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Influence of growing degree days (GDD) on flowering and fruit set of some commercial mango varieties under varying climatic conditions

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ABSTRACT : The present study was carried out at Department of Horticulture, Junagadh Agricultural University, Junagadh under south Saurashtra agroclimatic conditions during year 2012-13 and 2013-14. The treatments comprised of three locations *viz.*, Junagadh (L₁), Talala (L₂) and Dhari (L₃) and three commercially important mango varieties *viz.*, Kesar (V₁), Alphonso (V₂) and Rajapuri (V₃). The experiment was laid out in Randomized Block Design with Factorial concept (FRBD) and replicated four times. Significantly minimum days for bud differentiation (166.46 days with 1402.94 GDD) were observed at Talala location. Early flower initiation (73.04 days with 420.36 GDD) and short flowering span (60.42 days with 444.69 GDD) was observed at Talala location. Among varieties, early flower initiation (75.83 days and 381.04 GDD) and compact flowering span (60.63 days with 382.84 GDD) was observed in Kesar. Minimum days for fruit set (24.33 with 131.61 GDD), pea stage (20.63 with 173.10 GDD), marble stage (42.96 days and 446.48 GDD), egg stage (69.17 days and 809.13 GDD) and maturity (93.75 days with 1272.06 GDD) were required at Talala, while early fruit set (24.00 with 100.63 GDD), pea stage (20.83 with 144.47 GDD), marble stage (43.67 days and 361.66 GDD), egg stage (70.54 days and 694.79 GDD) and maturity (95.88 days and 1062.71 GDD) was noted in Kesar. The highest fruit set at pea (13.84%), marble (1.57%), egg stage (0.31%) and fruit retention (1.39%) were recorded at Talala. Among varieties, maximum fruit set at pea stage (13.84%) was recorded in Alphonso; on the contrary, it was maximum at marble (1.60%), egg stage (0.32%) and fruit retention (1.32%) in Kesar. Maximum numbers of fruits per tree were recorded at Talala location (335.21) and Alphonso variety (344.33).

KEY WORDS : Flowering, Fruit set, GDD, Location, Mango, Maturity, Stages, Variety

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Mango (*Mangifera indica* L., Family Anacardiaceae) unarguably is one of the oldest and choicest tropical fruits of the world and is rightly designated as “King of fruits” in the tropical world (Singh *et al.*, 2011). Mango is renowned for its excellent flavour, attractive fragrance, and high nutritional

value; and gradually gaining global market (Sikhamany, 2005). Climatic conditions play an important role in the fluctuating mango productivity. The increased area under fruit crops is due to acclimatizing as well as higher adoption of recommended production technologies. Growing degree days (GDD) is mean daily temperature

degree above the certain (base) temperature and can be calculated by taking the average of the daily maximum and minimum temperatures compared to a base temperature (17.9°C for mango).

RESEARCH METHODS

The research work entitled influence of growing degree days (GDD) on flowering and fruit set of some commercial mango varieties under varying climatic conditions was carried out at Department of Horticulture, Junagadh Agricultural University, Junagadh during the year 2012-13 and 2013-14. The treatments comprised of three locations *viz.*, Junagadh (L₁), Talala (L₂) and Dhari (L₃) with three commercially important mango varieties *viz.*, Kesar (V₁), Alphonso (V₂) and Rajapuri (V₃). The experiment was laid out in Randomized Block Design with Factorial (FRBD) and replicated four times. Daily meteorological data recording was done with automatic weather data logger instrument installed at individual experimental location in the field. Each data logger was programmed to record maximum as well as

minimum temperature and humidity at every 30 minutes interval. The 1st, July and 1st, November of consecutive year was set as cutoff date for BDS and rest of stages, respectively. Growing degree days (GDD) was computed by mean daily temperature degree above base temperature. The concern observations were recorded.

Statistical analysis :

The obtained data was analyzed by statistical significant at P<0.05 level, S.E. and C.D. at 5 per cent level by the procedure given by (Gomez and Gomez, 1984).

