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Studies of the relationship between weather parameters and yield of Potato, Maize and Toria crops in different districts of Chhattisgarh

Ranjit Singh, GK Das, Khilesh Kumar Sahu and Mukesh Pradhan

Abstract
The district wise area, production and productivity of potato, maize and toria crops of 15 years (2004-05 to 2018-19) has considered for study. Potato crop data have been collected from Directorate of Horticulture Chhattisgarh Raipur were as maize and toria crops data have been collected from the Directorate of Land Record Government of Chhattisgarh Indirawati Bhavan, Raipur (C.G.). Potato and toria crop that are grown during *rabi* season and maize crop grown during *kharif* seasons of 16 districts of Chhattisgarh. The study used weekly weather data (SMW (Standard Meteorological Week)) collected from the Department of Agrometeorology I.G.K.V. Raipur for the years 2004-05 to 2018-19 for five weather variables: Maximum Temperature (TMAX), Minimum Temperature (TMIN), and Relative Humidity morning (RH1), Relative Humidity evening (RH2), Sunshine hours (SSH), and Rainfall (RF). Keeping in view the objectives set out for the study, following methods have been used. The data are analyzed by using software like SPSS (Statistical Package for Social Science), Weather Cock and MS-EXCEL. Results showed that RH negatively affect the planting to emergence & tuber bulking stage of potato crop while sunshine hours & RH were positively affect the plant senescence stage in most of the districts. In maize crop, the impact of SSH was negatively correlated during vegetative, tasseling/silking and physiological maturity stage while RH was positively correlated with vegetative stage. Positive effect of TMIN was observed during grain filling stage in most of the maize growing districts. SSH was negatively affects the vegetative, reproductive and maturity stages of toria crop, while TMIN and RH were positively correlated with reproductive and maturity stage. RF was also found positively correlated with reproductive and maturity stage in 9 districts of Chhattisgarh.

Keywords: Relationship or correlation, Potato, Maize and Toria yield, weather parameters

Introduction
The potato (*Solanum tuberosum* L.) is India's most significant vegetable crop, called the "king of vegetables." potatoes are nutritionally superior to other vegetables and they're a short-season crop that produces more dry matter, edible energy, and edible protein in a shorter period of time than cereals like rice and wheat. It is a tropical South American native. India is the world's second-largest potato grower followed by China. Globally, India ranks 2nd in area and production. The area and production of potato in India is estimated around 2141.72 thousand ha. with production of 51310.01 thousand tones and average productivity of 23.95 mt./ha. In Chhattisgarh, potato is considered as an important cash crop. It is mainly cultivated in some parts of Surguja, Bilaspur, Raigarh, Jashpur and Koria districts with a total area of 44.87 thousand ha. and production of 694.61 thousand tones with an average productivity of 15.48 mt/ha. (Anonymous, 2019a) [1].

Maize (*Zea mays* L.) 2n = 20 belongs to the poaceae family and is known as the "queen of cereals" across the world. It is the third most important food crop after rice and wheat. Maize can be grown in a range of agro-climatic zones, from severe semi-arid to sub-humid and humid climates (Joshi *et al.* 2005) [6]. Globally, China is leading country in area and followed by USA and India's rank is 4th, while in production USA stand first with production of 392450.84 thousand tones followed by china 257173.9 thousand tones. India's rank is 7th in global production. The area under maize in India is 9027.13 thousand hectare and production of 27715.10 thousand tones with average productivity of 30.7 q/hectare in season (2018-19). The total area in the Chhattisgarh state is 118.39 thousand hectares, with 296.33 thousand tones productions. The average productivity is about 25.03 q/hectare in *kharif* season. It is grown throughout the state but dominant districts are Surguja, Bastar, Kanker, Koria and Jashpur respectively. (Anonymous, 2019b) [1].

The average annual rainfall requirement of maize crop is 500-1000 mm. How over it can be grown in >1000 mm rainfall subject to there will be no stagnation of water in the root zone. If rainfall is less than their requirement supplementary irrigation is also required. In hot and dry conditions, the grain of the maize plant ripens faster. The maize plant grows in temperatures ranging from 21°C to 27°C, however it can withstand temperatures up to 35°C. Maize is highly sensitive to frost, although it grows well in frost-free regions. The optimum soils for its effective cultivation are fertile, well-drained alluvial or red loamy soils that are free of coarse debris and high in nitrogen. Maize grows best on well-drained plains, but it may also be found in mountainous places.

