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Assessment of Weather Parameters Effect and Phenology of Mango Cultivars in South Gujarat of India

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ABSTRACT

The present investigation was conducted at Navsari Agricultural University, Navsari (Gujarat, India) during two consecutive seasons (2019-20 and 2020-21)to determine the degree of correlation between climatic parameters and duration for different phenophases in seven mango varieties *viz.*, Sonpari, Alphonso, Amrapali, Kesar, Dashehari, Totapuri and Rajapuri. Climatic parameters *viz*. temperature, relative humidity,wind velocity, bright sunshine hours and rainfallwere considered as independent variables and different phenological stages *viz.,* days to FBD, panicle initiation, flower opening, grain stage fruits, pea stage fruits, marble stage fruits and maturity as dependent variables. Results revealed that, climatic parameters *viz.,* temperature (maximum and minimum), relative humidity (maximum and minimum)and bright sunshine hours (day^{-1}) were significantly negatively correlated with days to FBD, pea stage fruits, marble stage fruits and mature stage fruits. However, none of the climatic parameter produced its significant correlation for days to gain stage fruits. It was also observed that, extended rainfall delayed flower bud differentiation and temperature fluctuations during panicle initiation, adversely affected its occurrence.

Key Words: Climatic parameters, Correlation coefficient, Mango, Phenophases.

INTRODUCTION

It is well known that, flowering and final harvest of any fruit crop is dependent on various climatic parameters *viz.,* temperature, relative humidity, wind velocity, rainfall, sunshine, soil moisture availability, *etc*. Among them, mango is most vulnerable to climate change. However, various cultivars of mango showing different behavior with weather parameters. The major environmental factors regulating floral transition and flowering initiation are day and night temperature. Day and night temperatures during the flowering period are emerging as the major environmental cue for floral differentiation. It has further significance in the global climate change scenario. The cooler temperature being the major factor in mango, the mature leaves perceive the optimum cooler temperature and synthesis a flowering promoter which is claimed to be subsequently transported to the apical meristem for vegetative to floral transition (Sreekumar *et al*, 2014). Climate change has been perceived as a major threat and has maximum impact on mango production in Gujarat state particularly in coastal areas of South Gujarat.

MATERIALS AND METHODS

The present investigation was carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during two consecutive seasons 2019-20 and 2020-21**.** The major objective behind this experiment was to study the degree of relationship between climatic parameters and mango phenology**.** The fifteen-years old trees of mango were selected with the seven varieties *viz.*, Sonpari, Alphonso, Amrapali,

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Kesar, Dashehari, Totapuri, Rajapuri.

Correlation study between climatic parameters and days to different phenological stages *viz.,* days to flower bud differentiation (from 1st July), days to panicle initiation, initiation offlower opening, grain stage fruits, pea stage fruits, marble stage fruits and maturity were studied. To study the correlation between days for a variety reaching to a particular phenological event and mean of environmental factors for effective time period were considered.

Weather variables *viz.,* maximum temperature (^{0}C), minimum temperature (^{0}C), relative humidity (%), average wind velocity (km hr^{-1}), total bright sunshine hours day^{-1} (BSSH) and total rainfall (mm)were considered for study. The degree of association was calculated by using Karl Pearson's coefficient of correlation.

$$r_{xy} = \frac{\text{Cov (X, Y)}}{\sqrt{\text{V (X) } V(Y)}}$$

Where,

r_{xy} = Correlation coefficient between X and Y

Cov(X, Y) = Covariance of X and Y

V(X) = Variance of weather variables X

V(Y) = Variance of days to different phenological Y

The significance of correlation coefficient (*r*) was tested by student's 't' test with *(n-2*) degree of freedom (Snedecor and Cochran, 1956) at 5 % level of significance.

$$t = \frac{\text{r (n} - 2)}{\sqrt{1 - \text{r}^2}}$$

RESULTS AND DISCUSSION

The month wise climatic parameters for the year 2019-20 and 2020-21 are represented in the Fig. 1 and Fig. 2 respectively. The degree of relationship between climatic parameters and mango phenology were computed for the year two consecutive seasons 2019-20 and 2020-21and presented in Table 1 and Table 2 respectively. The graphical representation depicted in the Fig 3 and Fig.4 respectively.

