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Survey and Occurrence of Major Biotic Stresses of Rice in Sangrur District of Punjab

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***Abstract*:** Field survey was conducted to investigate the prevalence of major biotic stresses of rice in different blocks of district Sangrur in Punjab. The Leaf folder, brown plant hopper, sheath blight, false smut and kernel smut were observed the major biotic stresses of rice in this region. The more damage of leaf folder and brown plant hopper populations observed in rice with combination of favourable meteorological factors such as reduced rainfall coupled with high humidity, high temperature and diminished sunshine hours. The damage of leaf folder and brown plant hopper population varied with weather conditions and significantly positive correlated with maximum temperature and negatively with occurrence of rainfall. The disease sheath blight might be due to the prevalence of highly favorable factors of high relative humidity, less temperature and occurrence of more rainfall convenient for disease development. The false smut and kernel smut diseases observed high incidence due to prevailing of favourable weather for long time coinciding with rainy days at the time of flowering stage of the crop, ultimately increasing the relative humidity which is a crucial factor for development of disease.

***Keywords*:** Biotic stresses, Weather parameters, Rice, Standard week, Survey

Rice (*Oryza sativa* L.) is an important cereal crop, which provides food and nutritional security for half of the human race. About 90 per cent of the world rice is grown and consumed in Asia. India is next only to China with respect to area under rice cultivation. In India, it is grown over an area of 45.07 mha with a production and productivity of 122.27 m tonnes and 2712 kg ha, respectively during 2020-21. In Punjab, it occupies an area of 31.49 lakh ha with a production and productivity of 208.83 lack tonnes and 6631 kg ha, respectively during 2020-21.

The yield is affected by many factors, out of which, climatic conditions and pest epidemics are most important. Insect-pests damage started from nursery sowing to transplanting and continues upto maturity of the crop. Although crop is subjected to attack by a number of pests under field condition, only a few of them are responsible for triggering severe economic damage (Heinrichs et al 2017). Yield losses due to rice pests in tropical Asia are expected to be about 25-43% (Savary et al 2012). In India, yield losses on account of insect-pests in rice occur to the extent about 25% (Dhaliwal et al 2010) and diseases have been assessed as 15.6% (Mondal et al 2017). Singh et al (2012) observed the maximum number (percent) of insect-pest infestation by plant hopper (44%) followed by leaf folder (30%) and stem borer (29%) during years of 2000-2009 in Punjab. The sheath blight of rice caused by *Rhizoctonia solani* Kuhn is one of the major fungal diseases of rice in tropical Asia causing upto 50 percent loss in grain yield (Roy 1993). It is a devastating disease in all rice growing regions of the world. In tropical and sub-tropical Asia, the disease is reported to cause an average loss of 5-10 percent (Willocquet et al 2011). Studies carried out at IRRI, Philippines reported 24 percent yield loss in susceptible cultivars under highest level of disease intensity and nitrogen application. However, in Arkansas, USA 5-15 percent yield losses have been attributed to sheath blight (Annou et al 2005). In India, losses due to this disease has been reported to vary from 5-13.5 per cent in the Punjab state (Thind et al 2001). False smut is an ascomycete fungal pathogen *Villosiclava virens* (anamorph: *Ustilaginoidea virens* [Cooke] Takahashi) (Tanaka et al 2008). The emergence of this disease is believed to be partially due to grown of hybrid rice varieties, which are mostly susceptible to the false smut. The smut ball density varied, on an average, between 0.6 and 4.8 (per infected panicle) depending upon locations in Kashmir region of India (Sanghera et al 2012) and average 2.0-12.2 smutted ball intensity (per infected panicle) recorded in Uttar Pradesh (Singh et al 2014). Quintana et al (2016) observed at least 2-3 balls per infected panicle when investigated 120 panicles in Paraguay of which 40 percent were symptomatic. The climatic factors favouring the disease are high humidity, low temperature and rainy days at the time of flowering. Infection with *U. virens* is promoted by high relative humidity (>90%), temperatures between 25 and 30°C, late planting and high soil fertility and