Toria belong to family cruciferae and genus *Brassica*. Toria (*Brassica spp.*) is the major *rabi* oilseed crop of India. It is also kown as Rai, Rapeseed-Mustard, Mohari, Tikkiya, Sarson in different region of India. Its seeds are also used to flavour curries and vegetables and are used as condiments in pickling. India is one of the largest toria growing countries in the world, occupying the second position in area and the third position in production after the Canada and China. The total area in the country is (6123.93 thousand hectare) with production of (9255.66 thousand tones) and average productivity is 15.11 q/hectare. (Anonymous, 2019c) [3]. It is grown almost all parts of Chhattisgarh but important districts are Surguja (83150 Mt), Jashpur (30080 Mt), Koria (21080 Mt), Dhamtari (17385 Mt) and Bastar (16536 Mt) are the total area in the state is 42.01 thousand hectare with production of 17.60 thousand tones and average productivity of 4.19 q/hectare. (Anonymous, 2018) [4].

Toria is a rabi season crop sown during October-November and harvest during March-April. Crop requires a temperature range of 18-25°C, low humidity, and almost no rain during flowering. For optimum development, it requires high temperatures during early growth phases and cool weather and a clear sky during the reproductive period, since overcast weather encourages the spread of insect pests. The major abiotic stressors that affect mustard crop productivity are drought, heat stresses, soil salinity, and frost. Due to unfavourable impacts on yield components, yield reductions under moisture stress (drought) varied from 17 to 94 percent in Indian mustard (Prasad, 2014) [9]. As a result, a steady supply of moisture is necessary. Because the optimal temperature for vegetative development is 30°C, increasing the temperature range or lowering the temperature lengthens the vegetative period, resulting in lower production (Venkataraman and Krishnan, 1992) [10].

Materials and Methods

Description of the study area

Chhattisgarh is situated between 17° 46 N and 24° 06 N latitude and 80° 15 E and 84° 24 E longitude in the country's east central region. It is bounded in the north and east by Uttar Pradesh and Jharkhand, on the east by Orissa, on the south by Telangana and Andhra Pradesh, and on the west by Madhya Pradesh and Maharashtra. The total geographical area of the state is about 135,194 km^2 (13.50) million hectares out of which 5.6 million hectare belongs to the grass cultivable land.

In Chhattisgarh cropping intensity is 135%. The climate of the state is dry sub-humid type. The Chhattisgarh state has devided in to three agroclimatic zones *viz*., Chhattisgarh plains, Bastar plateau and Northern hills. The study was carried out in 16 districts of Chhattisgarh state, which are: Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kabirdham, Bastar, Kanker, Dantewada, Bilaspur, Janjgir, Korba, Raigarh, Jashpur, Surguja and Koria districts.

Yield data

The district wise area, production and productivity of potato, maize and toria crops of 15 years (2004-05 to 2018-19) has considered for study. Potato crop data have been collected from Directorate of Horticulture Chhattisgarh Raipur were as maize and toria crops data have been collected from the Directorate of Land Record Government of Chhattisgarh Indirawati Bhavan, Raipur (C.G.). potato and toria crop that are grown during *rabi* season and maize crop grown during *kharif* seasons of 16 districts of Chhattisgarh.

Weather data

The study used weekly weather data collected from the Department of Agrometeorology I.G.K.V. Raipur for the years 2004-05 to 2018-19 for five weather variables: Minimum Temperature, Maximum Temperature, Relative Humidity morning, Relative Humidity evening, Sunshine hours, and Rainfall (C.G.).

Statistical tools used in the analysis

Keeping in view the research set out for the study, following methods have been used. The data are analyzed by using software like SPSS (Statistical Package for Social Science), Weather Cock and MS-EXCEL will be used.

Results and Discussion

Relationship or correlation between weather parameters and Potato yield for different districts of Chhattisgarh.

The correlation between weather parameters and potato yield was carried out to assess the impact of different parameters prevailed during the crop season for the different stages which were significant in making use of the weather resources for the production of potato yield are considered. The correlation between weekly weather parameters and yield of potato crop has been established. The length of each growth stage is greatly influenced by maximum temperature, minimum temperature, relative humidity morning (RH1), relative humidity evening (RH2), sunshine hours and rainfall. The comprised of different districts correlation matrix for the potato yield and weather parameters for *rabi* season *i.e.* from 44th SMW (planting emergence stage) to 7th SMW (plant senescence stage) was developed.

