Himachal Journal of Agricultural Research 48(1): 80-84 (2022)

Distribution and survival of flag smut of wheat caused by *Urocystis agropyri* (Preuss) A. A. Fisch. Waldh. in Himachal Pradesh

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Manuscript Received: 29.04.2022; Accepted: 12.05.2022

Abstract

Flag smut of wheat caused by *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh. is an important seed as well as soil borne disease that is now emerging as a serious problem in Himachal Pradesh. During the survey of wheat growing areas of Himachal Pradesh, the highest average incidence of disease (17.77 %) was recorded from Thural of district Kangra followed by Akrot of district Una, Bhager of district Bilaspur and Dhaulakuan of district Sirmour with 14.65, 10.56 and 9.19 per cent incidence, respectively. The overall average disease incidence was significantly higher in 2019-20 (7.12 %) as compared to 2020-21 (5.97 %). The pathogen inoculum buried at 2 cm below the soil surface for 8 months yielded highest spore germination of 18.92 per cent and no spore germination was recorded till 4 months of storage due to the dormancy in any of the screened storage conditions.

Key word: Flag smut, *Urocystis agropyri,* disease incidence and survival of inoculum

Flag smut caused by *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh. is an emerging disease of wheat in the state. The disease was first reported by Sydow and Butler (1906) in India from Layallpur (now in Pakistan). In India, the disease was also reported in several wheat growing states such as Bihar, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan and the mountains of Uttar Pradesh, (now Uttarakhand) (Goel *et al*., 1977). The major symptom of the disease is the formation of whitish to greyish longitudinal stripes/ smut sori between the veins of the leaf blades that later turn black after rupturing of these stripes or release of teliospores. Infected plant becomes stunted with few tillers and also contained deformed or twisted leaves (Purdy, 1965). The disease is more prevalent in locations with warm and dry weather, where soil temperature ranging from 18 to 24°C and moisture $\geq$ 60 per cent promotes the germination of teliospores. The pathogen surviving externally on seed as well as in soil is the primary source of inoculum for infection in the plant. Basandarai *et al*. (1993) recorded its incidence up to 50 per cent from mid and low hills of Himachal Pradesh. Therefore, a survey was conducted during *Rabi* season of 2019-20 and 2020-21 to know the distribution of flag smut within the state and surviving conditions of the causal agent.

Materials and Methods

During *Rabi* seasons of 2019-20 and 2020-21, six major wheat growing districts of Himachal Pradesh were surveyed to record the status of disease in the state and representative samples from those areas were collected to extract the fungal inoculum. Five spots of one meter square area in each field were marked diagonally and the number of total and diseased tillers per spot was counted to work out the per cent disease incidence using the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of smutted tillers}}{\text{Total number of observed tillers}} \times 100$$

Survival of inoculum

In this experiment, the collected infected plants were rubbed against iron wire mesh and sieved thoroughly by a fine muslin cloth to separate out the

inoculum/ teliospores. The extracted teliospores were then kept in three different storage conditions such as ambient-room temperature in the lab, cool freezed in refrigerator and buried in soil 2 cm below ground level in muslin cloth. Afterwards, the per cent germination of teliospores was assessed by recording the number of germinated and un-germinated teliospores regularly using a compound microscope, at an interval of 30 days up to eight months. To ensure the proper germination of teliospore, the stored teliospores of all the three storage conditions were presoaked individually by dusting them over the surface of sterile distilled water containing three petri plates each and kept in incubator (in dark) at 19±1°C for 7 days. Thereafter, the presoaked teliospores were transferred to the glass cavity blocks each containing 1 ml distilled water and small bits of tissues of lower stem portion of fresh seedling (30 mg/ ml) of wheat variety PBW 343 by using a clean glass rod and cover slips were placed over the cavity blocks and kept in incubator at 19±l°C (Goel and Jhooty 1984).

Results and Discussion

The data on disease incidence of flag smut recorded at different locations of Himachal Pradesh during 2019-20 and 2020-21 are presented in Table 1 and Fig 1. The data revealed the presence of the disease in six major wheat-growing districts of Himachal Pradesh. The highest average incidence of disease (9.07 %) was recorded in district Kangra followed by Una, Sirmour, Bilaspur and Mandi with 8.77, 8.53, 4.67 and 4.58 per cent incidence, respectively while, the least (3.66 %) in district Hamirpur. However, within all the surveyed locations,

Table 1. Incidence of flag smut of wheat at different locations of Himachal Pradesh