high amount of nitrogen fertilization (Ahonsi et al 2000, Rani et al 2015). The temperature, rainfall and sunshine hours are the most important environmental factors that are decisive for sporulation and formation of false smut balls by U. virens (Yashoda et al 2000). The incidence of false smut has increased after introduction of high yielding varieties and hybrids receiving high inputs, particularly excessive use of nitrogen fertilizers (Mohiddin et al 2012, Rani et al 2015). About 10-20 percent incidence has been reported with popular inbred rice varieties such as PR 116 and PAU 201 (Ladhalakshmi et al 2012). In India, crop loss has been recorded up to 44 percent (Pannu et al 2010). Kernel smut (*Neovossia horrida* Takah.) is considered a minor disease worldwide, but it has reached epidemic levels at rare intervals (Carris et al 2006, Brooks et al 2009). The disease was reported for the first time by Butler in 1913, occasionally the disease prevalent in most of paddy growing states as destructive form in Punjab, Uttar Pradesh, Haryana and Bihar states of North India.

The insect-pest scenario of rice has considerable changes due to the inclement climatic conditions in Punjab. The incidence and population buildup of a pest is highly dependent on prevailing weather conditions, excessive use of nitrogenous fertilizers and irrigation with growth stage of the crop. The present study has been carried out to find the prevalence of major biotic stresses in rice crop in this region, therefore, to formulate the tools required for issuing agro-advisory in speculation period for biotic stress in rice crop.

MATERIAL AND METHODS

A random field survey was conducted to investigate the prevalence of major biotic stresses of rice in different blocks of Sangrur district in Punjab during rice crop season 2017 and 2018 (Table 1). The regular observations on insect-pests and disease were recorded at stipulated period from farmers' fields. The data of leaf folder damage and brown plant hopper populations were recorded after appearance in field and an interval of 15 days to calculate the percent incidence as per leaf damage and number of brown plant hopper population per plant. Incidence of sheath blight was recorded on appearance of disease by following the standard evaluation system (IRRI 2002). Incidence of false smut and kernel smut diseases was recorded at the time of maturity randomly in per square meter area for the number of smut balls per infected plant and further the disease incidence was calculated as per infected grains. The incidence of leaf folder, false smut and kernel smut were calculated by using the formula as given below:

$$\text{Incidence of leaf folder damage (\%)} = \frac{\text{Number of damage leaf observed}}{\text{Total number of leaf examined}} \times 100$$

$$\text{Incidence of false and kernel smut (\%)} = \frac{\text{Number of smutted balls per plant}}{\text{Total number of grains in plant}} \times 100$$

Standard Evaluation System (0-9) based on relative lesion height of sheath blight (IRRI 2002).

0 : No infection observed,
1 : Lesions limited to lower 20% of the plant height
3 : 20-30%
5 : 31-45%
7 : 46-65%
9 : More than 65%

$$\text{Disease severity (\%)} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of observations x Maximum disease ration of scale}} \times 100$$

RESULTS AND DISCUSSION

The weather parameters like rainfall, temperature and relative humidity (Fig. 1) played important role for emerging and spread of insect-pests and diseases in rice crop. The incidence leaf folder and brown plant hopper observed more in *kharif* 2017 due to prevailing of high temperature. The damage of leaf folder recorded during 31th to 43th standard week and maximum damage incidence during 35th to 41th standard week due to high temperature and low rainfall. The damage of leaf folder was the maximum *i.e.* 41.24 percent in block Moonak and 41.12 percent in block Lehra during 39th standard week in season 2017 (Fig. 2). However, the damage was observed low due to continuous occurrence of rainfall in season 2018 (Fig. 3). The highest damage of recorded in 39th standard week during season 2017 and 35th standard week during season 2018 in all blocks due to maintain the high maximum temperature. Singh et al., 2012 noticed that the active phase of leaf folder from July to September with peak activity during August to September in Punjab. Shyamrao and Raghuraman (2019) noticed the infestation of leaf folder in the field from 31th standard week to 41th standard week. Singh et al (2012) also reported higher incidence of leaf folder positively correlated with the maximum temperature during the growing season. However,