Days to flower bud differentiation

The correlation matrix for the year 2019 - 20 presented in Table 1, indicated that, days for FBD were negatively correlated with maximum temperature(r = -0.98**) and minimum temperature (r = -1.0**), maximum relative humidity(r = - 0.96**) and minimum relative humidity(r= - 0.87**), wind velocity (r = - 0.99 **). However, it was positively correlated with bright sunshine hours (r = 0.99**).

In respect of year 2020 - 21, the correlation data depicted in Table 2, revealed that, days for FBD were negatively correlated with maximum temperature (r = - 0.94**) and minimum temperature (r = -1.0**), maximum relative humidity(r = - 0.96**) and minimum relative humidity(r = - 0.99**), wind velocity (r = - 0.98**). However, it was positively correlated with bright sunshine hours (r = 0.95**) and total rainfall (r = 0.97**).

The development fate of mango flower bud differentiation was strongly influenced by temperature. Minimum temperature < 21˚C and maximum temperature < 32˚C typically shall induced FBD in mango (Rajatiya *et al,* 2018). Temperature and humidity shown negative correlation, this might be due to slightly higher average temperature and humidity from 1st July till flower bud differentiation may had accelerated the accumulation of photosynthets which leads to hastened flower bud differentiation. During the year 2020-21, correlation matrix shows, highly significant positive correlation between total rainfall and days for FBD, this indicated that more rainfall delayed FBD. Similar results were obtained by Bally *et al* (2000), Rajan (2008) and Sinha *et al* (2020).

Days to panicle initiation

The correlation coefficients presented in Table 1 and Table 2, revealed that, maximum temperature were significantly negatively correlated with days to panicle initiation during 2019-20 (r= - 0.85*) and during 2020-21 (r = - 77*). Correlation coefficients for all other parameters found not-significant.

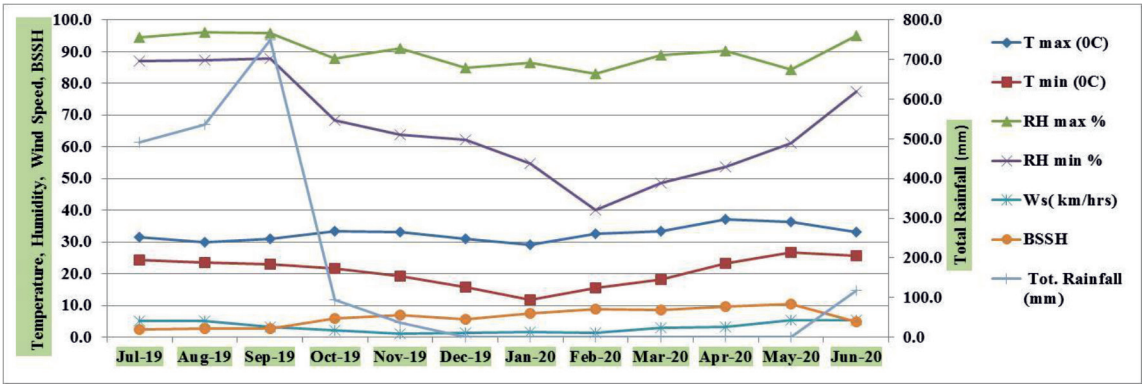

Fig. 1. Monthwise climatic parameters for the year 2019-20.

