Study on crop-weather calendar of Wheat for eastern plain zone of Uttar Pradesh.

ABSTRACT

An investigation entitled "**Study on Crop-weather calendar of wheat crop for eastern plain zone of Uttar Pradesh"** was carried out at the Department of Agricultural Meteorology, ANDUA&T, Kumarganj, Ayodhya. Crop weather calendar for wheat crop has been prepared for district Sultanpur through the collection of historical weather data of last 20 years (2000- 2020). Crop weather calendar of wheat was formulated by combining the weekly climatic averages and phenological calendar for the crop along with optimum weather criteria needed at different phenological stages of the crop. Climatic normal for wheat crop has been taken form 46th Standard meteorological week to 14th Standard meteorological week (from sowing toharvesting). From the crop weather calendar of wheat crop it was observed that for during seed emergence, T max 25-27^{0}C, T min 11.5-13^{0}C, RHm 92.5-92.8% andRHe 42-49%, at CRI, T max 24-26^{0}C and T min7.5-11^{0}C, and during milking stage of the crop,T max 30-33^{0}C, T min 12.3-14^{0}C, RHm 88-91%, RHe 43% were found conducive for better yield at district Sultanpur. Conducive weather conditions for infestation of army worm were T max 20-29^{0}C and T min 14-8^{0}C, RHm 90-94% and RHe 49-65% and rainfall of 1.5-11 mm from met. no. week 46th to 4th met. week and for leaf blight T max 20-28.5^{0}C, T min 12-17^{0}C, RHm 88-91% and RHe 42-52% from 1st to 10th met. week at booting and milking stage of the crop.

Keywords: Crop-Weather Calendar, Wheat, Climatic Normal.

Wheat (*Triticum aestivum* L.) belongs to the ***poaceae*** family. Wheat production is estimated to increase to a record 109.52 million tons in 2020-21 with an average national productivity of 3424 kg/ha. from 107.86 million tons in the previous year, while the output of coarse cereals is likely to increase to 51.15 million tons from 47.75 million tons. (II Advance Estimates of 2020-21, DAC&FW). Uttar Pradesh has been the largest producer state during 2019-2020 with production of 32.59 million tones followed by MP 19.61 million tons and Punjab 17.57 million tons. The wheat production is distributed in three agroclimatic zones of UP viz. western Uttar Pradesh (3.29 million ha) ,eastern uttar pradesh (5.24 million ha) and central Uttar Pradesh (0.68 million ha). (icar.org.in)

It is sown in mid-October to mid- November and harvested in March- April. Wheat is widely adapted crop. It's grown from temperate, irrigated to dry and high rainfall areas and from warm, humid to dry, cold environments. Wheat is a cool season crop, hence cool weather during vegetative development and warm weather for maturity is deemed ideal for wheat. During the heading and flowering phases, exceedingly high or low temperatures and drought are detrimental to wheat. Wheat production is considerably reduced by temperatures above the

optimum. According to Porter and Gawith (1999), the optimum temperature for wheat is around 20 °C, ranging between 17 °C and 23 °C; plants stop to grow below 0 °C or above 37 °C, and die at around − 17 °C or 47.5 °C. Increased daytime and nighttime temperatures decrease wheat yields in controlled environments (Prasad *et al*. 2008 .)

Detailed information of every important crop on their dates of sowing dates of commencement and duration of general cultural operations, vital periods in their life cycle and their most usual weather demands have in India been presented in a very pictorial form called the Crop Weather Calendar. (Varshneya and Pillai, 2008).

Crop weather calendar may be a comprehensive guide for researcher and farmers. It is a resource that provides information on average weather of every week, planting, sowing and harvesting periods of locally adopted crops in a specific agro-ecological zone.