Table 1: Generalized growth stages of Potato crop

S.N.	Stages	SMW
1.	Planting to emergence	44-46
2.	Tuber initiation	47-50
3.	Tuber bulking	51-2
4.	Plant senescence	3-7

Table 2: Relationship or correlation between planting to emergence stage in Potato crop

S.N.	Districts	Tmax (°C)	Tmin (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur			-(46)*			
2.	Mahasamund	+(47)*		-(44)**,(45)*	-(45)**	+(45)**	-(46)*
3.	Durg		+(44)**,(45)*		+(44)*		
4.	Bastar			+(44,45,46,47)*	-(47)**		
5.	Kanker				-(45)*	+(44)*	-(44)**,(45)*
6.	Janjgir	+(47)*					
7.	Korba	-(45)*					
8.	Raigarh		+(44)*, -(46)*		+(44)*		
9.	Jashpur			-(46)**			

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 3: Relationship or correlation between tuber initiation stage in Potato crop

S.N.	Districts	Tmax (°C)	Tmin (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Mahasamund			-(51)*			
2.	Bastar			+(48)*	-(48)*		
3.	Kanker	+(48)*					
4.	Dantewada		+(48)*				
5.	Bilaspur		+(49)**				
6.	Korba				-(49)*		
7.	Surguja				+(51)*		
8.	Koria	+(50)*					-(49)*

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 4: Relationship or correlation between tuber bulking stage in Potato crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Mahasamund				-(52, 3)*		-(52)*
2.	Durg					+(52)*	
3.	Rajnandgaon	-(52)*	-(52)*				
4.	Kabirdham					+(52)**	
5.	Bastar		+(52)*	+(52, 2)*	-(52, 1)*,(2)**		
6.	Kanker				-(3)*		
7.	Dantewada		+(1)**			-(1)**	
8.	Bilaspur		-(1)**	-(1, 2, 3)*	-(1)*	+(1)**	-(1)**
9.	Janjgir		-(52)*				
10.	Korba					+(52)*	
11.	Surguja			+(52)*			
12.	Koria		-(2)*			-(1)*	-(2)**

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 5: Relationship or correlation between plant senescence Stage in Potato crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur					-(4, 6)*	
2.	Dhamtari		-(6)*				
3.	Durg	-(7)**			+(7)**		+(7)*
4.	Rajnandgaon	+(6)*			-(6)*	+(6)*	-(6)**
5.	Kabirdham	-(7)*					-(5)*
6.	Bastar		+(6)*	+(5)*	-(4, 6)*		
7.	Kanker	-(7)*		-(5)*	-(4, 5)*		
8.	Dantewada					-(4)*	
9.	Bilaspur			-(5)*		+(4, 5)*	
10.	Janjgir				+(7)**	-(7)**	
11.	Jashpur	-(5)**			+(4)*,(5)**		+(5, 6)**
12.	Surguja	+(6)*	+(7)**		-(6)**		
13.	Koria			+(4)*			

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Relationship or correlation between weather parameters and Maize yield for different districts of Chhattisgarh.

The correlation between weather parameters and maize yield was carried out to assess the impact of different parameters prevailed during the crop season for the different stages which were significant in making use of the weather resources for

the production of maize yield are considered. The correlation between weekly weather parameters and yield of maize crop has been established. The length of each growth stage is greatly influenced by maximum temperature, minimum temperature, relative humidity morning (RH1), relative humidity evening (RH2), sunshine hours and rainfall. The comprised of different districts correlation matrix for the maize yield and weather parameters for *kharif* season *i.e.* from 24th SMW (germination stage) to 41th SMW (physiological maturity stage) was developed.

