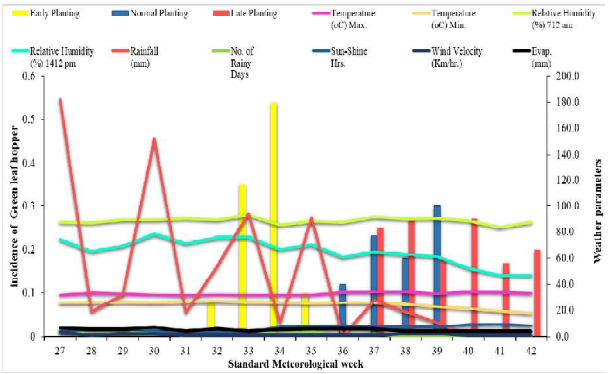

Fig. 5: Effect of weather parameters on the population of green leaf hopper in three planting dates

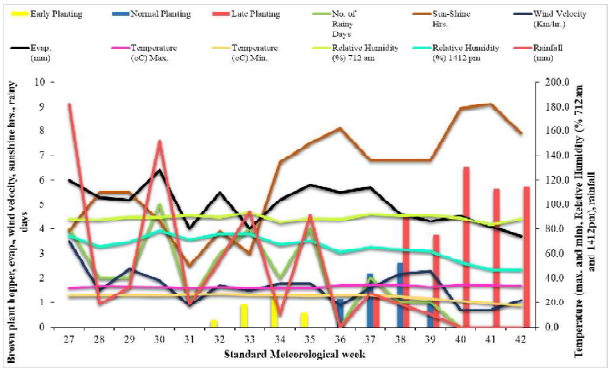

Fig. 6: Effect of weather parameters on the population of brown plant hopper in three planting dates

In late planting, the maximum temperature (r = 0.71), morning relative humidity (r = 0.08), and sunshine hours (r = 0.60) all had positive correlations, while the minimum temperature (r = -0.64), evening relative humidity (r = -0.69), rainfall (r = -0.47, number of rainy days (r = -0.58), wind velocity (r = -0.22), and evaporation (r = -0.22) all had negative correlations (r = -0.42).

The study conducted by Yadav *et al.* (2018) is in agreement with the current findings that early planting is beneficial to prevent insect pest damage. The maximum damage by green leaf hopper was observed in delayed planting followed by normal

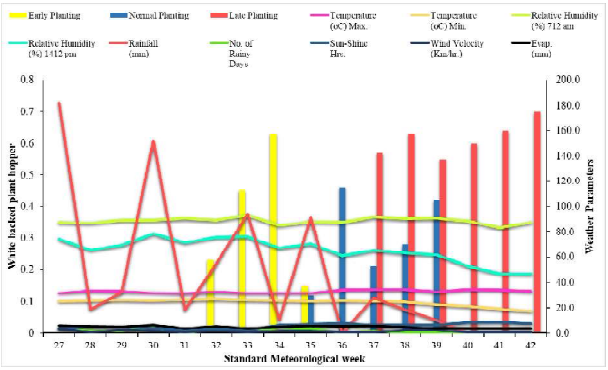

Fig. 7: Effect of weather parameters on the population of white backed plant hopper in three planting dates

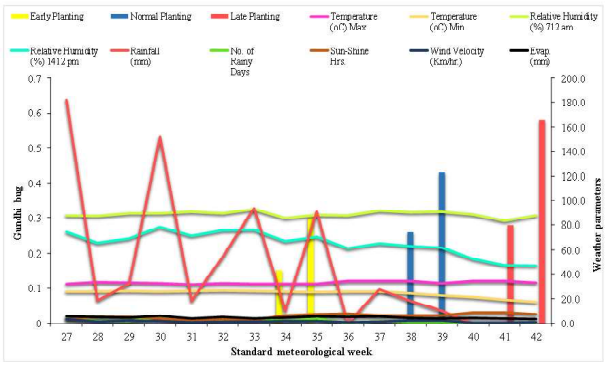

Fig. 8: Effect of weather parameters on the population of gundhi bug in three planting dates

and least in early planting.