RESEARCH FINDINGS AND DISCUSSION

Number of days required for flower bud differentiation was significantly affected at locations only. Early bud differentiation (166.46 days with 1402.94 GDD) were observed at Talala location and found non-significant among varieties (Table 1). Number of days and GDD required for flower initiation and progressive phenological stages affected significantly. Minimum days

Table 1: Days and GDD requirements at bud differentiation, flower initiation and flowering span of different mango varieties at various locations

Treatments	Calendar days and GDD requirements for different stages					
	Bud differentiation		Flower initiation		Flowering span	
	Days	GDD	Days	GDD	Days	GDD
Location						
L ₁ - Junagadh	175.21	1621.88	79.79	399.20	63.88	452.08
L ₂ - Talala	166.46	1402.94	73.04	420.36	60.42	444.69
L ₃ - Dhari	178.83	1657.18	85.25	358.40	64.75	410.78
S.E. ±	2.446	--	1.93	--	0.80	--
C.D. (P=0.05)	6.96	--	5.49	--	2.29	--
Variety						
V ₁ - Kesar	170.71	1549.42	75.83	381.04	60.63	382.84
V ₂ - Alphonso	172.63	1559.77	79.46	393.78	63.08	424.70
V ₃ - Rajapuri	177.17	1572.81	82.79	403.15	65.33	500.00
S.E. ±	2.446	--	1.93	--	0.80	--
C.D. (P=0.05)	NS	--	5.49	--	2.29	--
C.V. (%)		6.91		10.24		6.24

NS = Non-significant

Table 2 : Daily GDD accumulations for various growth stages at different locations for mango varieties

Treatments	Bud differentiation	Flower initiation	Fruit set	Pea stage	Marble stage	Egg stage	Maturity
L ₁ - Junagadh	9.26	5.00	5.11	7.61	8.93	10.21	11.25
L ₂ - Talala	8.43	5.76	5.41	8.39	10.39	11.70	13.57
L ₃ - Dhari	9.27	4.20	3.82	7.33	8.69	9.94	10.85
V ₁ - Kesar	9.08	5.02	4.19	6.94	8.28	9.85	11.08
V ₂ - Alphonso	9.04	4.96	4.77	7.61	9.32	10.42	11.83
V ₃ - Rajapuri	8.88	4.87	5.21	8.56	10.15	11.39	12.54

for flower initiation (73.04 days with 420.36 GDD) and short flowering span (60.42 days with 444.69 GDD) was observed at Talala location. So far variety is concern, early flower initiation (75.83 days and 381.04 GDD) and shorter flowering span (60.63 days with 382.84 GDD) was observed in Kesar. Minimum days for fruit set (24.33 with 131.61 GDD), pea stage (20.63 with 173.10 GDD), marble stage (42.96 days and 446.48 GDD), egg stage (69.17 days and 809.13 GDD) and maturity (93.75 days with 1272.06 GDD) were required at Talala and fruits completed all the stages earlier as compared to Junagadh and Dhari locations. In concern to varieties, early fruit set (24.00 with 100.63 GDD), pea stage (20.83 with 144.47 GDD), marble stage (43.67 days and 361.66 GDD), egg stage (70.54 days and 694.79 GDD) and maturity (95.88 days and 1062.71 GDD) was noted in Kesar variety compared to Alphonso and Rajapuri. Significant effect of days and GDD was noted for fruit set (%) to retention (%). Maximum fruit set at pea (13.84%), marble (1.57%), egg stage (0.31%) and fruit retention (1.39%) were recorded at Talala which was higher as compared to Junagadh and Dhari locations. For varieties, maximum fruit set at pea stage (13.84%) was recorded in Alphonso, on the contrary, it was found maximum at marble (1.60%), egg stage (0.32%) and fruit retention (1.32%) in Kesar which was higher as compared to Alphonso and Rajapuri varieties of mango (Table 3). Effect of days and GDD found significant on number of fruits. Maximum numbers of fruits per tree were recorded at Talala location (335.21) and Alphonso variety (344.33).

The delayed flowering at Dhari might be due to the highest altitude at Dhari (229m) as compared to Talala (148m) and Junagadh (81m). Though, altitude is not the finalizing tool for the flowering but, one of the important factors. Due to higher altitude temperature regime remained cooler compared to lower altitudes. Lower temperature accumulated less GDD and might resulted in late flowering (Table 2). The statements made by Polito (2009) and Mathieu (2006) after their research findings are closely in agreement with present research work. Rajan (2008) investigated that the altitude also affects the time of flowering. These lesser GDD accumulations leads the bud to break the dormancy earlier than warmer ones. Byrne and Bacon (1992) clearly stated that if winter temperatures do not satisfy a variety's chilling requirement, trees will show signs of delayed bloom and foliation, reduced fruit set. Along with local climatic

Table 3: Effect of days and GDD on fruit set, fruits at pea, marble and egg stage, fruit retention and number of fruits/ tree of mango varieties at various locations