Table 1. Survey of major insect-pest and disease of rice in different block of Sangrur district

Blocks	Location as per GPS Coordinates	
	Latitude	Longitude
Sangrur	30°14'40.4"N	75°50'28.0"E
Sunam	30°07'47.1"N	75°48'16.8"E
Dhuri	30°22'20.5"N	75°51'40.2"E
Malerkotla	30°31'39.9"N	75°52'47.0"E
Lehra	29°56'10.8"N	75°48'22.1"E
Moonak	29°49'29.0"N	75°53'24.0"E

Baskaran et al (2017) observed that the relative humidity and rainfall were positively correlated with trap catches, temperatures were positively correlated to the susceptibility to leaf folder in rice. Supawan and Chongrattanameteekul (2017) recorded with the increasing temperature within the upper threshold of the species generally promoted insect population growth. Although statistically non-significant, relative humidity and rainfall indicated negative correlation

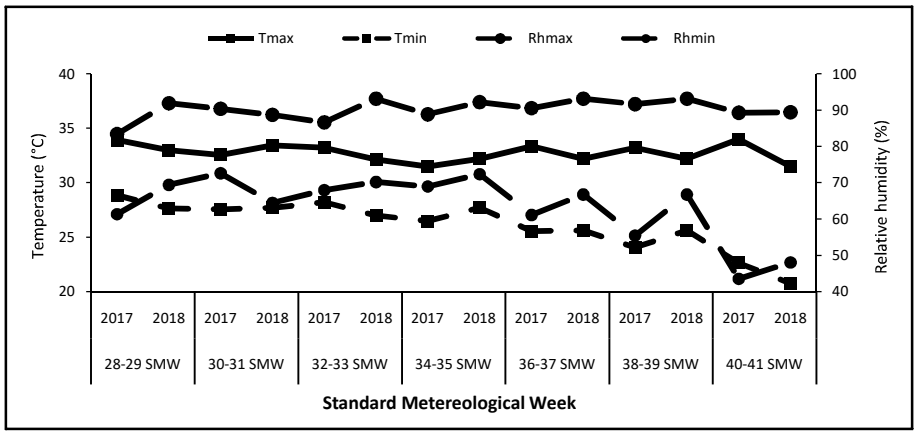

Fig. 1. Temperature and relative humidity of Sangrur district during 2017 and 2018

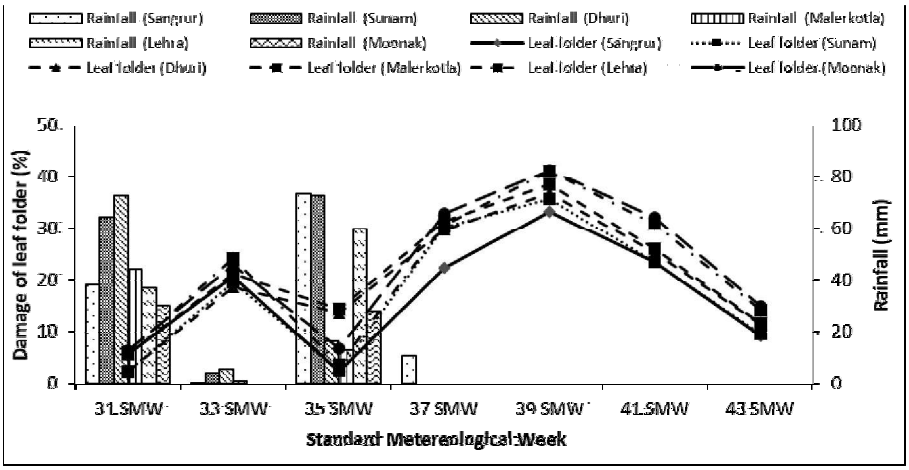

Fig. 2. Effect of rainfall on leaf folder damage of rice in different blocks of Sangrur district during 2017