Effect of planting date on the incidence of brown plant hopper (*Nilaparvata lugens*) during year 2020

In Late planting rice brown plant hopper (BPH) was most prevalent than normal planting (Table 7). Early planted crop had the least incidence of BPH. In early planting the incidence of pests was noted in standard week 34th (20th Aug. to 26th Aug.). In normal planting, the incidence occurred during the standard weeks 36th (3rd Sept. to 9th Sept.) to 39th (24th Sept to 30th Sept.) with a peak at the 38th week (17th Sept. to 23rd Sept.). The incidence of the late-planted crop was prevalent for six weeks with a peak during the 40th standard meteorological week (1st Oct. to 7th Oct.). Three planting dates were examined to determine how various abiotic factors affected the brown plant hopper population. Early planting showed a positive correlation with the lowest temperature (r = 0.29), evening relative humidity (r = 0.30), rainfall (r = 0.09), number of rainy days (r = 0.35), wind velocity (r = 0.03), and evaporation (r = 0.00), and a negative correlation with the highest temperature (r = -0.48), morning relative humidity (r = -0.05), and sunshine hours (r = -0.14). In a normal planting, the maximum temperature (r = 0.57) and minimum temperature (0.08), morning relative humidity (r = 0.36), sunshine hours (r = 0.25), wind velocity (r = 0.12), and evaporation (r = 0.04) were all positively correlated, while evening relative humidity (r = -0.13), rainfall (r = -0.26), and the number of rainy days (r = -0.27) were negatively correlated (r = -0.26). The only parameter that exhibits positive correlation in late planting is the maximum temperature (0.60), while the other parameters, such as the minimum temperature (r = -0.89), morning and evening relative humidity (r = -0.21 and -0.85), rainfall (r = -0.49, number of rainy days (r = -0.67), wind velocity (r = -0.36), and evaporation (r = -0.36), all exhibit negative correlation (r = -0.61).

Bhatt (2016) also studied the effect of planting dates on the pest incidence during *kharif* 2013 and 2014 and found that BPH population was highest in normal planting. It was also recorded that the maximum yield was found in early and normally planted rice. Chakraborty (2009) found similar results with maximum and minimum temperature. Adhikari *et al.* (2021) showed positive correlation with temperature, RH and rainfall.

Effect of planting date on the incidence of white backed plant hopper (*Sogatella furcifera*) during year 2020:

The incidence of WBPH was similar to BPH in early and late plantings, while in normal planting rice was observed in standard week 35 (27th Aug. to 2nd Sept.). The large number of insects was documented in late planting, with a peak during 36th standard week (3rd Sept. to 9th Sept.) onward. Early-planted crops had the least amount of damage (Table 8).

Three planting dates were used to examine the impact of various abiotic conditions on the white-backed plant hopper population. Early planting

Table 4: Effect of planting dates and their correlation with weather parameters on the incidence of rice hispa (*Dicladispa armigera*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Temperature(°C) Min.	Relative Humidity(%) 712 am	Relative Humidity(%) 1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart Early Planting	Per cent dead heart Normal Planting	Per cent dead heart Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	2.31	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	1.75	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	1.7	0.34	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	2.84	1.59	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	3.13	8	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	0.72	7.19	4.43
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	0	2.21	5.14
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	5.18	2.74
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	0.79	3.41
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	0.93	2.33
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	4.67	4.24
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	0
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	0
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	0
Correlation coefficient		EP	-0.54	0.48	0.45	0.63	0.28	0.47	-0.72	0.05	-0.01		Mean	
(r) between weather		EP	-0.29	0.28	0.17	0.21	-0.07	0.11	-0.08	-0.02	-0.13	1.56	2.81	2.23
parameters separately with each planting date		LP	0.02	0.16	0.00	-0.01	-0.18	-0.01	0.38	0.14	0.21			

