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A survey of tomato blossom and flower drop to the influence of environmental phenomena (*solanum lycopersicum* L.)

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Abstract

In India, the production of Tomato (*Solanum lycopersicum* L.) varies every season and their market price also fluctuated. *S. lycopersicum* plants are self-pollinated. Pollination is an important ecological interaction and the first step for the sexual reproduction. Tomatoes Blossom and flower drop is a serious effect of the environmental factors. The present study was carried out during the monsoon season (October – December 2017) to the evaluate influence of abiotic factors on the production of tomato in Namakkal district, Tamil Nadu, India. During monsoon season the production of tomato was severely affected by various abiotic factors. The influence of maximum temperature has a positive correlation with tomato flower blossom and flower drop. Rainfall, Relative Humidity, and Wind have negative correlation the flower blossom and flower drop.

Keywords: Flower blossom/drop, Temperature, Relative Humidity, Wind, Rainfall

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Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop. At present, about 160 million tons of fresh tomatoes are the production from 4.7 million hectares in India (FAOSTAT, 2011). *S. lycopersicum* are native to South America but were brought to Europe sometime in the 15th century, where they soon became popular and were exported around the world. Pollination is an important ecological interaction and the first step for the sexual reproduction of most plant species (Murcia, 1996). The ecosystem service for sustainable crop production is the mutualistic interaction between plant pollination. Tomatoes Blossom drop and reduced fruit set in a tomato can seriously impact yields. *S. lycopersicum* plants are self-pollinated at the rate of 98% or more. Pollination occurs primarily between 10 am to 4 pm (Levy *et al.,* 1978). Insect pollinators are not important for pollination of tomatoes grown in open field production (Levy *et al.,* 1978). The primary causes of blossom drop tomatoes are environmental factors (e.g., Temperature and Relative Humidity), secondary causes can include lack of water, reduced or extended light exposure, excessive wind, and heavy fruit set. The Intergovernmental Panel on Climate Change (IPCC, 2007) reports an approximate temperature increase ranging from 1.1 to 6.4° C during the 21st century. The Fourth Assessment Report (AR4) developed by the Intergovernmental Panel on Climate Change (IPCC, 2007) lists many observed changes in the global climate. The biological impacts of rising temperatures depend upon the physiological sensitivity of organisms to temperature change (Hegland *et al.,* 2009). Discussed the consequences of temperature-induced changes in plant-pollinator interaction. They found that the timing of both plants flowering and pollinator activity seems to be strongly affected by temperature. Without pollination, which stimulates fruit set, the flowers die or drop. This condition can affect tomatoes, peppers, snap beans and another fruiting vegetable. In tomatoes, blossom drop is usually preceded by the yellowing of the pedicle. Tomato flowers must be pollinated within approximately 50 hours or they will abort and drop off. This is about the time it takes for the pollen to germinate and travel up the style to fertilize the ovary at temperatures above 12.78°C (Monica Ozores-Hamrton and Gene McAvoy, 2012). A recent review has emphasized that plant-pollinator interactions can be affected by changes in climatic conditions in subtle ways. The aim of present study is to investigate the data on the impacts of climatic changes on tomato crop pollination.

Material and Methods

A study of the incidence areas of open field *S. lycopersicum* cultivation was carried out at the Kandaswami Kandar's college of Namakkal District (11.1202° N, 78.0040° E), North-western district of Tamil Nadu, India. The study area receives North East monsoon during the months of October – December. The normal level rainfall of the Namakkal District is about 291.4 mm in October to December (RMC, 2017). The observations were made at weekly intervals for tomato plants October to November - 2017. Eight *S. lycopersicum* plants cultured in pots separate

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tubs and placed in an open field and weekly observation made individually on each plant regarding flower blossom, flower drops out. Meteorological data such as temperature, relative humidity, wind speed and rainfall during the study period were also recorded to assess the influence of these factors on the flowers losing incidences. The correlation coefficients between abiotic factors with flower blossom/drop was worked out by using the PSPP Statistical software Linux Mint 18.3, and various multivariate statistical methods, including Canonical Correspondence Analysis (CCA) Legendre and Legendre, (1998) and Bray - Curtis Similarity (Clarke, 1993) Analyzed using PAST Statistical Software Version 3.17.

