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Short Communication

Influence of weather variables on progression of white rust disease of Indian mustard

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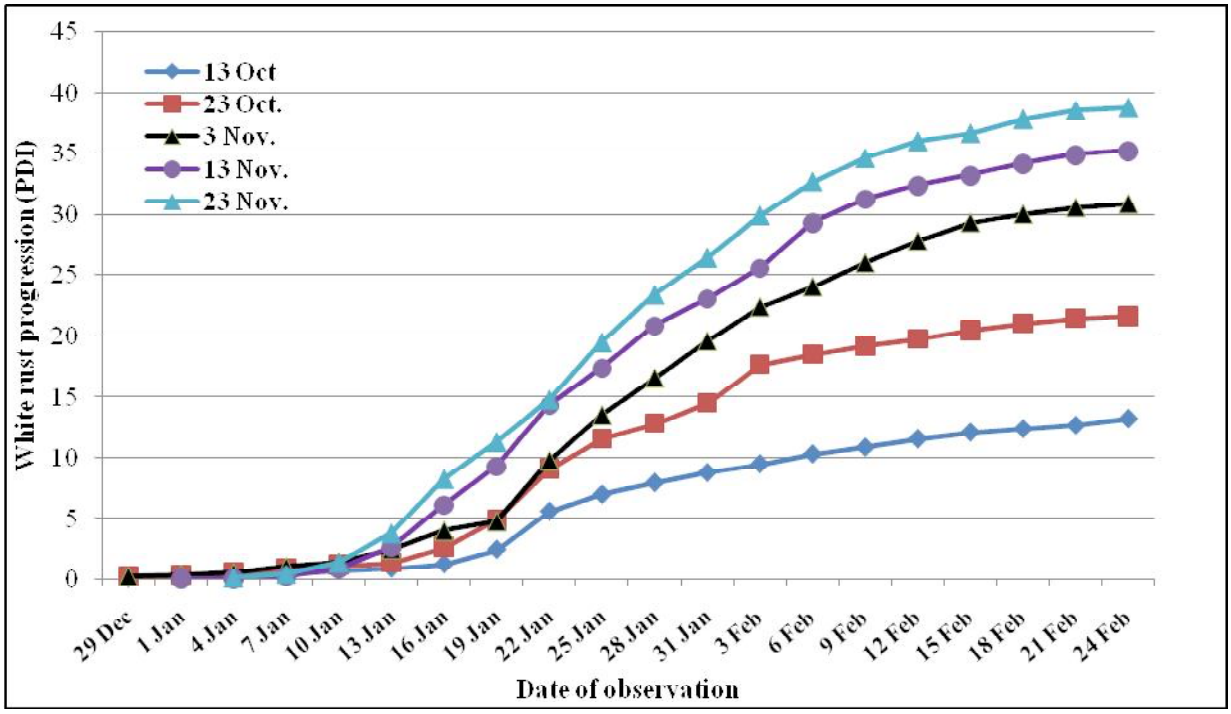
Indian mustard [*Brassica juncea* (L.) Czern & Coss.) is one of the major oilseed crops cultivated traditionally as a pure crop as well as intercrop (mixed crop) in marginal and sub-marginal soils in the eastern, northern and north western states of India. Cool and moist climate of winter months is the major factor for luxuriant growth and productivity of mustard in these states. The existence of low production and productivity in India is due to several constraints comprising both biotic and abiotic stresses. White rust incited by the biotrophic oomycete pathogen *Albugo candida* (Pers. ex. Lev) is the serious fungal disease that causes yield loss of 89.8 per cent in India. The recent reports showed that the losses could be in the range from 17 to 34 per cent (Yadav *et al*., 2011) in India. In India, Indian mustard is sown from September to November, depending on the prevailing temperature and availability of soil moisture for seed germination. Off-season crops are grown in non traditional areas from May to September and this is coupled with harbouring of the fungal pathogen by oilseed *Brassica* crops and alternative hosts could cause carryover of *A. candida* from one crop season to another (Kolte, 1985). Thus, air-borne spores of *A. candida* from the primary source of inoculum may form polycyclic disease (Kolte, 1985). Weather is an important factor in the severity of white rust of Indian mustard, which governs the variability in onset and epidemic of the disease. Epidemiology of white rust in Indian mustard in relation to weather parameter in Uttar Pradesh and Rajasthan (Chattopadhyay *et al*., 2011) was reported in literature and the results showed that late sown crop suffered with more disease. Since, Haryana is the hot spot for this disease; hence the studies on timing of attack of pathogen and disease progression in relation to changing weather conditions has been undertaken for prediction of disease.