It also provides information on the sowing rates of seed and planting material and the so the most agricultural practices. This tool supports farmers and agriculture extensionists in taking appropriate decisions on crops and their sowing period, respecting the agro-ecological dimension. It also provides a strong base for emergency/contingency planning of the rehabilitation of farming systems after disasters. (Rao, *et al*. 2015)

The objectives of this study are to find out the suitable climatic normal and the phenophase wise congenial weather for the better yield of wheat crop and to present it on a single sheet of paper, so it can be used by forecasters to issue the appropriate agro-advisory.

MATERIALS AND METHODS

Eastern plain zone UP covers the **10 districts** namely Barabanki, Faizabad, Sultanpur, Jaunpur, Azamgarh, Mau, Ballia, Ghazipur, Varanasi and Sant Ravidas Nagar. Rainfall is adequate with a normal of 1,025 mm. The climate is dry sub-humid to moist sub-humid. Over 70% of the land is cultivated and more than 80% of the cultivated area is irrigated.

Weather data for last twenty years (2000-2020) were collected from Department of Agricultural Meteorology, ANDUA&T, Kuamrganj, Ayodhya and IMD. Weekly climatic normal for standard meteorological weeks (1^{st} - 52^{nd}) for this location were computed. (Table.1) These meteorological data sets were arranged in weekly format for cropping season from the month of sowing to the month of harvest of the crop. The collected weather data of Sultanpur district were arranged and calculated to find out average, summation, maximum and minimum value which was used for further analysis.

Crop weather calendar of wheat crop for district Sultanpur was formulated by combining the weekly climatic averages and phenological calendar for the crop along with optimum weather criteria needed at different phenological stages of the crop. Processing of

data worked on the basis of standard date of sowing recommended for given crops and the standard average duration of crop. The collected weather data was tabulated to find out average value of weather parameters *viz.* Tmin, Tmax, Rainfall, morning RH (RHm), evening RH (RHe) andEvaporation for further analysis. The range of different meteorological parameters for the higher production of wheat crop at district Sultanpur was worked out from the actual meteorological data of high productivity crop year which was collected form the ATIC of ANDUA&T, Kumarganj Ayodhya. Table.2

Table 1. Climatic Normal for Weather Parameters (2000-2020)							
Week/ Weather Parameter	**T min (^{0}C)**	**T max (^{0}C)**	**RHm(%)**	**RHe (%)**	**Rainfall (mm)**	**Evp (mm/day)**	**Bss(hrs.)**
1	6.7	19.1	89.8	63.8	4.7	12.0	4.49
2	6.1	19.3	85.9	61.1	1.1	13.5	4.72
3	7.2	20.8	86.6	57.6	5.2	14.1	5.71
4	7.0	21.3	88.2	56.3	5.3	15.4	7.28
5	7.7	22.8	87.7	53.2	1.3	18.2	6.73
6	8.6	24.5	90.0	52.7	5.7	20.6	7.18
7	9.6	23.5	86.1	51.1	3.5	21.4	8.7
8	10.8	27.0	86.2	46.2	5.5	25.1	8.49
9	11.9	27.8	83.6	43.8	3.6	26.4	8.32
10	12.2	29.5	79.9	42.1	4.2	27.2	8.56
11	13.5	30.6	78.6	40.4	2.5	30.3	8.39
12	14.9	33.2	74.1	34.9	0.4	34.5	8.38
13	16.1	34.0	71.7	30.6	0.4	36.6	8.7
14	17.0	36.3	68.8	31.1	0.7	40.8	8.81
15	19.2	36.3	62.5	28.8	0.8	48.3	8.81
16	21.1	37.9	66.6	32.1	1.4	47.0	9
17	21.7	40.1	62.9	31.4	3.5	50.5	9.15
18	23.0	37.4	69.2	32.8	5.1	48.7	9.34
19	23.8	39.0	67.0	33.5	5.1	52.6	9.3
20	24.0	39.1	69.4	34.7	3.7	54.0	9.18
21	25.6	38.6	70.6	36.7	5.5	52.4	8.41
22	25.4	38.7	69.2	40.2	10.9	51.7	8.6
23	25.9	38.5	73.2	43.8	25.1	51.4	8.13
24	26.5	37.7	72.8	48.1	22.7	47.5	7.24
25	26.7	35.7	80.3	57.7	38.3	41.9	5.69
26	26.7	35.4	82.2	59.6	66.2	37.0	4.57