Results

The data shows on the Abiotic factors (Table 1) such as Temperature, Relative Humidity, Wind Speed and Rainfall in Namakkal district (Tamil Nadu) during the study period (October – November 2017). The abiotic factors influence for tomato blossom/drop on open field culture. The highest temperature (35.14°C) and lowest (23.86°C) was recorded on I and IX week respectively. Maximum relative humidity (RH) was recorded on the IX week (95.43 %) and < 50% in I week (48.86 %). In III and IV weeks of our study period, maximum wind speed (18.57 Km/h) and minimum speed (4.57 Km/h) were recorded. During the tomato culture 1.28mm rainfall was recorded (II week) in the study area. Highest flower blossom (9) and flower drop (6.38) was registered in VII week (Figure 1).

Table 2 indicated the correlation between abiotic factors on the tomato flower blossom and drop. Among the abiotic factors, maximum temperature has a positive correlation with flower blossom (0.01) and flower drop (0.01) at the 0.01 percent level. A negative correlation has existed between minimum temperature (-0.27), maximum and minimum relative humidity (-0.05; -0.25); wind (-0.57; -0.31) and rainfall (-0.65) with flower drop respectively. Maximum wind and rainfall exhibit a negative correlation for the flower blossom (-0.61, -0.65) at the 0.05 level.

Table 1. The Meteorological data and the tomato flower blossom/drop Namakkal district of Tamil Nadu (Weekly Data)

Weeks	Min Temp	Max Temp	Min RH	Max RH	Min Wind	Max Wind	Rainfall	Flower Blossom	Flower Drop
I	26.14±1.21	35.14±1.35	48.86±5.49	85.86±6.54	4.86±1.07	15.29±3.35	1.04±1.00	1.88±0.99	0.63±0.74
II	25.86±1.21	33.86±2.19	55.00±8.23	91.14±1.35	5.57±1.13	14.14±4.60	1.28±0.88	5.25±3.54	4.50±2.93
III	26.29±0.95	33.29±2.43	56.86±16.71	86.00±4.28	6.29±0.49	18.57±2.15	0.33±0.65	3.88±1.36	2.74±1.91
IV	26.14±0.90	33.86±2.34	50.71±9.62	88.00±4.28	5.86±1.35	16.00±4.20	0.18±0.20	4.00±2.83	3.25±2.25
V	24.00±0.82	29.00±2.38	67.57±12.01	83.71±17.37	4.57±1.51	17.86±6.41	0.50±0.43	6.50±4.96	4.75±4.17
VI	24.14±0.69	30.14±1.95	62.00±12.30	92.57±3.41	6.00±1.00	15.43±3.99	0.24±0.36	7.63±2.92	5.38±2.50
VII	24.43±0.53	32.43±1.51	53.00±9.73	90.14±5.15	5.43±0.98	10.71±3.35	0.24±0.34	9.00±1.85	6.38±2.20
VIII	25.00±0.82	31.86±0.90	54.14±6.23	93.29±1.80	5.43±0.98	17.00±3.42	0.06±0.09	4.25±5.34	3.63±5.10
IX	23.86±0.38	27.29±1.70	79.71±9.39	95.43±3.69	6.86±2.79	18.29±3.99	3.11±3.32	0.57±0.98	0.29±0.76

Table 2. Pearson Correlation Coefficients for the influence of abiotic factors on the *S. lycopersicum* flower blossom/drop

	Min Temp	Max Temp	Min RH	Max RH	Min Wind	Max Wind	Rainfall	Blossom	Blossom Drop
Min Temp	1	0.90	-0.73	-0.41	-0.07	0.00	-0.27	-0.31	-0.27
Max Temp		1	-0.94	-0.40	-0.32	-0.40	-0.46	0.01	0.01
Min RH			1	0.36	0.45	0.51	0.69	-0.24	-0.25
Max RH				1	0.62	-0.10	0.43	-0.12	-0.05
Min Wind					1	0.28	0.47	-0.35	-0.31
Max Wind						1	0.26	-0.61	-0.57
Rainfall							1	-0.65	-0.65
Blossom								1	0.98
Blossom Drop									1