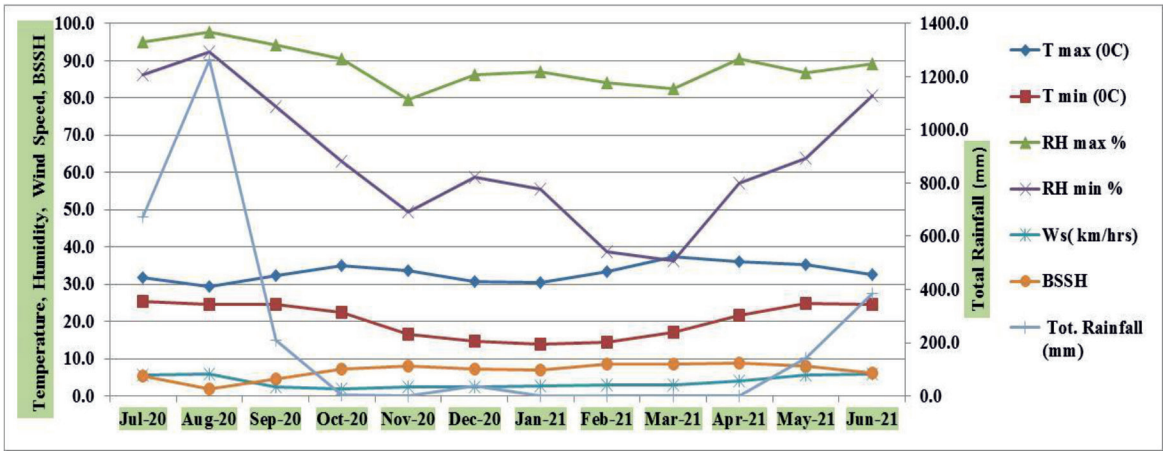

Fig. 2. Monthwise climatic parameters for the year 2020-21.

Rajatiya *et al* (2018) also reported significant negative correlation between days after FBD for panicle emergence and maximum and minimum temperatures and bright sunshine hours.

It was observed that, minimum temperature and its consistency plays crucial role in deciding panicle initiation. Minimum temperature should be lower contentiously for certain period. *e.g.* Sonpari required seven days for attaining panicle initiation (28th Jan., 2020) from flower bud differentiation (21st Jan., 2020). During this period minimum temperature was ranged from 9.8 to 15.5 ^{0}C. However, Dashehari required thirteen days for attaining panicle initiation (22nd Jan., 2020) from flower bud differentiation (9th Jan., 2020). This delay was might be due to fluctuations in minimum temperature. In these thirteen days, for initial five days *i.e.,*9th Jan., 2020 to 13th Jan., 2020 minimum temperature was ranged from 13.0 to 18.0 ^{0}C. In later eight days *i.e.,* from 14th Jan., 2020 to 22nd Jan., 2020 minimum temperature was ranged from 9.8 to 13.7 ^{0}C. In this context, Rao (1998) reported that minimum temperature below 13^{0}C for continuous seven days favored panicle initiation in mango cultivar Neelum and Totapuri.

Days to initiation of flower opening

The correlation matrix for the year 2019 - 20 for days to initiation of flowering, indicated that, there were significant and negative correlations with maximum temperature (r =-0.79*), positive with minimum relative humidity (r =0.82*) and wind velocity (r = 0.93*). For the year 2020-21, correlation coefficient for minimum temperature was significant and positive (r = 0.85*). Correlations

Table 1. Correlation co-efficient between weather variables and phenology of mango varieties (2019-20).

Weather variables	Days required for						
	FBD	Panicle initiation	Initiation of flower opening	Grain stage	Pea stage	Marble stage	Maturity
T_{max} (^{0}C)	-0.98**	-0.85*	-0.79*	-0.44	-0.84*	-0.85*	-0.77*
T_{min} (^{0}C)	-1.00**	-0.62	-0.44	-0.51	-0.89**	-0.49	-0.15
RH_{max} (%)	- 0.96**	-0.36	-0.66	0.63	0.46	0.15	-0.15
RH_{min} (%)	-1.00**	0.29	0.82*	0.59	0.44	0.19	-0.01
Wind velocity (km hr^{-1})	-0.99**	0.19	0.93**	-0.07	0.41	0.11	0.28
BSSH	0.99**	-0.30	-0.58	-0.31	-0.25	0.45	-0.24
Total rainfall (mm)	-0.27	NA	NA	NA	NA	NA	0.07

coefficients for all other parameters were found non-significant during both years (Table 1 and Table 2).