The experiment was conducted at Oilseeds research farm, Department of Genetics and Plant breeding during *rabi* 2014-15 and 2015-16. The experiment was carried out with two Indian mustard cultivars *viz*., RH 30 and RH 0749. The experiment was laid out in a randomized block design, replicated thrice, maintaining plot size of 3 rows of 3 m length with row to row spacing of 30 cm and plants were placed 10 cm apart. The seeds of each cultivar were sown in five different dates, starting from third week of October approximately at ten days interval. The observation on disease severity was made on twenty leaves showing initial symptoms in each variety and replication in different dates of sowing. The leaves showing the initial symptoms were tagged and observations on disease severity were recorded starting from the appearance of symptoms at an interval of three days. The leaves were tagged in such a way that, only one leaf was selected from each plant, thus 20 plants were chosen for the observation on disease severity. The white rust severity was scored following revised rating scale (0-6) of Conn's *et al*. (1990) as 0, 1, 2, 3,4,5,6 for 0 (no symptom), 0-5, 5-10, 10-20, 20-35, 35-50 and >50 % leaf area covered by pustule.

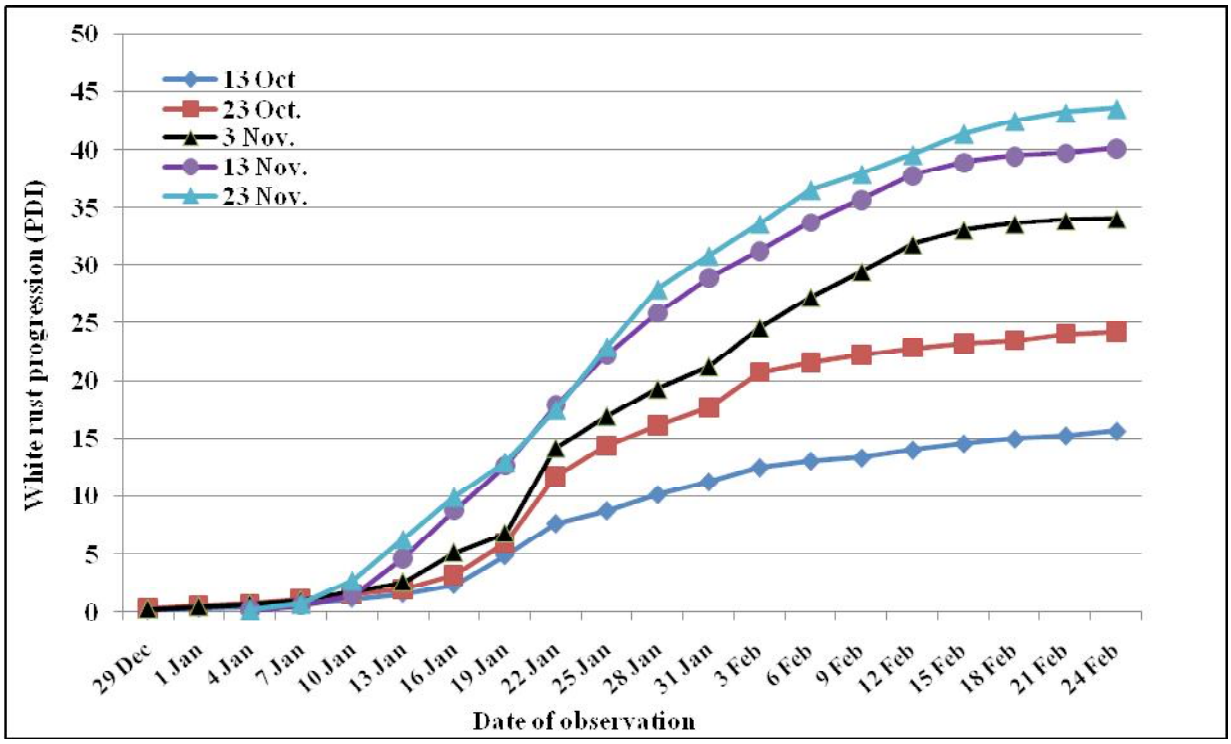
The per cent disease index (PDI) was calculated by using following formula:

$$PDI = \frac{\text{Sum of all the numerical ratings}}{\text{Number of leaves examined x maximum disease grade}} \times 100$$

The data on weather factors such as temperature (maximum, Tmax and minimum, Tmin), relative humidity (morning, RHM and evening, RHE), average vapour pressure (morning, VPM and evening, VPE), evaporation, cumulative rainfall, wind velocity (WS) and duration of sunshine hours (BSS) were obtained from the Department of Agro-Meteorology, CCS HAU, Hisar for both seasons and data of two years pooled. The influence of weather parameters on white rust development was analyzed on marked plants.



Progression of white rust on variety RH 30



Progression of white rust on variety RH 0749

Fig. 1: Progression of white rust of Indian mustard in different dates of sowing during *rabi* 2014-15 and 2015-16.

Onset of white rust disease

It was apparent that the first appearance of white rust varied among the different dates of sowing and which was governed by suitable weather conditions. In first three dates of sowing *i.e.* 13 Oct, 23 Oct, 3 Nov, sown crops, the disease appeared in last week of December (29 Dec) in both RH 30 and RH 0747 (Fig 1). The average weather values during the

Table 1: Correlation matrix between weather parameters and per cent disease intensity in different dates of sowing (pooled data of two years for the two varieties).

	Weather parameters									
Date of sowing	T. Max.	T. Min.	VPM	VPE	RHM	RHE	WS	BSS	Evaporation	Rainfall
13th Oct	-0.636**	-0.189	-0.196	-0.325*	0.124	0.421*	0.062	-0.413*	-0.337	0.421**
23rd Oct.	-0.663**	-0.253	-0.219	-0.391*	0.111	0.394*	-0.113	-0.463**	-0.423**	0.309*
3rd Nov.	-0.696**	-0.232	-0.226	-0.435**	0.042	0.362**	0.079	-0.331*	-0.261	0.558**
13th Nov.	-0.701**	-0.092	-0.121	-0.363*	0.119	0.552**	0.039	-0.491**	-0.465*	0.461**
23rd Nov.	-0.723**	-0.025	-0.015	-0.294*	0.271	0.682**	0.094	-0.603**	-0.419**	0.529**

Significance: *at 5%; ** 1%

initiation of the disease indicated that, sudden fall of temperature (maximum and minimum temperature of 18.4 ^{0}C and 2.7 ^{0}C, respectively) with increased relative humidity (morning and evening RH of 99 %- and 59 %, respectively) in the last week of December favoured the onset of the disease. The initiation of disease delayed by a week in later sown crops, indicating that the pathogen required favourable growth stage of the crop to attack despite the weather conditions were favouring during this period.

The onset and development of disease under natural conditions is influenced by environmental factors, crop growth stage, and the type of the host cultivar and availability of pathogen inoculums.

Progression of white rust in different dates of sowing on variety RH 30 and RH 0749.

The cumulative increase in white rust diseases intensity was recorded during two consecutive years (2014-15 and 2015-16) on staggering dates of sowing and it was observed that, once after the appearance of the disease in the field, the disease progression was slow and non-significant among different observations in all the dates of sowing during the initial four dates of observations *i.e.* from 29 Dec. to 07 Jan on variety RH30. However the disease gained its momentum and progression differed significantly during second week of January (on 10th Jan) in all the dates of sowing (Fig 2). The results showed that per cent disease intensity periodically increased with time in all the dates of sowing. The similar results were also observed on variety RH0749; however three days delayed for disease to attain its significant difference; indicating differential response of varieties to white rust disease.