Multivariate Analysis

Canonical Correspondence Analysis, and Bray-Curtis Similarity were calculated with the environmental factor and tomato flower blossom and drop during the culture period. Figure 2, based on which 2 distinct groupings could be distinguished that apparently reflected differences in abiotic factor stress in tomato flower blossom/drop in the study area. Group I (Flower blossom/drop, Maximum Temperature, and Minimum Temperature); Group II included (Maximum Wind, Minimum Wind, Rainfall, Maximum RH and Minimum RH). Correspond to relatively Maximum and Minimum temperature, very highly influenced by a tomato flower drop and flower bloom. In Figure 3, a relationship has existed between the abiotic factors with flower blossom and a drop in the study place. However, from the CCA results, it is evident that abiotic factors such as Rainfall, Minimum Wind Speed, and Maximum Temperature have directly affected the tomato flower blossom and drop. Convincingly be presumed that in their place, the pollination is mainly stopped from maximum temperature and minimum wind, the rainfall also effected for the tomato flower bloom and drop because it highly increases relative humidity.

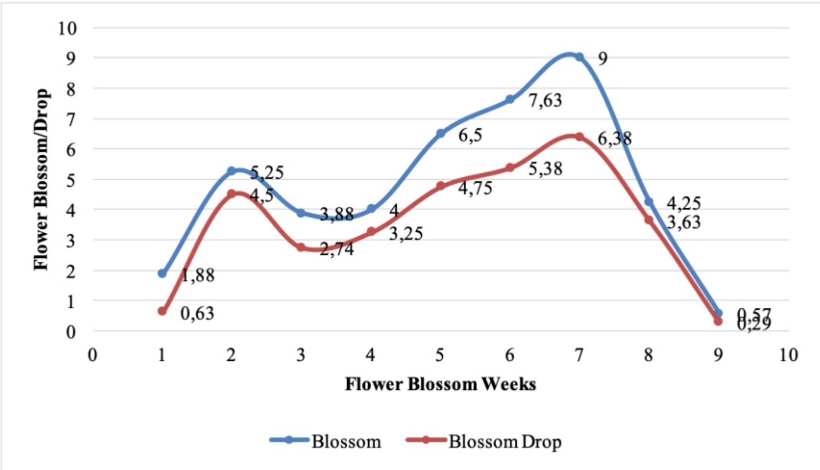

Figure 1. The Influence of abiotic factors on *S. lycopersicum* flower Blossom / Drop