Late flowering cultivars *viz.,* Amrapali and Dashehari required less days for initiation of flower opening than early flowering cultivars (Alphonso, Kesar and Rajapuri). Higher temperatures (>30^{0}C) during Feb., may hastened flower opening in lesser days than quite lower (< 30^{0}C) temperature during January. Differences in correlation coefficients for 2019-20 and 2020-21, were might be due to different time of flower opening in these years.

These results are in confirmation with findings of Kanzaria *et al* (2015) and Rajatiya *et al* (2018).

Days to grain stage

It was revealed that, correlation coefficients between days to grain stage and all climatic parameters for effective period were non-significant for both years.

None of the environmental parameter found

Table 2. Correlation co-efficient between weather variables and phenology of Mango varieties (2020-21).

Weather variable	Days required for						
	FBD	Panicle initiation	Initiation of flower opening	Grain stage	Pea stage	Marble stage	Maturity
T_{max} (^{0}C)	-0.94**	-0.77*	0.20	-0.19	-0.77*	-0.93**	-0.87**
T_{min} (^{0}C)	-1.00**	-0.68	0.85*	0.17	0.20	-0.55	-0.56
RH_{max} (%)	-0.96**	0.30	-0.51	-0.11	0.27	0.49	-0.70
RH_{min} (%)	-0.99**	0.08	0.55	0.04	0.83	0.86*	-0.33
Wind velocity (km hr^{-1})	-0.98**	0.39	-0.31	0.46	-0.30	-0.19	-0.25
BSSH	0.95**	-0.37	-0.71	-0.14	-0.94**	-0.77*	0.28
Total rainfall (mm)	0.97**	NA	0.43	0.08	0.71	NA	-0.16

*Significant at 5 % level of significance, **Significant at 1 % level of significance.
NA- rainfall wasn't received during effective period.

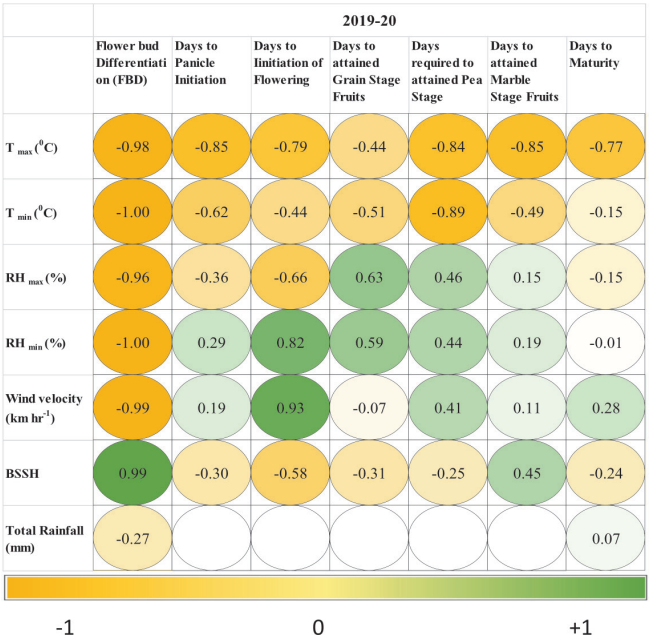

Fig. 3. Correlation co-efficient between weather variables and phenology of mango varieties (2019-20).

