To develop of weather base regression predictive models and validated of karnal bunt disease of Haryana, India

anil kumar¹

¹Affiliation not available

August 24, 2021

INTRODUCTION

The fungal seed born disease popularly known as Karnal bunt is generally expressed as a cool winter/spring weather disease in the North. The weather conditions during the susceptible period are critical factors in bunt development. An average temperature range of 18 °C to 22 °C, coupled with high relative humidity (morning) or the day relative humidity, is considered optimum for infection. In the study of various diseases, its appearance in or over the crops, plants, trees and its economical product parts or grains of the crops i.e. wheat, field crops and other which were influenced by the weather condition along with the crucial parameters. The weather fluctuation and variability and environment condition will be play the very crucial role to create the optimum favourable condition and resulted to cause the infestation. Long term weather parameters were analyzed i.e. temperature, relative humidity, radiation and rainfall from 1st to 12th standard meteorological weeks but 6th to 12 SMWs are favored to development of the grain infestation disease. Workneh et al. (2007) studied the weather variables (temperature and rainfall amount and frequency) were collected and used as predictors in discriminant analysis for classifying bunt positive and -negative fields using incidence data for 1997 and 2000 to 2003 in San Saba County. Due to western disturbance in the North West part of the country were received the periodically rainfall to maintained the high level of relative humidity (Singh *et al.*, 2018). The higher level of relative humidity that can be maintained the higher humidity within the crop canopy and favored the fungal growth might be due to the increasing leaf or canopy wetting period. The momentum within the crop canopy will be reduced so higher level of humidity will be maintained. The simple linear regression model showed that the maximum temperature and morning relative humidity had maximum influence on the development of leafhopper population. The stepwise linear regression model was explained the coefficient of determination (R^2) of leafhopper population with the range 40 to 90 per cent in respective year (Janu *et al.*, 2018). sStansbury and McKirdy (2002) reported that there was a strong correlation (r :0.83) between the Humid Thermal Index (HTI) model, which used long-term, average-monthly data, and the rainfall model, which was based on the per cent chance of at least three Suitable Rain Events (SRE) during the susceptible period (August to October). Results suggest that northern wheat growing areas are too hot and dry (HTI<2.2, chance of SRE 15–27%), southern areas are marginal to too cold and/or wet (HTI > 3, chance of SRE 68–97%), eastern areas are marginal to too hot and dry (HTI around 2.2, chance of SRE 24–50%), and western areas are suitable (HTI between 2.2 and 3.3, chance of SRE 41–78%).

MATERIAL AND METHODS

Observational Stations, year data use and site characteristics

For Karnal were used data cropped seasons for Hisar, Karnal, Rewari and Rewari were used for development of multiple regression models, those parameters were significant influence after taking the statically analysis. The collaborative experiments were performed between Department of Plant Pathology and Agricultural Meteorology, CCS HAU, Hisar. The Karnal bunt diseases in percentage (%) analyzed and weather parameters and its analysis performed by Department of Agril. Meteorology. The frequency or number seasonal analyzed

Karnal bund diseases were use (n) number were varies according the data availability and diseases severity was found during the course of study. Daily weather parameters collected from representative agromet observatory of Hisar, Karnal, Sirsa and Bawal through the respective geo-references of met station. The Hisar and Sirsa come under the South West part of Haryana or western agroclimatic zone and it popularly known as per climatic classification as the semi-arid region or agroclimatic region of western Haryana but Rewari is under arid climate (Table 1).

Table 1: Data used, climate, severity and site meteorological references

Stations	Data used	Latitude	Longitude	Altitude (m)	Remarks	Remarks
					Climate	Diseases
Hisar	1980-81 to 2015-16 n=36 season/year	29 ⁰ 10'N,	75 ⁰ 46' E	215	Semi-arid region	Lower,
Karnal	1997-98 to 2015-16, 20 seasons	29 ⁰ 43'N	76 ⁰ 58' E	215	Humid region	Moderate
Rewari	1989-90 to 2015-16, n=27 seasons/year	28 ⁰ 10'N	76 ⁰ 35' E	229	Arid region	Low
Sirsa	n=20 years for Sirsa	29 ⁰ 10'N	75 ⁰ 46' E	215 m	Semi-arid region	Low

The standard statically procedure were followed to development of regression equation of respective stations. Also significant weather relations evaluated from 6 to 12 SMWs at respective station in the state depicted in the Table 2. For the development of regression equation, significant weather parameters used to explain the variability for the karnal bund fungal disease. The various parameters are used to mention below with code, week number and parameters description.