Table 6: Generalized growth stages of Maize crop

S.N.	Stages	SMW
1.	Germination	24
2.	Vegetative	25-30
3.	Tasseling/Silking	31-32
4.	Milking/Kernel development	33-35
5.	Grain filling	36-39
6.	Physiological Maturity	40-41

Table 7: Relationship or correlation between germination stage in Maize crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Janjgir		-(24)*				

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 8: Relationship or correlation between vegetative stage in Maize crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Mahasamund			+(29)*	+(28)*		
2.	Durg					+(26)*	
3.	Bastar	+(30)*				-(28, 29)*	+(29)**
4.	Kanker	+(30)*				-(28)**	+(29)*
5.	Dantewada				-(26, 28)*		
6.	Bilaspur	-(30)*			+(28)*	-(26,28,30)*	
7.	Janjgir		-(27)*			-(26)*	
8.	Korba	-(30)**	-(27)*			-(28, 30)**	
9.	Raigarh	-(30)*				-(27, 28)*	+(25)*
10.	Jashpur	-(30)**			+(30)*	-(30)*	
11.	Surguja	-(30)**			+(30)*	-(30)**	
12.	Koria				+(30)*	-(30)*	

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 9: Relationship or correlation between tasselling/silking stage in Maize crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Kanker	+(31)*					
2.	Korba	-(32)*				-(31)*	
3.	Jashpur					-(32)*	

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 10: Relationship or correlation between cob development stage in Maize crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Durg		+(34)*				
2.	Bilaspur			-(33)*	+(35)**	-(35)*	
3.	Janjgir			-(34)*	+(35)*	-(35)*	
4.	Raigarh			-(33,34)**,(35)*	+(35)**		
5.	Jashpur						+(35)*
6.	Surguja						+(35)*

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 11: Relationship or correlation between milking/grain filling stage in Maize crop

S.N.	Districts	Tmax (°C)	Tmin (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur		+(39)**				
2.	Mahasamund		+(39)**	+(38)**			
3.	Dhamtari			+(38)**			
4.	Durg			+(38)*			
5.	Rajnandgaon		+(39)*				
6.	Bastar		+(39)*		-(36)**		
7.	Kanker				-(36)*		
8.	Bilaspur		-(36)*				
9.	Raigarh			-(37)*	+(38)*		

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 12: Relationship or correlation between physiological maturity stage in Maize crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur					-(41)**	
2.	Mahasamund					-(41)*	
3.	Dhamtari					-(41)*	
4.	Kabirdham	-(41)**					
5.	Bastar					-(41)*	+(41)*
6.	Kanker					-(41)*	
7.	Dantewada				-(40)*	-(41)**	
8.	Korba	-(41)**					
9.	Raigarh			-(40)**,(41)*			
10.	Jashpur	-(41)**			+(41)*		

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Relationship or correlation between weather parameters and Toria yield for different districts of Chhattisgarh

The correlation between weather parameters and toria yield was carried out to assess the impact of different parameters prevailed during the crop season for the different stages which were significant in making use of the weather resources for the production of toria yield are considered. The correlation between weekly weather parameters and yield of toria crop has been established. The length of each growth stage is greatly influenced by maximum temperature, minimum temperature, relative humidity (morning), relative humidity (evening), sunshine hours and rainfall. The comprised of different districts correlation matrix for the toria yield and weather parameters for *rabi* season *i.e.* from 46th SMW (seedling stage) to 11th SMW (physiological maturity stage) was developed.

Table 13: Generalized growth stages of Toria crop

S.N.	Stages	SMW
1.	Seedling	46-48
2.	Vegetative	49-1
3.	Reproductive	2-7
4.	Maturity	8-11

Table 14: Relationship or correlation between seedling stage in Toria crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Rajnandgaon			-(46)**			
2.	Bastar	+(48)*	+(47)*		-(46)*		
3.	Dantewada				-(46)**		
4.	Bilaspur				+(47)*	+(46)*,(47)**	
5.	Janjgir					+(46)**,(47)*	
6.	Korba					+(47)**	
7.	Raigarh			-(46)*			
8.	Jashpur			+(47)*			

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 15: Relationship or correlation between vegetative stage in Toria crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur			-(50)*			
2.	Mahasamund		+(1)*				
3.	Durg			-(50)**		-(51)*	+(50)*
4.	Rajnandgaon			-(52)*			
5.	Kabirdham					-(1)*	
6.	Bastar		+(49, 50)*			-(52, 1)*	
7.	Kanker		+(52)*, (1)**			-(52, 1)*	
8.	Dantewada	+(1)*	+(52)*,(1)**		-(49)*	-(52, 1)**	+(1)*
9.	Bilaspur						+(52)*
10.	Korba						+(52)*
11.	Raigarh		-(52)*		+(50)*		
12.	Jashpur					-(52, 1)*	
13.	Surguja					-(50,52)*,(1)**	
14.	Koria				+(1)*	-(1)**	