It was observed that a the increase in white rust intensity was slow and non-significant during initial two weeks of onset of the disease *i.e* till 10 Jan; which was due to availability of lower amount inoculum on few plants at border of field in the form of infection court or pathogen must have required time to acclimatize the host plant surface to gain the momentum. The significant difference in disease intensity was observed after second week of January and which was favoured by prevalence of 2-5 sunshine hours per day, concomitant with lower mean maximum and minimum temperature (14.8-17.7 ^{0}C, 4.9-7.8 ^{0}C respectively) higher relative humidity (95.8-96. 7% and 52.5-53.3 % respectively) with cloudy weather and precipitation must have brought changes in the disease progression; these observations get cognizant from Bal and Kumar (2014) wherein they reported that white rust progression in initial weeks, after onset of disease was slow and non-significant among the observations and later on a significant difference in disease progression was observed.

The differences in disease intensity continued to be significant even after second week of February (till 18 Feb) in both RH30 and RH0749 varieties; however increase in white rust progression was more on late sown crops (crops sown in November) as compared to early sown crops (October sown crops). The maximum increase in disease intensity was recorded during third week of January (16 to 22 January) in both RH30 and RH0749 in all the dates of sowing (Fig 2). During this period, the maximum temperature and minimum temperature ranged from 14.8-17.7 ^{0}C and 4.9-7.8 ^{0}C, respectively, morning and evening RH varied between 96-97% and 52-53%, respectively with 2.1-5.4 sunshine hours with intermittent rainfall and lighter winds during this period might have created the congenial conditions for growth, multiplication and spread of the pathogen. It was apparent from present investigation that, white rust was favoured by low temperature, high morning and evening relative

humidity, low sunshine hours coupled with precipitation during the months of December to January under Haryana conditions. White rust development on *Brassica juncea* under field conditions in relation to environmental conditions in India has been reported by various workers (Lakra and Saharan, 1990). The present findings also corroborate with reports of earlier workers (Lakra and Saharan, 1991); who reported that white rust progression was more during the period between first fortnights of January to first fortnight of February.

The disease attained its saturation in third week of February in both varieties in all dates of sowings and during which the disease progression was very negligible. Among all dates of sowing, the final disease intensity at the end of season was highest on late sown crops *i.e*. on 23 Nov. sown crop in both RH30 (43.58%) and RH0749 (38.72%). The lowest white rust intensity (13.19% and 15.67%, respectively on RH30 and RH0749) on in first date of sowing; indicating that disease severity also increased with delayed sowing. This may be due to fact that delayed sowing coincide with vulnerable growth stage of the crop and favourable weather conditions. The prevalence of low bright sunshine hours (2h day^{-1}) coupled with high morning RH (90%) during early hours of the day and low temperature (>15 ^{0}C) might favoured the rapid progression of disease in late sown crops in both the varieties. The presence of such weather conditions decides the longevity of the white rust attack period and further buildup of inoculum on the crop; which may consequently produces heavy disease infection through its polycyclic nature of spread. The occurrences of higher severity of white rust in late sown crops in the present investigation are in conformity with the reports of previous workers (Lakra and Saharan, 1990; Singh *et al*., 2009; Biswas *et al*., 2011). Thus, under Haryana conditions, it would be advisable to plant the crop in the month of October to enable escape or non-coincidence of the susceptible stage with favorable temperature and humidity factors.

Quantitative relationship between weather factors and white rust development.