District	Location	Disease incidence (%)		
		2019-20	2020-21	Mean
Kangra	Aalampur	5.18	4.70	4.94
	Lambagaon	9.01	8.07	8.54
	Dehra	5.11	4.98	5.05
	Thural	20.10	15.43	17.77
	Mean	**9.85**	**8.30**	**9.07**
Una	Una	3.07	2.70	2.89
	Akrot	16.58	12.71	14.65
	Mean	**9.83**	**7.71**	**8.77**
Sirmour	Dhaulakuan	10.17	8.20	9.19
	Kolar	8.63	7.10	7.87
	Mean	**9.40**	**7.65**	**8.53**
Hamirpur	Galore	6.34	4.59	5.47
	Khidki	3.29	2.97	3.13
	Barsar	2.51	2.25	2.38
	Mean	**4.05**	**3.27**	**3.66**
Bilaspur	Samoh	2.21	2.00	2.11
	Jhabola	5.10	4.87	4.99
	Bhager	10.78	10.33	10.56
	Sariun khas	3.01	2.87	2.94
	Ghumarwin	2.85	2.66	2.76
	Mean	**4.79**	**4.55**	**4.67**
Mandi	Jahu	6.23	5.32	5.78
	Slahpar	4.78	4.42	4.60
	Bhangrota	3.45	3.25	3.35
	Mean	**4.82**	**4.33**	**4.58**
Overall mean		7.12	5.97	6.54

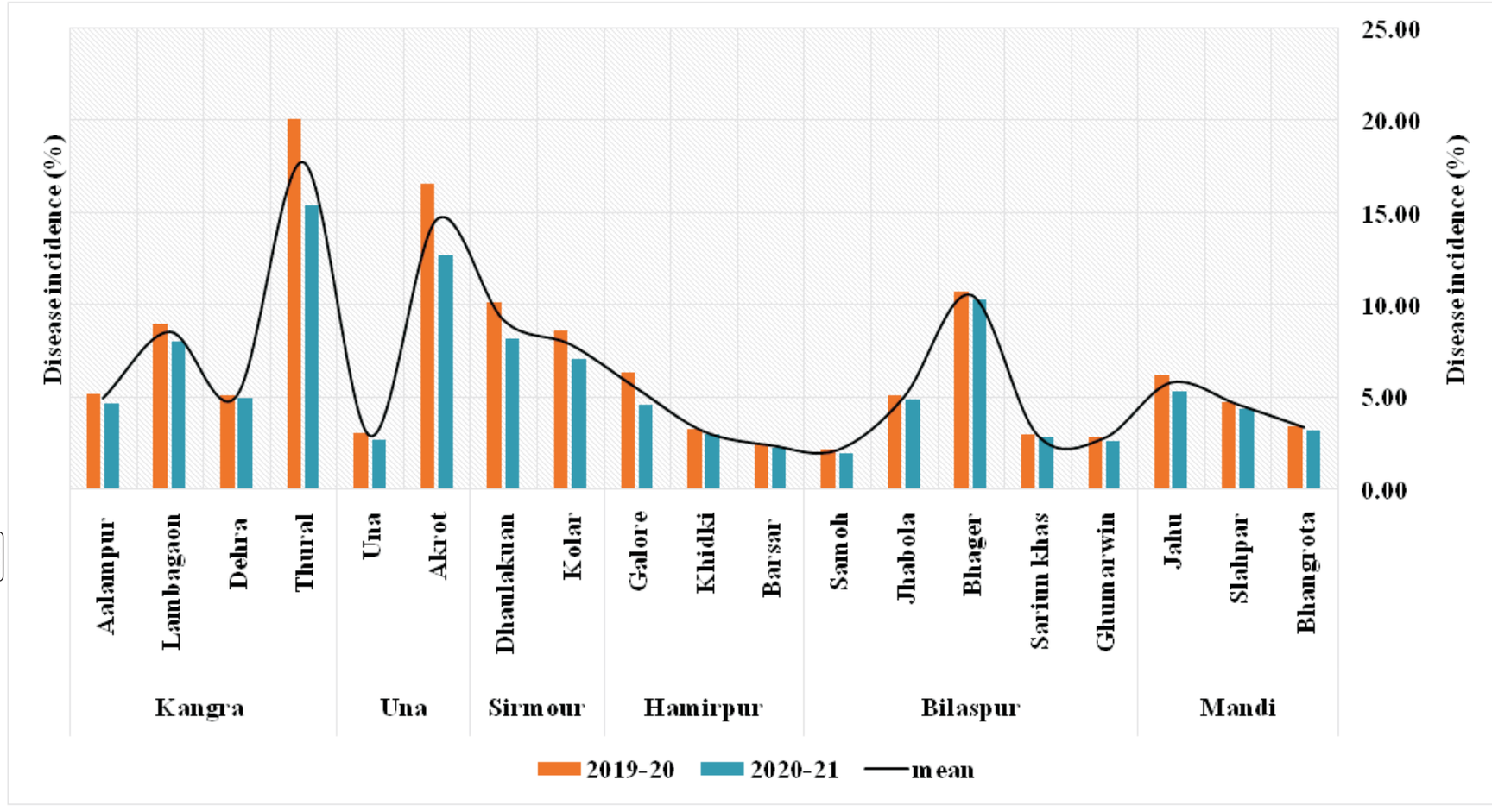

Fig 1. Disease incidence (%) of flag smut of wheat at different locations of Himachal Pradesh