Table 2: Significant weather variable used for development of regression models

Sr. #	Codes	Description
1	RD ₆ , RD ₁₀ , RD ₁₁ & RD ₁₂	Rainy day (RD) of 6 th , 10 th , 11 th and 12 th Standard Meteorological week (S)
2	Tmax ₄ , Tmax ₆ , Tmax ₉ & Tmax ₁₁	Maximum temperature of 4 th , 6 th , 9 th and 11 th SMWs
3	Tmin ₆ & Tmin ₈	Minimum temperature of 6 th & 8 th SMW
4	Rf ₉ & Rf ₁₁	Rainfall of 9 th and 11 th SMW
5	Ep ₆ & Ep ₁₀	Pan evaporation of 10 th SMW
6	SSH ₁₀	Sunshine hour of 10 th SMW
7	WS ₁₁	Wind speed of 11 th SMW
8	RHe ₁₂	Evening relative humidity of 12 th SMW

In the Table 2 mentioned the following weather or dependent weather parameters of independent weather. First evaluated and work out the significant and its relationships of defined parameters during the specific meteorological weeks. Further significant correlation was tested and then regression or multiple regression models was developed using significant meteorological parameters during 6th to 12th SMW (5th February to 25th March) was developed for four station of Haryana.

RESULTS AND DISCUSSION

Data pertaining to average infection (%) of karnal bunt disease of wheat and meteorological parameters of 6th to 12th SMW depicted in Table 1 & 5, for the respective station and were analyzed. The coefficient of correlation obtained between various meteorological parameters and cointifying the weather association on average karnal bunt infection (%) under varying weather condition.

Significant Relationship as Correlation

Long term relationship studied was performed in between weather parameter and karnal bund disease for the respective stations. Data pertaining to average infection (%) of karnal bunt disease of wheat and mete-

orological parameters of 6th to 12th SMW (5th February to 25th March) from 1981-82 to 2012-13 of Karnal station were analyzed for most sensitive crop growth stage corresponding to ear emergence and subsequent crop growth stages. The coefficient of correlation obtained between various meteorological parameters and average karnal bunt infection (%). Rainfall and number of rainy days along with minimum temperature during the 6th SMW to 12th SMWs were the most important weather parameters indicating favorable role in the development of the Karnal bunt disease. Wind speed was also important during this week for the transfer of primary spordia from soil to leaf. Rainfall along with morning and evening relative humidity during 9th SMW indicated favorable role in further multiplication of secondary spordia. Rainfall and rainy days during 10th, 11th and 12th meteorological weeks helped in multiplication of karnal bunt disease in wheat. Rainfall along rainy days and maximum temperature and relative humidity 11th meteorological weeks helped in multiplication of karnal bunt disease in wheat.

Table 3: Long period average prevailed weather conditions funder development and progression of karnal bunt disease percentage (6th to 12th SMWs)