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

showed a positive correlation with minimum temperature (r = 0.39), evening relative humidity (r = 0.40), rainfall (r = 0.18), number of rainy days (r = 0.41), wind velocity (r = 0.24), and evaporation (r = 0.05), while maximum temperature (r = -0.52), morning relative humidity (r = -0.06), and sunshine hours showed a negative correlation (-0.30). In a normal planting, maximum (r = 0.39) and minimum (r = 0.14) temperatures, morning relative humidity (r = 0.18), sunshine hours (r = 0.31), wind speed (r = 0.31), and evaporation (r = 0.15) were all positively correlated, while evening relative humidity (r = -0.10), rainfall (r = -0.29), and the number of rainy days (r = -0.29) were negatively correlated (r = -0.29). In late planting, there was a positive correlation with the highest temperature (0.69) and the number of sunshine hours (r = 0.62) and a negative correlation with the lowest temperature (r = -0.77), morning (r = -0.11) and evening (r = -0.80), relative humidity, rainfall (r = -0.56), number of rainy days (r = -0.63), wind velocity (r = -0.10), and evaporation (r = -0.47).

The outcomes of the study by Sarkar *et. al.* (2018) was in accordance with the above finding, it was observed that white backed plant hopper infestation was more in planting on 1st august and showed positive correlation with the minimum temperature and sunshine. Kumar *et.al.* (2017) also reported the maximum infestation of WBPH in 39th standard week.

Effect of planting date on the incidence of Gundhi Bug (*Leptocorisa acuta*) during year 2020

Instances of the gundhi bug were noted at the milking stage of the crop for each of the planting dates shown in Table 9.

Table 5: Effect of planting dates and their correlation with weather parameters on the incidence of whorl maggot (*Hydrellia philipina*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Temperature(°C) Min.	Relative Humidity(%) 712 am	Relative Humidity(%) 1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart Early Planting	Per cent dead heart Normal Planting	Per cent dead heart Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	2.05	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	1.65	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	1.19	1.14	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	3.36	3.99	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	3.4	2.23	0.54
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	1.86	5.91	4.67
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	7.77	3.92
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	0.14	8.39
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	0.27	2.19
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	0	4.04
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	2.34
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	1.77
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	0
Correlation coefficient (r)		EP	-0.69	0.41	0.16	0.55	0.31	0.55	-0.46	-0.03	0.05		Mean	
between weather		NP	-0.07	0.29	-0.02	0.15	0.03	0.11	0.15	-0.19	0.20	1.50	1.95	2.79
parameters separately		LP	0.48	-0.02	0.19	-0.22	-0.24	-0.19	0.50	-0.11	0.18			
with each planting date														

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

Late planting had the highest mean incidence with more chaffy grains. Three planting dates were examined to determine how various abiotic factors affected the population of the gundhi insect. In early planting, there was a positive correlation with the minimum temperature (r = 0.15), evening relative humidity (r = 0.15), rainfall (r = 0.13), number of rainy days (r = 0.31), sunshine hours (0.21), wind velocity (r = 0.07), and evaporation (r = 0.27) while a negative correlation with the maximum temperature (r = 0.12), morning relative humidity (r = 0.28), sunshine hours (r = 0.13), and wind velocity (r = 0.31) all correlated favorably, while the minimum temperature (-0.13), evening relative humidity (r = -0.12), rainfall (-0.21, number of rainy days (r = -0.21), and evaporation (r = -0.21) all correlated unfavourably (r = -0.26). In late planting, there was a positive correlation with maximum temperature (r = 0.16 degrees) and sunshine hours (0.39) and a negative correlation with minimum temperature (r = -0.85 degrees), morning (r = -0.37 degrees), and evening (r = -0.69 degrees), relative humidity, rainfall (r = -0.29 degrees), number of rainy days (r = -0.43 degrees), wind speed (r = -0.34 degrees), and evaporation (r = -0.34 degrees) (r = -0.51).

Chakraborty (2009) observed a positive relation to the minimum temperature with evening RH and negative correlation with morning RH. Khare *et al.* (2020) showed a positive correlation with RH and negative with abiotic factors.

Effect of planting dates on different insect damage, population and yield of three planting dates.