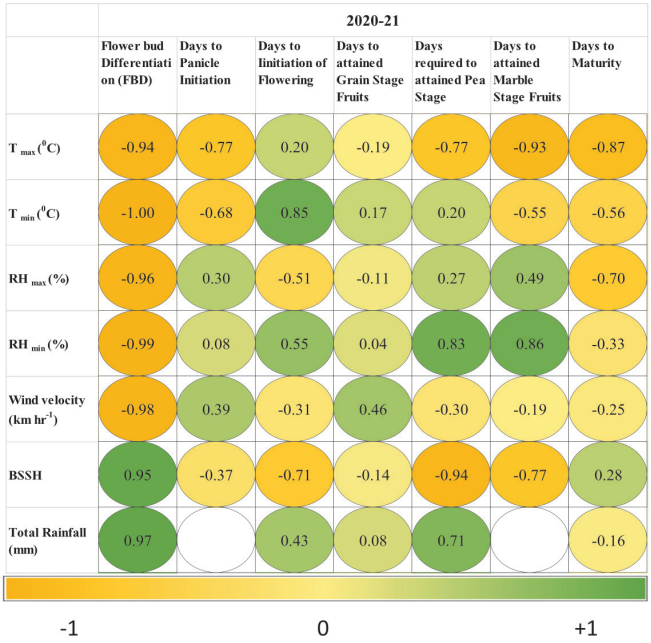

Fig. 4. Correlation co-efficient between weather variables and phenology of mangovarieties (2020-21).

significantly correlated. The time period between flower opening and attaining grain stage involve series of events starting from pollen production till ultimate fertilization and up to subsequent fruit setting, was quite short. So, the time required for these events may be quite similar during both the years. So, more or less, this process might be biologically driven rather than climatic parameters. These results were in line with the findings obtained by Rajatiya *et al* (2018).

Days to pea stage

During the year 2019-20 days to attained pea stage fruits showed significant negative correlation with maximum (r = -0.84*) and minimum (r = -0.89**) temperatures. For the year 2020-21, maximum temperature (r = -0.77*) and bright sunshine hours (r = -0.94**) recorded significant negative correlation. All other climatic parameters for both the trials recorded non-significant correlations.

Late flowering cultivars *viz.,* Amrapali and Sonpari required less days for attaining pea stage fruits than early flowering cultivars *viz.,* Alphonso, Kesar and Rajapuri. This was might be due to difference in temperature for the effective period. Late flowering cultivars attained pea stage fruits in minimum days during comparatively higher maximum temperature (> 32 ^{0}C) than early flowering cultivars when maximum temperature was below 29 ^{0}C. This supports results of negative correlation between days required and temperature for effective period. Bright sunshine hours also showed negative correlation this was due to more sunshine hours, which might have promoted growth of fruits through photosynthesis. These results were in accordance Kanzariya *et al* (2015),Varu *et al* (2015), Yadav (2016), Rajatiya *et al* (2018) and Sinha *et al* (2020).

Marble Stage Fruits

During the year 2019-20, days to marble stage fruits showed significant negative correlation with maximum temperature (r = - 0.85*). For the year 2020-21, days to marble stage fruits were negatively correlated with maximum temperature (r = -0.93**) and bright sunshine hours (r = -0.77*). However,

maximum relative humidity recorded significant positive correlation (r = 0.86*) during this year.

This might be due to higher temperature and more bright sunshine hours promoted photosynthesis thereby growth of pea stage fruit accelerated to marble stage in comparatively shorter period. These results were in accordance with findings reported by Varu *et al* (2015), Yadav (2016), Rajatiya *et al* (2018) and Sinha *et al* (2020).

Days to maturity

During the year 2019-20 and 2020-21, days for attaining maturity showed significant negative correlation with maximum temperature (r = -0.77* and r = - 0.87**, respectively). All other climatic parameters during both trials failed to produce significant effect.

It is well known that higher temperature hastens maturity in mango. This might be due to faster growth of fruits during higher temperatures in summer than late varieties which were matured in June-July month when temperatures are comparatively mild. Theresults of present findings were in accordance with findings reported by Yadav (2016), Rajatiya *et al* (2018) and Sinha *et al* (2020).

CONCLUSION

The present investigation revealed that climatic parameters *viz.,* temperatures, relative humidity and bright sunshine hours hastens flower bud differentiation, and subsequent fruit development in mango. However, extended rainfall delayed flower bud differentiation and temperature fluctuations during panicle initiation, adversely affect its occurrence. The correlation might be useful to know that there is a predictable relationship between weather variables and mango phenology. The current study enough scope to understand effect of weather variables in relation to phenology which helps mango growers take active decision to avoid yield losses.

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