27	26.5	33.5	85.0	70.2	68.4	32.4	4.89
28	25.8	33.1	87.8	71.3	57.7	36.0	4.11
29	26.0	32.9	87.9	72.5	71.0	31.1	4.85
30	26.3	32.8	88.6	72.4	45.1	29.3	5.68
31	26.2	32.0	87.9	71.7	44.4	29.3	4.92
32	26.4	33.3	85.7	70.6	40.8	32.6	4.95
33	26.1	33.1	90.4	74.7	67.0	27.4	4.38
34	26.2	32.4	89.6	73.4	51.7	31.0	4.45
35	26.0	29.5	89.2	70.1	30.8	33.6	5.42
36	25.8	32.9	86.9	70.2	37.4	31.6	4.59
37	25.6	32.9	89.4	70.1	36.5	32.5	5.06
38	25.0	32.7	89.1	69.7	35.9	31.8	6.07
39	23.8	32.6	88.3	69.1	39.7	30.5	6.52
40	22.9	32.6	86.2	64.7	11.3	32.8	7.17
41	21.0	32.9	85.3	59.8	6.7	32.2	7.5
42	19.2	32.1	86.8	52.6	5.2	31.1	8.19
43	16.9	31.3	87.1	50.9	0.5	28.3	7.69
44	15.4	30.4	87.5	48.3	0.0	27.0	8.26
45	13.9	29.9	89.0	49.6	0.3	25.8	7.89
46	13.2	28.9	88.8	49.2	0.6	25.3	7.37
47	11.6	27.5	85.0	46.5	0.0	23.0	7.14
48	10.5	27.2	87.2	46.7	0.0	21.3	6.8
49	8.9	25.4	87.9	47.9	0.0	30.9	6.85
50	8.7	24.0	88.5	53.4	2.0	19.7	6.59
51	7.3	22.2	89.9	56.7	0.0	22.2	5.88
52	6.6	22.2	91.2	58.3	1.4	30.2	5.77

Table 2. Highest Productivity Year for wheat at Sultanpur

Year	2015	2016	**2018**	2020
Productivity of wheat qha^{-1}	286.49	261.03	**354.71**	322.66

The data on weather condition favorable for incidence of pest and nature of weather warnings were collected from the Entomology Department of ANDU&T Kumarganj Ayodhya. The investigation is based on data collection of pest investigation on wheat and weather and averaged over last 5 years.

Structure of crop-weather calendar

Structure of crop weather calendar consists of main three parts viz: **upper part**, which contains the location specific weather data for the crop growing season, **middle part** which shows the typical life history of the crop in the form of diagram. Important "growth phases" related to the crop like sowing, germination/ emergence, transplanting (in the case of rice), vegetative growth, flowering, grain formation and maturity period etc. are indicated. In addition, suited to the above acquaintance, the middle part of the calendars revealed the compatible meteorological condition for the crop (stage-wise or whole crop growth period) which will lead towards high yield of the crop. In the **bottom part** favorable weather conditions for the incidence of pest and diseases are reported. (Fig.1)