Table 6: Effect of planting dates and their correlation with weather parameters on the incidence of green leaf hopper (*Nephotettix virescens*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Min.	Relative Humidity(%) 712 am	1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart Early Planting	Normal Planting	Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	0	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	0	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	0.08	0	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	0.35	0	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	0.54	0	0
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	0.1	0	0
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	0.12	0
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	0.23	0.25
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	0.18	0.27
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	0.3	0.18
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	0.27
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	0.17
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	0.2
Correlation coefficient (r)		EP	-0.44	0.26	-0.06	0.26	0.03	0.27	-0.16	0.02	-0.06		Mean	
between weather		NP	0.39	0.00	0.39	-0.15	-0.29	-0.27	0.25	0.17	-0.04	0.12	0.08	0.13
parameters separately with		LP	0.71	-0.64	0.08	-0.69	-0.47	-0.58	0.60	-0.22	-0.42			
each planting date							EP							

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

Table 7: Effect of planting dates and their correlation with weather parameters on the incidence of brown plant hopper (*Nilaparvata lugens*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C)		Relative Humidity(%)		Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart		
			Max.	Min.	712 am	1412 pm						Early Planting	Normal Planting	Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	0	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	0	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	0.28	0	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	0.92	0	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	1.33	0	0
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	0.57	0	0
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	1.15	0
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	2.2	1.22
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	2.61	4.54
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	1.11	3.76
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	6.49
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	5.63
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	5.73
Correlation coefficient (r) between weather parameters separately with each planting date		RP	-0.48	0.29	-0.05	0.30	0.09	0.35	-0.14	0.03	0.00	Mean		
		NP	0.57	0.08	0.36	-0.13	-0.26	-0.26	0.25	0.12	0.04	0.34	0.64	2.74
		LP	0.60	-0.89	-0.21	-0.85	-0.49	-0.67	0.67	-0.36		-0.61		

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

Table 8: Effect of planting dates and their correlation with weather parameters on the incidence of white backed plant hopper (*Sogatella furcifera*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C)		Relative Humidity(%)		Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart		
			Max.	Min.	712 am	1412 pm						Early Planting	Normal Planting	Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	0	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	0	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	0.23	0	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	0.45	0	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	0.63	0	0
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	0.15	0.12	0
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	0.46	0
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	0.21	0.57
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	0.28	0.63
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	0.42	0.55
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	0.6
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	0.64
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	0.7
Correlation coefficient (r) between weather parameters separately with each planting date		EP	-0.52	0.39	-0.06	0.40	0.18	0.41	-0.30	0.24	0.05	Mean		
		NP	0.39	0.14	0.18	-0.10	-0.29	-0.29	0.31	0.31	0.15	0.16	0.14	0.37
		LP	0.69	-0.77	-0.11	-0.80	-0.56	-0.63	0.62	-0.10	-0.47			

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

Table 9: Effect of planting dates and their correlation with weather parameters on the incidence of gundhi bug (*Leptocorisa acuta*) during *kharif* 2020