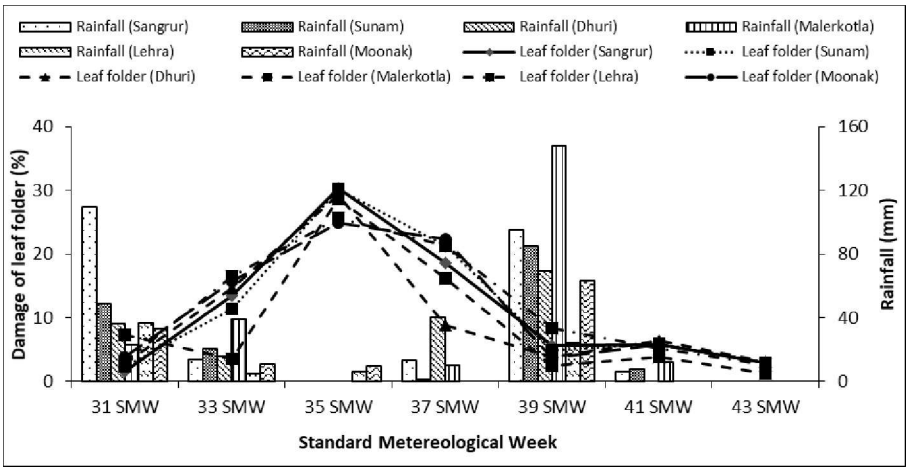

Fig. 3. Effect of rainfall on leaf folder damage of rice in different blocks of Sangrur district during 2018

with rice leaf folder population.

In season 2017, the populations of BPH recorded from 33th to 43th standard week in all blocks due to occurrence of very less rainfall and continuous high temperature upto 34°C. The maximum population of BPH was recorded as 41.37 BPH per hill in block Lahra and 40.47 BPH per hill in Malerkotla on 39th standard week (Fig. 4). The population recorded low as pervious season but highest observed in 37th-39th standard week (Fig. 5). Similarly, the maximum population reached 38th week and afterward started declining from 39th week and negligible by the end of October *i.e.* 42th and 43th weeks during 2011 and 2012 in Rice Research Station, Kaul, Haryana (Kumar et al 2017). The results from this study also support the view that peak level of population occurred during the 38th standard week in third week of September in BHU Varanasi, Uttar Pradesh (Chaudhary et al 2014), in Meerut, Uttar Pradesh (Kumar et al 2019, Verma et al 2021), in Srikakulam district of Andhra Pradesh (Chitti Babu et al 2020). BPH population appeared during 30th standard week and reached to its peak during 40th standard week in Varanasi, Uttar Pradesh (Sharma et al 2018). In present study, as maximum temperature of 33-34°C, minimum temperature 22-25°C and occurrence of very less rainfall were favorable factors for buildup of peak damage of leaf folder and brown plant hopper and such conditions were prevalent during crop season 2017. The damage of leaf folder and brown plant hopper populations correlated positive with maximum temperature and negatively with rainfall.