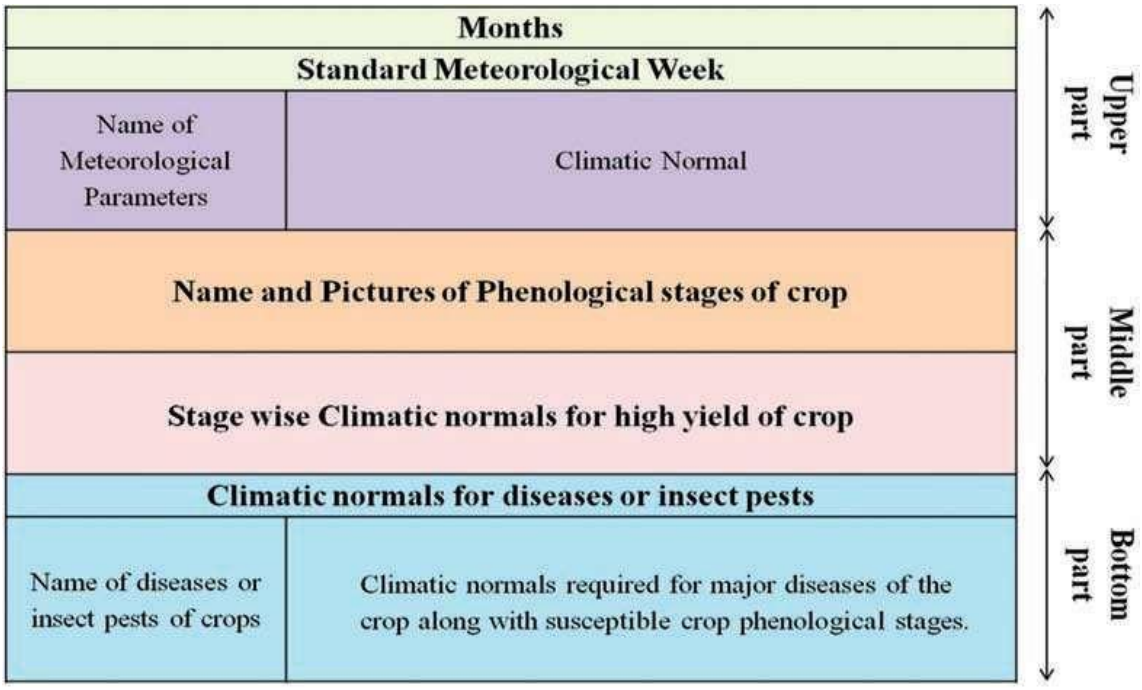

Fig 1: Structure of crop weather calendar

RESULTS AND DISCUSSION

Crop Weather Calendar for Wheat (District Sultanpur)

Climatic normal for Wheat at Sultanpur

Climatic normal for wheat crop has been taken form Standard meteorological week 46th to 14th met. week (from sowing to harvesting). The highest normal rainfall (5.43 mm) was found during 2nd met. week followed by 5.33mm during 3rd met. week. The highest normal T max (36^{0}C) and T min (16.9^{0}C) were found during 14th week. Highest morning RH (RHm) was during 52nd week (91%) and minimum evening RH (RHe) found during 13th week (30%)(Fig. 2).

Phenophase-wise weather for better yield for wheat at district Sultanpur

Wheat seed had taken 6-7 days to emerge. During seed emergence, T max 25-27^{0}C, T min 11.5-13^{0}C, morning RH (RHm) 92.5-92.8% and evening RH (RHe) 42-49% were found conducive for better yield. The optimum temperature range for the early growth stages of wheat is lower than the threshold forthe later growth stages because wheat production can be considerably reduced by temperatures above the optimum. Narayanan *et al*. 2015 also reported that Increased daytime and nighttime temperatures decrease wheat yields in controlled environments.