Month	Date	Metro Week No.	Temperature(°C) Max.	Min.	Relative Humidity(%) 712 am	1412 pm	Rainfall (mm)	No. of Rainy Days	Sun-Shine Hrs.	Wind Velocity (Km/hr.)	Evap. (mm)	Per cent dead heart Early Planting	Normal Planting	Late Planting
July	02-08	27	32.1	25.6	88	74	182.0	4	3.9	3.5	6.0	0	0	0
July	9-15	28	33.3	25.8	87	65	18.8	2	5.5	1.5	5.3	0	0	0
July	16-22	29	32.8	26.2	89	69	32.0	2	5.5	2.4	5.2	0	0	0
July	23-29	30	32.3	25.7	89	78	151.7	5	4.3	1.9	6.4	0	0	0
July-Aug	30-05	31	31.5	26.3	91	71	18.2	1	2.5	0.9	4.0	0	0	0
Aug	06-12	32	32.5	26.8	89	76	54.2	3	3.9	1.7	5.5	0	0	0
Aug	13-19	33	31.9	26.2	93	76	94.0	4	3.0	1.5	4.0	0	0	0
Aug	20-26	34	32.0	25.8	85	67	10.3	2	6.7	1.8	5.2	0.15	0	0
Aug-Sep	27-02	35	32.1	25.4	88	70	91	4	7.5	1.8	5.8	0.3	0	0
Sep	03-09	36	34.0	25.7	88	61	0	0	8.1	0.9	5.5	0	0	0
Sep	10-16	37	34.1	25.6	92	65	27.6	2	6.8	1.6	5.7	0	0	0
Sep	17-23	38	34.2	24.6	90	63	18.5	1	6.8	2.2	4.6	0	0.26	0
Sep-Oct	24-30	39	32.6	22.8	91	62	10.2	1	6.8	2.3	4.3	0	0.43	0
Oct	01-07	40	34.2	21.3	89	53	0	0	8.9	0.7	4.5	0	0	0
Oct	08-14	41	34.0	19.2	83	48	0	0	9.1	0.7	4.1	0	0	0.28
Oct	15-21	42	33.0	17.4	88	47	0	0	7.9	1.1	3.7	0	0	0.58
Correlation coefficient (r) between weather parameters separately with each planting date		EP	-0.33	0.15	-0.24	0.15	0.13	0.31	0.21	0.07	0.27		Mean	
		NP	0.12	-0.13	0.28	-0.12	-0.21	-0.21	0.13	0.31	-0.26	0.05	0.06	0.09
		LP	0.16	-0.85	-0.37	-0.69	-0.29	-0.43	0.39	-0.34	-0.51			

*EP= Early Planting, NP= Normal Planting, LP= Late Planting

Table 10: Effect of planting date on per cent white head and yield during *kharif* 2020

Treatment	Yellow stem borer damage Dead heat (%)	White ear head (%)	Leaf folder damage(%)	Rice hispa damage (%)	Whorl maggot damage (%)	Brown plant hopper (No. of Insects)	White backed plant hopper (No. of Insects)	Green leaf hopper (No. of Insects)	Gundhi bug (No. of Insects)	Yield (q ha^{-1})
Early Planting	6.30	6.27	1.17	1.56	1.50	0.34	0.16	0.12	0.05	42.68
Normal Planting	9.85	30.55	1.45	2.81	1.95	0.64	0.14	0.08	0.06	15.38
Late Planting	13.32	21.8	1.71	2.23	2.79	2.74	0.37	0.13	0.07	3.48

The lowest damage due to yellow stem borer were recorded in early planting which were significantly lower than that recorded in normal and late plantings. Late planting showed maximum % white ear in the field. The grain yield recorded was highest for early plantings in both years (Table 10).

CONCLUSION

Under field conditions, the planting date effects on the incidence of yellow stem and the highest infestation was seen in late transplanted crop. The minimum damage was found in early planting during *kharif* 2020, showing early planting is suitable to evade the damage by yellow stem borer. Leaf folder damage was seen more or less similar during early, late and normal plantings during the season. The per cent damaged leaves due to rice hispa infestation was seen minimum in early planting and maximum damage in normal planting. The damage due to whorl maggot was seen maximum in the late planting and minimum in early planting.

The impact of planting date on the occurrence of brown plant hopper can be observed. When compared to normal and early planting, the population of brown plant hoppers was most noticeable in late planting. The peaks of incidence varied with planting dates. In early and late plantings, the population of green leaf hoppers remained very consistent, but it was negligible during normal planting. Although the largest population for the white-backed plant hopper was found in late planting, the maximum peak for incidence varied with different planting dates. Gundhi bug occurrence is visible during the milking stage of crop, therefore depending on planting dates, it appears during different standard weeks.

Minimum white ear was seen in early planting as compared to normal and late planting which signifies the importance of early planting for better control of yellow stem borer. The maximum yield was seen in early planted crop followed by normal and least in late planted. The difference in yield was significant from early to late planting showing early planting to be most suitable for getting maximum grain yield.

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