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 16: Relationship or correlation between reproductive stage in Toria crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur					-(3, 7)**	
2.	Mahasamund				+(7)*	-(3)*,(7)**	
3.	Dhamtari				+(7)**	-(3, 7)*	

4.	Durg				+(3)*	-(3, 7)**	+(3)*
5.	Rajnandgaon			+(7)*			
6.	Kabirdham	-(2)*		+(7)*			
7.	Bastar		+(7)**	-(5,6,7)*	-(4,6)*,(5,7)**	-(2,4)*,(7)**	
8.	Kanker					-(5)*	
9.	Dantewada	+(6)*	+(4,5)*			-(4,5)*	
10.	Bilaspur				+(3)**	-(2)*	
11.	Janjgir				+(3)**	-(2)*	
12.	Korba	-(2)*					
13.	Raigarh					-(3)*	
14.	Jashpur		-(5)*	+(2,4,5)*,(3)**	+(3)*	-(3,7)*	+(3)*
15.	Surguja				+(3)*	-(2)*,(3,7)**	+(3)*
16.	Koria	-(2)*		+(2,5,7)*	+(3,7)*	-(7)*	

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

Table 17: Relationship or correlation between maturity stage in Toria crop

S.N.	Districts	TMAX (°C)	TMIN (°C)	RH 1 (%)	RH 2 (%)	SSH (hr)	RF (mm)
1.	Raipur		+(11)*		+(9)*	-(9)*	+(9)*
2.	Mahasamund		+(11)*			-(9)*	
3.	Dhamtari	-(9,10)*		+(9)*	+(9)*		
4.	Durg					-(9)**	
5.	Rajnandgaon		+(11)**				
6.	Kabirdham	-(9)*	-(10)*				
7.	Bastar	+(11)*			-(8,11)**		
8.	Kanker	-(9)*					
9.	Bilaspur		-(10)*		+(9,11)*		+(9)*
10.	Janjgir				+(11)*		+(9)*
11.	Korba					-(9,11)*,(10)**	+(9)*
12.	Raigarh					-(9,10)**	+(9)*
13.	Jashpur			+(8,9)*			+(9)*
14.	Surguja			+(8)*,(9)**	+(11)**	-(8,9,11)**	+(9)*
15.	Koria			+(8)*,(9)**	+(11)*		+(9)*

() = Bracket value is SMW (Standard Meteorological Week), + = Positive relationship or positive correlation, - = Negative relationship or negative correlation, ** = highly significant at 1% level, * = Significant at 5% level.

The analysis of the effect of weather parameters on crop yield revealed that positively and negatively correlation. Relative humidity (negatively/positively) and sunshine hours positively correlated with potato yield but sunshine hours, maximum temperature was negatively and relative humidity & mimimum temperature was positively correlated with maize yields. While toria yield, was negatively correlated with sunshine hours but positively correlated with minimum temperature, relative humidity and rainfall.

Lal *et al*. (1998) [7] reported the analysis of effect of weather parameters on crops yields revealed that most of individual weather parameters did not show any significant impact on crops yields. However, combined weather parameters showed significant effect on selected crops which indicates that crop yields are influenced by combinations of weather parameters. Maximum temperature showed negative effects in maize and rice as high temperature induces stress to plants by reducing water resources that are essential for crop growth. Akintunde *et al.* (2013) [5] similarly studied the effect of agroclimatic factors on some selected food crops such as rice and maize which showed positive effect with crop yield because of sunshine hours has an important role in photosynthesis and crop productivity. Similar results work done by Pathak *et al.* (2003) [8].

Conclusion

The relative humidity negatively affect the planting to emergence & tuber bulking stage of potato crop while sunshine hours & relative humidity were positively affect the plant senescence stage in most of the districts of Chhattisgarh. In maize crop, the impact of sunshine hours was negatively correlated during vegetative, tasseling/silking and physiological maturity stage. While relative humidity was positively correlated with vegetative stage. Positive effect of minimum temperature was observed during grain filling stage in most of the maize growing districts.

Sunshine hours was negatively affects the vegetative, reproductive and maturity stages of toria crop. While minimum temperature and relative humidity were positively correlated with reproductive and maturity stage. Rainfall was also found positively correlated with reproductive and maturity stage in 9 districts of Chhattisgarh.

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