At CRI stage of the crop, T max and T min 24-26^{0}C and 7.5-11^{0}C, respectively, and at tillering stage T max 15-23^{0}C, T min 5-3.5^{0}C, morning RH (RHm) 94-97%, evening RH (RHe) 47-48% and BSS >4 hrs/day were found conducive for district Sultanpur. During milking stage of the crop, T max 30-33^{0}C, T min 12.3-14^{0}C, morning RH (RHm) 88-91%, RHe 43% and BSS>7.5 hrs./day and while during dough stageof the crop T min(15-18^{0}C), T max 30^{0}C, RHm 82-85% and BSS more than 8 hrs./day were found conducive for better yield. Cold weather during vegetative phase and warm weather during maturity is desirable for wheat. Long periods of heat stress (above 35^{0}C) conditions in wheat crop during crown root initiation, flowering, and grain filling stages can cause significantyield reduction and may lead to total crop damage. Similar responses to high night temperature have been found under field conditions from stem elongation to anthesis (García *et al*. 2015) and from post-anthesis to maturity (García *et al*. 2016). (Fig.2)

Congenial weather requirements infestation of insect and diseases of Wheat at Sultanpur

T max 20-29^{0}C and T min 14-8^{0}C, RHm 90-94% and RHe 49-65% and rainfall of 1.5-11 mm from met. no. week 46th to 4th met. week and T max 20-28.5^{0}C, T min 12-17^{0}C, RHm 88-91% and RHe 42-52% from 1st to 10th met. week at booting and milking stage, were found conducive weather conditions for army worm with no of larva/plant ranging from 0.51-0.57%

(Table:3) and leaf blight with disease intensity ranging from 9.8%-34.5% (Table:4), respectively,in wheat crop at district Sultanpur (Fig.2). It is clear from the Table 4 that 9.8% disease intensity of the leaf blight was found in met. Week 1st with max temperature 19.2^{0}C while the intensity reduced to 6.45% with decease in max temperature (18.7^{0}C). The table also denotes that as the temperature increases with increase in rainfall from 3rd met week to 10th met week the disease intensity of leaf blight also increases. Similar results are also concluded by Devi *et al*, 2017.

Table:3. Weather Parameters for Army Worm of Wheat (Averaged over 5 years)

Std. MET. Week No.	T max (^{0}C)	T min (^{0}C)	RHm %	RHe %	RF (mm)	No. of larva/plant %
46	29.1	14.0	90.9	49.5	1.5	0.51
47	27.5	11.2	88.8	43.9	0.0	0.52
48	28.8	12.3	90.5	49.9	0.0	0.54
49	24.0	9.9	93.5	54.2	0.0	0.59
50	23.1	9.4	88.1	54.5	3.7	0.3
51	21.8	6.6	92.1	57.8	0.0	0.32
52	20.8	6.5	94.0	63.2	0.0	0.38
1	19.2	7.9	93.2	65.4	1.8	0.4
2	18.7	6.3	91.9	62.1	1.1	0.46
3	20.0	6.6	93.9	60.4	3.5	0.52
4	21.6	7.9	91.8	59.2	11.3	0.57

Table: 4. Weather Parameters for Disease Intensity of Leaf Blight (Averaged over 5 years)

Std. MET. Week No.	T max (^{0}C)	T min (^{0}C)	RHm %	RHe %	RF (mm)	Leaf blight Disease intensity %
1	19.2	7.9	93.2	65.4	1.8	9.8
2	18.7	6.3	91.9	62.1	1.1	6.45
3	20.0	6.6	93.9	60.4	3.5	19.35
4	21.6	7.9	91.8	59.2	11.3	17.1
5	22.7	7.9	90.9	54.6	0.5	20.25
6	23.4	7.9	91.2	50.4	1.5	5.9
7	24.7	9.5	87.7	50.4	0.5	6.3
8	27.4	12.0	87.7	47.2	9.2	20.6
9	27.2	12.9	88.5	47.8	8.3	40.7
10	28.8	12.6	85.1	49.1	10.2	34.5