Sheath blight disease might be due to the prevalence of highly favorable factors like high relative humidity, less temperature and more rainfall for disease development. The

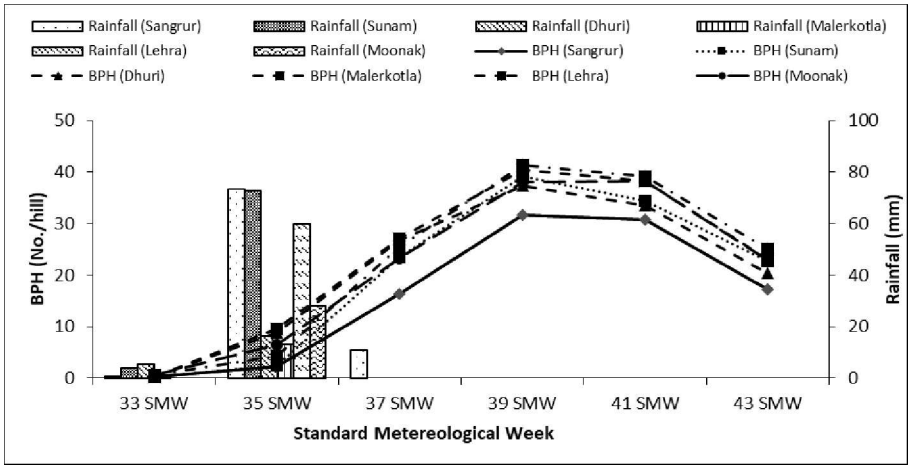

Fig. 4. Effect of rainfall on BPH population of rice in different blocks of Sangrur district during 2017

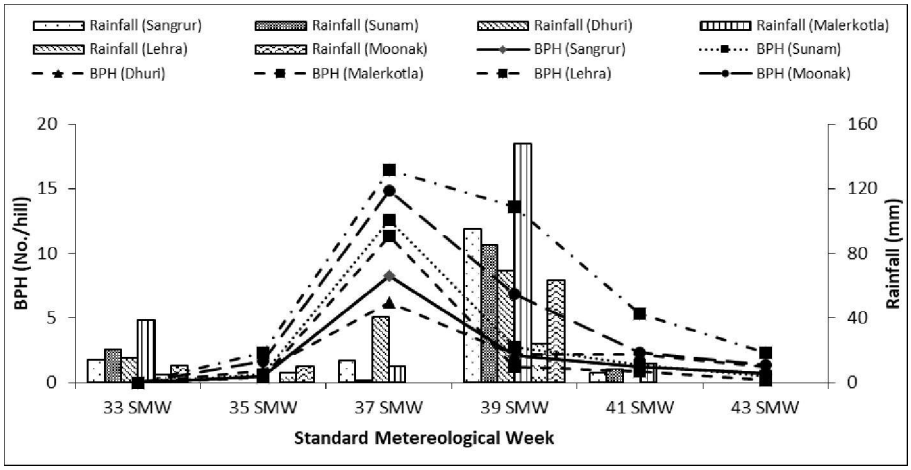

Fig. 5. Effect of rainfall on BPH population of rice in different blocks of Sangrur district during 2018

disease severity of sheath blight was recorded from 31th to 43th standard weeks in both season of crop in all blocks. In 2017, the disease severity was found highest in Sangrur (28.64%), Sunam (26.71%) and Lehra (22.15%) in 35th standard week followed by decreasing the disease severity (Fig. 6). However, in crop season 2018 the disease severity was more remain throughout the season in field from 31th to 43th standard week due to continuous occurrence of rainfall. The highest disease severity was found 39th standard week in Malerkotla (46.65%) and Sangrur (38.64%) (Fig. 7). The disease incidence of sheath blight recorded 10.5 to 36.5 percent incidence in Cuddalore district of Tamil Nadu (Neha et al 2016), 30-76 percent incidence in Chhattisgarh, (Parshuram et al 2017), 15 to 42 percent incidence in areas of Allahabad (Yaduman et al 2018) and 20 to 80 percent incidence in five districts of eastern Uttar Pradesh (Thera et al 2021).