The quantitative relationship between the white rust progression and weather variables for different dates of sowing on variety RH30 and RH0749 obtained by performing correlation and multiple regression analysis for pooled data of two years (2014-15 and 2015-16). The data revealed that maximum temperature had significant negative correlation while the minimum temperature had a negative non significant correlation with white rust intensity in all dates of sowing; with white rust progression in all dates of sowing in both RH30 and RH0749. The average vapour pressure morning and evening had a negative relation with disease progression. The white rust progression revealed that, the RH evening has significant positive correlation; while positive non-significant correlation with the RH morning during both seasons on varieties RH30 and RH0749 (Table 1). The sunshine hours and evaporation had negative impact on the progression of white rust while cumulative rainfall was found to favour the white rust progression. The wind speed did not showed consistent relation with white rust development in different dates of sowings. It was clear from the present study that, all the test variables played an important role in the progression of white rust disease; in addition to other unknown factors. In general, white rust progression was positively favoured by the RH and cumulative rainfall whereas temperature, vapour pressure, sunshine hours and evaporation had negative impact on the white rust progression. The results of the present investigation are in conformity with those reported by Singh *et al*. (2009).

Multiple regression equation was developed for the prediction of white rust occurrence from two years pooled data of disease intensity for two varieties and weather variables. The results of multiple regression equation exhibited negative correlation of disease progression with temperature and sunshine hours while positive correlation with rainfall and relative humidity (evening). The contribution of these factors *viz*., maximum temperature, cumulative rainfall, sunshine hours and evening RH on disease development was statistically significant with co-efficient of determination (R^2) as 78%.

Equation: $Y = 36.257 - 0.887TMAX + 0.513RF - 1.016SS + 0.263RH$

(R^2=0.78)

It can be concluded that, the development of white rust on Indian mustard under Haryana conditions was influenced by time of sowing and prevailing weather conditions during the season. The late sown crops suffered more from white rust severity due to coincidence of susceptible flowering stages with higher relative humidity and rainfall; they favoured the significant development of white rust, while; temperature, vapour pressure, sunshine hours and evaporation had negative impact on the white rust progression during the same time. Thus, under Haryana conditions, it would be advisable to plant the crop in the month of October to enable escape or non-coincidence of the susceptible stage with favorable temperature and humidity factors.

REFERENCES

Bal, R.S. and Kumar, A. (2014). Studies on the epidemiology of white rust and Alternaria leaf blight and their effect on the yield of Indian mustard. *African J. Agric. Res*., 9(2): 302-306.

Biswas, C., Singh, R. and Kumar, P.V. (2011). Dynamics of white rust disease in mustard (*B. juncea*) in relation to date of sowing and weather parameters. *Indian J. Agri. Sci*., 181: 1187-1190.

Chattopadhyay, C., Agrawal, R., Kumar, A., Meena, R.L., Faujdar, K., Chakravarthy, N.V.K., Kumar, A., Goyal, P., Meena, P. D. and Shekhar, C. (2011). Epidemiology and development of forecasting models for white rust of *Brassica juncea* in India. *Arch. Phytopathol. Pl. Prot*., 44(8): 751-763.

Conn, K.L., Tewari, J.P. and Awasthi, R.P. (1990). A disease assessment key for Alternaria black spot in rapeseed and mustard. *Can. Pl. Dis. Sur*., 70: 19-22.

Kolte, S.J. (1985). White rust: *In: Diseases of annual edible oilseed crops*, *rapeseed-mustard and sesame diseases*. CRC press, Boca Raton, Florida, USA. 2 (2): 27-35.

Lakra, B.S. and Saharan, G.S. (1990). Role of host resistance and planting time in progression of white rust and yield of mustard. *Indian Phytopathol*., 43: 201-206.

Lakra, B.S. and Saharan, G.S. (1991). Influence of thermo hydro and potential evapotranspiration on white rust epidemic of mustard. *Cruciferae Newsl.*, 15:150-151.

Singh, H., Kaur, P., Kaur, R., Mukherjee J and Bal, S.K. (2009). Influence of meteorological parameters on the incidence and development of white rust and Alternaria blight in mustard (*Brassica juncea* L.) crop in the south-western region of Punjab. *J. Agrometeorol.,* 11(SI): 135-142.

Yadav, D.K., Vignesh, M., Sujata, V., Yadav, A.K., Mohapatra, T. and Prabhu, K.V. (2011). Characterization of Indian mustard (*B. juncea*) indigenous germplasm line BIOYSR for white rust resistance. *Ind. J. Pl. Gen. Resour*., 24: 400-442.

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