CROP WEATHER CALENDAR

CROP NAME: WHEAT **DURATION : 125-130 DAYS** **STATE: UTTAR PRADESH** **DISTRICT: SULTANPUR**

CLIMATIC NORMAL

MONTHS	NOVEMBER			DECEMBER				JANUARY				FEBUARY				MARCH				APRIL	
Std Weeks	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T Max. (^{0}C)	28.9	27.5	27.1	25.4	23.9	22.1	22.2	19	9.2	20.8	21.3	22.8	24.4	23.4	27	27.8	29.5	30.6	33	33.9	36.2
T Min (^{0}C)	13.1	11.5	10.4	8.9	8.6	7.3	6.5	6.7	6	7.1	6.9	7.6	8.5	9.6	10.7	11.9	12.1	13.5	14.9	16	16.9
RHe (%)	49.2	46.5	46.6	47.9	53.3	56.6	58.2	63.7	61	57.6	56.2	53.1	52.6	51.1	46.2	43.7	42.1	40.3	34.8	30	31
RHm (%)	88.8	85	87.1	87.9	88.4	89.8	91.1	89.8	85.8	86.6	88.2	87.6	87	86.1	86.2	83.6	79.8	78.5	74.1	71	68.8
Rain(mm)	0	1.58	0.53	2.43	1.42	3.36	2.88	1.9	5.43	5.33	0.18	1.55	3.83	3.58	2.15	2.21	0.96	1.31	1.76	1.73	0.94
evp (mm)	25.3	23	21.3	30.9	19.7	22.2	30.2	12	13.5	14.1	15.4	18.2	20.6	21.4	25.1	26.4	27.2	30.3	34.5	36.6	40.8
BSS (hr/day	7.37	7.14	6.8	6.85	6.59	5.88	5.77	4.49	4.72	5.71	7.28	6.73	7.18	8.7	8.49	8.32	8.56	8.39	8.38	8.7	8.81

Phenophasewise weather for better yield

Phenophase	EMERGENCE	C.R.I	TILLERING	JOINTING	EAR EMER	FLOWERING	MIKING	DOUGH	MATURITY
Duration (day)	(6-7)	21	(21-24)	(19-21)	(19-21)	(11-13)	(11-14)	(16-19)	(9-11)
T Max. (^{0}C)	25-27	24-26	15-23	13-21	21	24	33-30	30-32	30
T Min (^{0}C)	11.5-13	7.5-11	5-3.5	5.9-4.8	7.2-5	8.1-7.2	12.3-14	13	15-18
RHe (%)	42-49	45-49	47-48	50-53	45	43	52-42	34	23-25
RHm (%)	92.5-92.8	92.8-92.4	94-97	96-97	91-95	88-91	92	80-81	82-85
WS (kmph)		1.3-1.8	2-2.8	2.3-2	2.7-4.1	4-2.2	4-3.5	3.3-3.6	7.3-4.8
BSS (hr/day)		>6	>4	>5.5	>6	>7.5	>7.5	>7.5	8.5
Rain (mm)		0	0	1	0	0	0	0	0
Eva (mm		11.5-15	11-12.7	12.5-15	17	22-20	23	24	28-26

Congenial weather for pest/

Army Worm T Max. 20-29^{0}C, T Min. 8-14^{0}C ,RHm 90-94%, RHe 49-65%, RF 1.5-10mm

Leaf Blight max 20-28°C, T Min 12-17°C, RHm 88-91%, RHe 42-52%

Fig 2. Crop Weather Calendar for Wheat

CONCLUSION

Crop weather calendar of wheat crop contains a detailed information on wheat crop regarding its climatic requirements from sowing of crop to till harvesting of crop with additional information about the favorable weather conditions of major attacking pest and disease pf wheat viz. army worm and leaf blight. Crop contingency plans and Agromet advisory services are variety of the measures to tackle this sort of situations which requires understanding of the crop phenology and effect of weather parameters on crop growth. Corp weather calendar assumes great importance in this scenario. The crop weather calendars visiting be useful to crop insurance personnel in identifying critical stages and appropriate weather indices. It will be of immense use in preparing Agromet advisory bulletins, crop contingency plans and development of insurance products.

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