The incidence of false smut and kernel smut recorded per meter square area from infected field. In season 2017, false smut (0.115%) and kernel smut (0.048%) infected smut balls were highest in Sangrur block (Fig. 8). However, the incidence of false smut and kernel smut was more in 2018 which might be attributed to the favourable weather conditions coinciding with the susceptible stages of the crop. The prevailing weather remain favourable for long time coinciding with rainy days at the time of flowering stage of the crop, ultimately increasing the relative humidity which is a crucial factor for development of disease like false smut and kernel smut. The highest incidence of false smut (0.242%) and kernel smut (0.146%) recorded in Malerkotla during season 2018 (Fig. 9). The severe density of smut balls (per infected panicle) in the range of 1.6-7.1 in the seven surveyed locations of Egypt (Atia 2004), average between 0.6 and 4.8

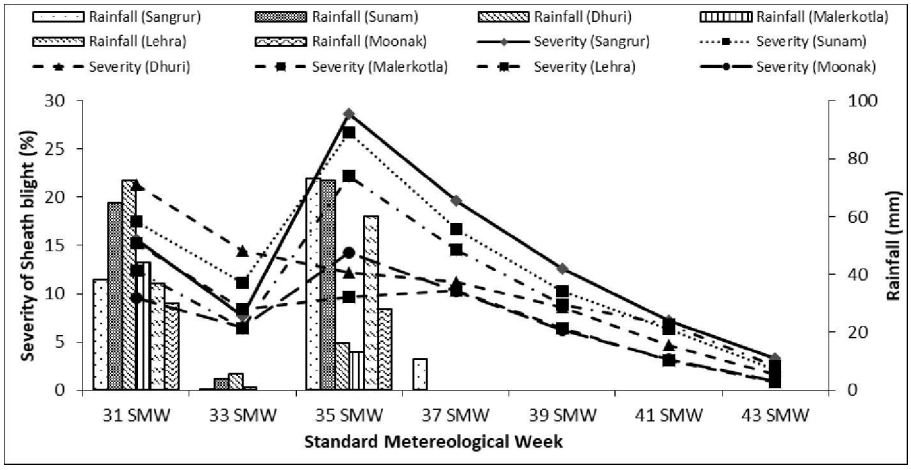

Fig. 6. Effect of rainfall on sheath blight disease severity of rice in different blocks of Sangrur district during 2017

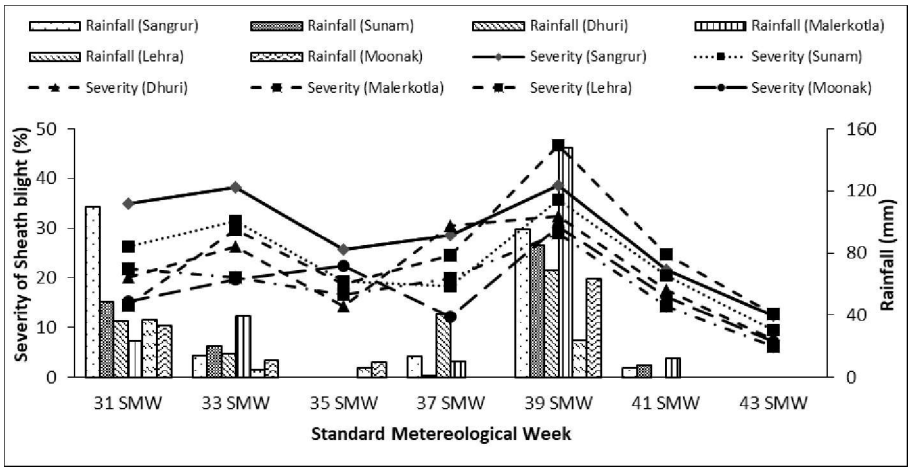

Fig. 7. Effect of rainfall on sheath blight disease severity of rice in different blocks of Sangrur district during 2018