Treatments	Fruit set			Pea stage			Marble stage			Egg stage			Maturity			Fruit retention	Number of fruits/ tree
	Days	GDD	%	Days	GDD	%	Days	GDD	%	Days	GDD	%	Days	GDD	%		
Location																	
L ₁	25.50	130.38	13.34	23.25	176.95	1.45	46.71	416.99	1.45	71.50	729.79	0.27	96.54	1086.41	0.15	1.13	286.29
L ₂	24.33	131.61	13.84	20.63	173.10	1.57	42.96	446.48	1.57	69.17	809.13	0.31	93.75	1272.06	0.19	1.39	335.21
L ₃	27.42	104.66	12.37	24.50	179.61	1.30	50.25	436.56	1.30	79.04	785.51	0.24	107.13	1162.68	0.11	0.88	241.42
S.E. ±	0.538	--	0.241	0.631	--	0.045	1.064	--	0.045	1.075	--	0.008	1.561	--	0.01	0.06	8.418
C.D. (P=0.05)	1.53	--	0.69	1.80	--	0.13	3.03	--	0.13	3.06	--	0.02	4.44	--	0.02	0.17	23.96
Variety																	
V ₁	24.00	100.63	13.39	20.83	144.47	1.60	43.67	361.66	1.60	70.54	694.79	0.32	95.88	1062.71	0.17	1.32	303.63
V ₂	25.83	123.21	13.84	22.92	174.39	1.39	46.46	432.78	1.39	72.04	751.01	0.27	97.13	1149.03	0.14	1.04	344.33
V ₃	27.42	142.81	12.32	24.63	210.81	1.33	49.79	505.59	1.33	77.13	878.63	0.22	104.42	1309.41	0.13	1.03	214.96
S.E. ±	0.538	--	0.241	0.631	--	0.045	1.064	--	0.045	1.075	--	0.008	1.561	--	0.01	0.06	8.418
C.D. (P=0.05)	1.53	--	0.69	1.80	--	0.13	3.03	--	0.13	3.06	--	0.02	4.44	--	0.02	0.17	23.96
C.V. (%)	11.18	--	8.96	7.72	--	15.45	--	--	14.05	--	--	--	13.31	--	13.31	25.78	14.34

Location: L₁- Junagadh, L₂- Talala, L₃- Dhari; Variety: V₁- Kesar, V₂- Alphonso, V₃ - Rajapuri

conditions, it is possible that flowering span might be of more genetic concern. Due to climatic parameters flowering span might differ but whenever variety completed GDD requirements the span is over. The findings by Thomas *et al.* (2000) also support current research; they stated that the period of flowering in mango is governed by local climatic conditions, the variety and cultural practices. The accumulation of extra GDD might accelerate the physiological processes in the plant and awarded early flowering and progressive stages. But, for varieties it might be varietal characteristics individually performed. The earliness in the fruit set, pea stage, marble stage, egg stage and maturity at Talala was shouted because of accumulation of daily extra GDD and earliness in previous growth stages. Earliness in Kesar was might be due to the distinct varietal requirement of GDD. Moreover, fruit size was smaller than Rajapuri and a distinct genetically makeup. The same might be the case for Alphonso, even though it received lesser numbers of GDD during the growth span. Malte (2011) for mango revealed the similar results like current work. Ravi *et al.* (2002) evaluated different mango cultivars and reported that these cultivars differed in nature of producing flowers, setting fruit and ripening period.

Per cent fruit set at pea stage were higher in Alphonso variety but it was less at marble stage. This might be a varietal character that made higher fruit drop in Alphonso variety at pea stage and fruit drop was lesser in Kesar variety. Hence, fruit set at marble stage was found maximum in Kesar variety. An investigation carried out by Uddin and Amin (1995) in mango also supported the present investigation. Rodrigo and Herrero (2002) made generalized statement that pre-blossom temperatures affect fruit set and subsequent yields. Talala received daily extra GDD compared to other locations, the physiological processes accelerated; cell division and cell expansion might be positively affected by extra GDD. Moreover, bud differentiation was earliest at the Talala location. No doubt bud differentiation is a qualitative event but the event might take place in more numbers of buds. Hence, more numbers of fruits were received which contribute to the yield at various locations. Number of hermaphrodite flowers, pollination and fruit retention at various locations and for different variety might played a vital role for the yield character. Majumder

and Sharma (1990) and Rajan (2008) worked for mango and supported current research work.

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