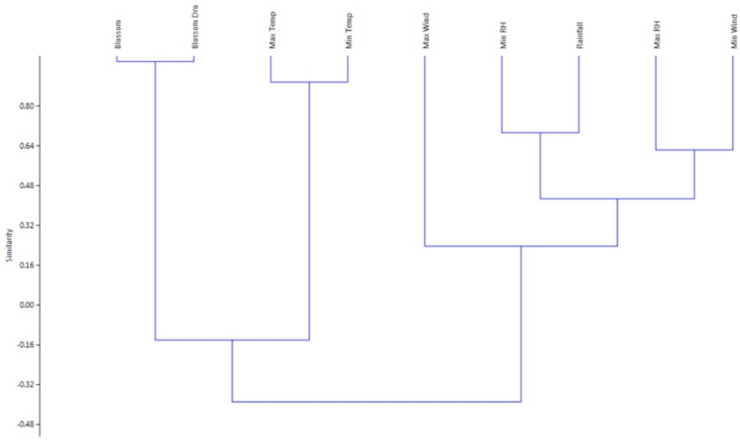

Figure 2. Bray - Curtis similarities Analyzed

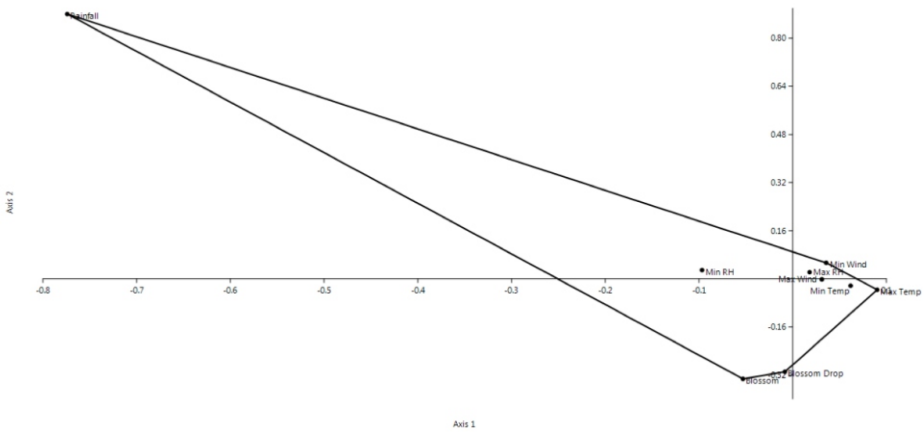

Figure 3. Canonical Correspondence Analysis (CCA)

Multivariate Analysis

Canonical Correspondence Analysis, and Bray-Curtis Similarity were calculated with the environmental factor and tomato flower blossom and drop during the culture period. Figure 2, based on which 2 distinct groupings could be distinguished that apparently reflected differences in abiotic factor stress in tomato flower blossom/drop in the study area. Group I (Flower blossom/drop, Maximum Temperature, and Minimum Temperature); Group II included (Maximum Wind, Minimum Wind, Rainfall, Maximum RH and Minimum RH). Correspond to relatively Maximum and Minimum temperature, very highly influenced by a tomato flower drop and flower bloom. In Figure 3, a relationship has existed between the abiotic factors with flower blossom and a drop in the study place. However, from the CCA results, it is evident that abiotic factors such as Rainfall, Minimum Wind Speed, and Maximum Temperature have directly affected the tomato flower blossom and drop. Convincingly be presumed that in their place, the pollination is mainly stopped from maximum temperature and minimum wind, the rainfall also effected for the tomato flower bloom and drop because it highly increases relative humidity.

Discussion

Extreme temperature, such as high daytime temperatures (above 29 °C), low night-time temperatures (below 13 °C) will cause serious flower drop from tomato plants. Tomatoes grow best if daytime temperatures range between 21°C and 29°C. Tomato plants can tolerate more extreme temperatures for short periods, several days or nights with temperatures outside the ideal range will cause the plant to abort fruit set and focus on survival (Mills, 1988). Temperatures over 40° C for only four hours can cause the flowers to abort. If the night temperatures fall below 12° C or if the day temperatures are above 29° C, the pollen becomes tacky and nonaviable, pollination can't occur. If the flowers weren't pollinated, the flowers will die and fall off. Chemicals growth regulators can sometimes help overcome low-temperature effects, but the resulting fruit is usually seedless and of poor quality.

The ideal relative humidity for tomato growth and development ranges between 40% and 70%. Relative humidity plays a major role in pollen transfer. If relative humidity is lower than the optimal range, it interferes with pollen release because the pollen is dry and unable to stick to the stigma. If relative humidity is higher than the optimal range, the pollen will not shed properly (Mills, 1988; Ozores-Hampton and McAvoy, 2010). Maximum Relative Humidity (RH) was higher throughout the study period and thus cause a fall in tomato production in the culture period. Excessive wind can drop flowers and or physically stopped them off, reducing fruit set. Excess wind can reduce the amount of energy the plant produces and thus can reduce flower production and fruit set (Monica Ozores-Hamrton and Gene McAvoy, 2012). Some areas will likely experience decreased rainfall, leading to more extensive drought periods. Thus water stress may decrease flower numbers. Snow cover might also be responding more to snow cover than to temperature (Inouye, 2008).

Conclusion

The production of tomato in the study area was seriously reduced by abiotic factors during the North-East monsoon season, because of fluctuation in temperature, wind speed, rainfall and relative humidity. Thus abiotic factors will play a major role in the production of tomatoes and also affects the economic growth of India.

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