Stations	SMWs	Tmax (°C)	Tmin (°C)	RHm (%)	RHe (%)	WS (km/hr.)	BSS (hr.)	Rain fall (mm)
Hisar	6	21.6	6.5	92.9	56.0	3.6	7.0	1.9
Karnal		21.8	6.2	90.0	48.0	4.52	7.20	5.8
Rewari		21.1	6.3	83.0	52.0	3.70	7.70	10.3
Sirsa		20.8	7.5	82.0	50.0	1.40	5.80	7.1
Average		21.3	6.6	87.0	51.5	3.3	6.9	6.3
Hisar	7	22.4	7.6	92.8	55.2	3.8	6.3	1.9
Karnal		22.8	7.7	90.7	48.9	4.6	7.0	4.4
Rewari		23.1	7.7	82.0	50.0	3.4	7.6	13.5
Sirsa		22.1	8.7	82.0	49.0	2.3	6.1	8.1
Average		22.6	7.9	86.9	50.8	3.5	6.8	7.0
Hisar	8	25.0	10.4	93.4	53.5	3.9	6.4	2.3
Karnal		23.5	7.9	90.2	47.1	5.1	7.6	4.7
Rewari		24.5	8.5	81.0	50.0	3.2	8.0	2.7
Sirsa		22.9	10.4	82.0	52.0	2.4	5.9	4.8
Average		24.0	9.3	86.7	50.7	3.7	7.0	3.6
Hisar	9	25.4	9.5	92.8	49.7	3.5	7.4	2.4
Karnal		24.9	8.7	89.3	43.7	4.7	7.6	8.9
Rewari		26.1	9.0	80.0	48.0	3.8	7.9	7.2
Sirsa		25.0	11.1	79.0	48.0	2.3	6.6	4.2
Average		25.4	9.6	85.3	47.4	3.6	7.4	5.7
Hisar	10	26.2	10.4	90.2	50.6	3.4	7.3	2.9
Karnal		27.3	9.9	87.0	40.1	4.9	7.7	3.4
Rewari		28.3	9.9	79.0	42.0	3.9	8.4	4.5
Sirsa		27.0	11.3	74.0	45.0	2.1	7.4	8.5
Average		27.2	10.4	82.6	44.4	3.6	7.7	4.8
Hisar	11	27.3	11.5	90.3	52.6	4.2	7.7	3.2
Karnal		28.3	11.7	86.7	41.8	5.3	7.6	5.8
Rewari		30.4	11.5	78.0	39.0	3.9	8.8	5.1
Sirsa		28.9	13.7	74.0	45.0	2.9	5.5	2.4
Average		28.7	12.1	82.3	44.6	4.1	7.4	4.1
Hisar	12	29.9	13.1	86.9	41.7	4.0	8.4	3.6
Karnal		29.9	12.8	84.7	37.3	5.6	7.7	3.0
Rewari		32.2	13.5	77.0	34.0	4.3	8.8	0.9
Sirsa		30.2	15.7	69	41.0	2.1	7.1	1.5
Average		30.6	13.8	79.4	38.5	4.0	8.0	2.3

The prevailed weather conditions were evaluated to take the long term average during the 6 to 12 SMWs at four studied location of the state, Haryana which was depicted in the Table 3. The results reveal that the long period average in the respective weekly based weather parameters analyzed and resulted i.e. rainfall amount varies 1.9 to 13.5 mm and 0.3 to 0.7 day, pan evaporation 2.3 to 5.8 mm, average wind speed 1.4 to 5.58 kilometer per hour, relative humidity highest and lowest obtained (morning 69 to 92.8 % & evening 34 to 52 %) and temperature influenced as maximum 20.8°C to 32.2 °C & minimum 6.3 °C to 15.6 °C from 6th to 12 SMWs in the respective stations of state, Haryana which depicted in the Table 3. The 6th to 12th SMWs weather parameters values ranged play significant the conducive condition against for the multiplication & development of karnal disease in the wheat seeds for the respective locations (Table 3). The analyzed results were also seem to the waiting period of wheat leaves, higher days of foggy weathers condition and minimum temperature (especially during night time) quit warmers side or warm night, that were increased the chances of infestation. The significant parameters use to developed the regression models and then used for the prediction of karnal bunt disease depicted in the Table 4.

Table 4: Weather based multiple regression models for karnal bunt disease of four stations

Sr. #	Stations	Data used	Regression equations developed respectively year data used
1	Hisar	1989-90 to 2012-13	$Y = 0.024 + 0.038RF5 - 0.100RD5 + 0.012RF11 - 0.041RD11 + 0.099RD12$
2	Karnal	1980-81 to 2012-13	$Y = -0.282 + 0.042 RD6 + 0.028 Tmin8 + 0.023 RD8 + 0.002 Tmin9 + 0.001 R$
3	Rewari	1997-98 to 2012-13	$Y = 0.921 + 0.039Tmax6 + 0.255RD6 - 0.005RF9 - 0.061 Tmax10 - 0.022RF11 +$
4	Sirsa	1999-2k to 2012-13	$Y = 0.596 + 0.051RD6 + 0.105RD10 - 0.020 Tmax11 + 0.021RF11 - 0.149RD11$

Above multiple regression models were used for prediction of karnal bunt disease for the respective stations for the years 2012-13 and 2017-18 and statistically evaluated the percent deviation over the actual analyzed data. After development of regression equation for prediction of seed born karnal bunt fungal disease with the different weather parameters over the wheat crop during the rabi season (Table 5). The 6th to 12th SMWs were found the suitable and significant with the higher level of coefficient of determination or predictability. The 6th to 12th SMWs were found the suitable and significant with the higher level of coefficient of determination or predictability. Multiple regression model was developed using significant meteorological parameters during 6th to 12th SMW was developed for Sirsa, Karnal, Hisar and Bawal. The significant weather relations evaluated from 6 to 12 standard meteorological weeks at respective station in the state. The variability in occurrence of karnal bunt disease for Hisar zone was explained up to 79% with the help of weather parameters. The variability in occurrence of karnal bunt disease for Rewari zone was explained up to 92% with the help of weather parameters. The long term meteorological data base of four stations predictive regression model development for prediction of seed born karnal bunt fungal disease with the different weather parameters over the wheat crop during the *rabi* season.