the maximum average disease incidence of 17.77 per cent was observed at Thural of district Kangra followed by Akrot of district Una, Bhager of district Bilaspur, Dhaulakuan of district Sirmour, Lambagaon of district Kangra, Kolar of district Sirmour, Jahu of district Mandi and Galore of district Hamirpur with 14.65, 10.56, 9.19, 8.54, 7.87, 5.78 and 5.47 per cent incidence, respectively. The minimum average disease incidence of 2.11 per cent was recorded at Samoh of district Bilaspur.

During 2019-20 and 2020-21, a similar trend in disease incidence was observed at all locations of surveyed districts. The highest incidence of disease was recorded from Thural (20.10 and 15.43 %, respectively) of district Kangra followed by Akrot (16.58 and 12.71 %, respectively) of district Una, Bhager (10.78 and 10.33 %, respectively) of district Bilaspur, Dhaulakuan (10.17 and 8.20 %, respectively) of district Sirmour, Lambagaon (9.01 and 8.07 %, respectively) of district Kangra and Kolar (8.63 and 7.10 %) of district Sirmour and least at Samoh of district Bilaspur *i.e.* 2.21 and 2.00 per cent, respectively during 2019-20 and 2020-21. Similarly, the overall mean incidence of disease (7.12 %) in 2019-20 was higher as compared to the average incidence (5.97 %) reported during 2020-21. In a similar study, 30-35 per cent incidence of disease had been recorded by Sethi and Singh (1971) from Kangra and Kullu districts of HP. An extensive incidence of flag smut (~ 50 %) was seen in lower and mid hill areas of the state (Bansandrai *et al*., 1993). Sharma and his coworkers (2011) observed 3-25 per cent disease incidence in HP from district Kangra, Bilaspur and Una. Kumar *et al*., (2021) also recorded 10-15 per cent incidence of disease from Dhanot of district Kangra.

Thus, it can be concluded from above result that distribution of disease varying from 2.11 to 17.77 per cent within locations of six surveyed districts of Himachal Pradesh and it might occurred due to the existing weather conditions during the cropping seasons as well as the varieties grown i.e. either susceptible or resistant in the areas.

Survival of inoculum

In this experiment (Table 2), the highest mean germination in spore was observed in soil burial *i.e.* 4.46 per cent followed by storage at room temperature (1.59 %) and the spores did not germinated in freezed condition. However, the maximum mean germination of spore (9.08 %) was obtained after 8 month of storage followed by 7 (4.99 %) and 6 (1.57 %) months of storage and no germination in spore was recorded till 4 months of storage in any storage conditions.

While among three storage conditions upto 8 months, the maximum spore germination was recorded in soil burial method after 8 months of storage (18.92 %) followed by its 7 month (11.75 %) storage and at room temperature after 8 month of storage (8.33 %). Similarly, Verwoerd (1929) found that *U. agropyri* spores remains viable in infected plant material for 5 years after being dried and preserved in a

Table 2. Effect of storage conditions and period on the survival of inoculum (teliospores) of *Urocystis agropyri*

Storage condition	Germination % after storage period (months)								
	1	2	3	4	5	6	7	8	Mean
Room	0.00	0.00	0.00	0.00	0.00	1.17	3.22	8.33	1.59
temperature	(1.00)*	(1.00)	(1.00)	(1.00)	(1.00)	(1.47)	(2.05)	(3.05)	(1.45)
Freezer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Burial in soil	0.00	0.00	0.00	0.00	1.46	3.55	11.75	18.92	4.46
(below 2 cm)	(1.00)	(1.00)	(1.00)	(1.00)	(1.57)	(2.11)	(3.57)	(4.46)	(1.96)
Mean	0.00	0.00	0.00	0.00	0.49	1.57	4.99	9.08	-
	(1.00)	(1.00)	(1.00)	(1.00)	(1.19)	(1.53)	(2.21)	(2.83)	
CD (P=0.05)	Storage condition = NS								
	Storage period = NS								
	Storage condition × Storage period = 1.45								

*Figures within parentheses are square root transformed values

plant press at room temperature in the laboratory. However, an increase in per cent spore germination with corresponding increase in the age of spores was reported by Allan and Duran (1979) and also reported viability in spore remained up to 2 years. Shekhawat (2008) recorded mean maximum spore germination (59.60 %) after maximum 20 month of storage and found no germination in spores of *U. agropyri* till 4 months due to the dormancy. Thus, it can be concluded that soil is the best place for survival of spores as compared to other storage conditions and the spore germination also increased with the increase in the age of inoculum after passing their dormancy period.

Conflict of interest: The authors declare that they have no conflict of interest.

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