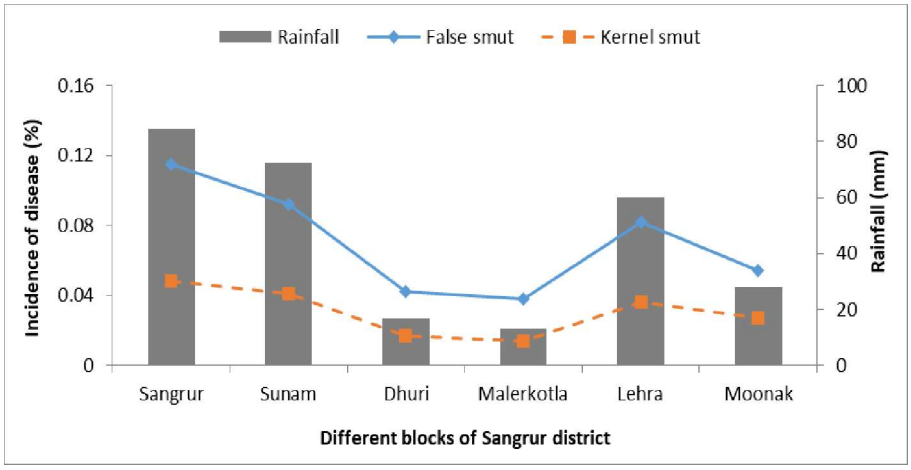

Fig. 8. Effect of rainfall on disease incidence of rice in different blocks of Sangrur district during 2017

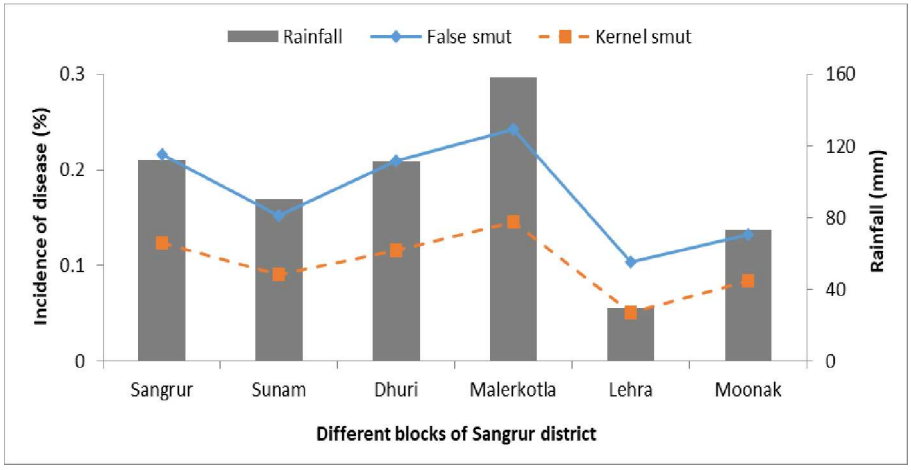

Fig. 9. Effect of rainfall on disease incidence of rice in different blocks of Sangrur district during 2018

smutted balls (per infected panicle) depending on locations and years (2010 and 2011) in Kashmir region of India (Sanghera et al 2012) and range of 2.0-8.0 average smut ball density (per infected panicle) during an extensive survey in the six districts of Uttar Pradesh of India (Singh et al 2014). In Punjab, 10 to 20 per cent infected tillers were recorded in popular inbred of rice like PR 114, PR 116 and PAU 201 (Ladhalakshmi et al 2012). Duhan and Jakhar (2000) reported incidence of kernel smut across different rice cultivars ranged from 0.05 to 1.20 percent. Mandhare et al (2008) collected the 630 seed samples of different varieties of rice from Nasik, Pune, Satara, Sangli, Kolhapur districts of state Maharashtra and observed that the incidence of kernel smut was low (0.00-0.4%).

CONCLUSIONS

It has observed that the high temperature and low rainfall favour to spread and build-up of insect population and in contrast occurrence of more rainfall and maintained the high humidity helpful for developing of disease in rice crop. It is very important study to know the preference weather conditions for occurrence and peak period of activity to spread and development of major biotic stresses. Therefore, proper monitoring and management strategies will be planned against these biotic stresses to avoid economic loss of the crop.

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