Table 5: Observed and predicted Karnal bunt disease for Haryana state

Year	Karnal	Karnal	Karnal	Hisar	Hisar	Hisar	Rewari	Rewari	Rewari	Sirsa	Sirsa	Sirsa
	Pr.	Ob	%D	Pr.	Ob	%D	Pr.	Ob	%D	Pr.	Ob	%D
2012-13	0.207	0.164	-26.2	0.359	0.484	25.8	0.256	0.242	-5.8	0.072	0.068	-5.8
2013-14	0.082	0.063	30.1	0.067	0.043	-55.8	0.324	0.276	-17.4	0.062	0.041	-51.2
2014-15	0.162	0.307	-47.2	0.160	0.198	-46.4	0.391	0.148	29.0	0.275	0.068	30.4
2016-17	0.180	0.164	9.8	0.064	0.065	-1.1	0.173	0.140	23.4	0.027	0.024	12.5
2017-18	0.086	0.086	13.2	0.108	0.100	8.0	0.106	0.101	4.6	0.002	0.003	33.3

Note: Pr.: Predicted, Ob.: Observed, %D: Percentage deviation

The result reveal that shows among the station, over all predictability were ranging from -5.8 to 55.8, but

higher percentage deviation was observed at Hisar and Rewari station as compared to the Sirsa and Karnal, which might be due to variability in the wheat seed disease infection and point value used in the analysis. The prediction and deviation percentage quit higher in the semi-arid agroclimatic condition of western Haryana. The results showed that these regression models predicted the Sirsa and Karnal station for the karnal bunt disease in the state within the acceptable limit (Table 5). Over prediction and higher percentage deviation were observed in the Rewari and Hisar condition, respectively. Model showed more deviation (model over and under predicted) for year 2013-14 and 2014-15 may be due to rainfall amount received above the normal from 6 to 11th SMWs. The results showed that these regression models predicted the Karnal bunt disease in the state within the acceptable limit for the year 2016-17 & 2017-18, except Sirsa station (Table 5).

CONCLUSIONS

The result concluded that among the station, over all predictability ranging and higher predictability were explained at Sirsa station, under semi-arid agroclimatic condition of western Haryana. The 6th to 12th SMWs were found the suitable and significant with the higher level of coefficient of determination or predictability. Multiple regression model was developed using significant meteorological parameters during 6th to 12th SMW was developed for Sirsa, Karnal, Hisar and Bawal. The variability in occurrence of karnal bunt disease for Hisar zone was explained up to 79% with the help of weather parameters. The variability in occurrence of karnal bunt disease for Rewari zone was explained up to 92% with the help of weather parameters. The long term meteorological data base of four stations predictive regression model development for prediction of seed born karnal bunt fungal disease with the different weather parameters over the wheat crop during the *rab*i season. Among the station, over (+/positive) and under predictability (-ve/negative) percent deviation in the semi-arid, arid, humid and per humid agroclimatic condition of Haryana.

REFERENCES

- Janu, A., Dahiya, K. K., Kumar, A. and Jakhar, P. (2018). Weather variables influence on the incidence of leafhopper in transgenic *Bt* . cotton in semi arid region, Hisar. *J. Agrometeorol.*,20(SI): 266-270.
- Singh, R., Singh, R., Karwasra, S.S., Kumar, A. and Choudhary, D. (2018). Climate suitability for karnal bunt (*Tilletia indica*) disease of wheat crop in Haryana. *J. Agrometeorol.*,20(SI-1):184-187.
- Stansbury, C. D. and McKirdy, S. J. (2002). Forecasting climate suitability for Karnal bunt of wheat: a comparison of two meteorological methods. *Australasian Plant Pathology* , 31(1)81-92.
- Workneh, F., Allen, T. W., Nash, G. H., Narasimhan, B., Srinivasan, R. and Rush, C. M. (2007). Rainfall and Temperature Distinguish Between Karnal Bunt Positive and Negative Years in Wheat Fields in Texas. *Ecology and Epidemiology* , 98(1):95-100. doi:10.1094/ PHYTO-98-1-0095