

GROWING DEGREE DAYS REQUIREMENT OF MANGO CULTIVARS FOR MATURITY UNDER SUB HUMID PLATEAU REGION OF EASTERN INDIA

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Abstract

The Growing Degree Days requirement (GDD) for fruit maturity of 71 mango cultivars hybrids under sub humid plateau region of eastern India were determined during 2000-01 at HARP, Ranchi. The GDD requirement ($^{\circ}\text{C}$) ranged from 1660.38 in Mithua to 3222.25 in Kataki. Accordingly, based on the GDD requirement the cultivars/hybrids have been classified into five different groups viz. requiring less than 1800 $^{\circ}\text{C}$, requiring 1800-2000 $^{\circ}\text{C}$, requiring 2000-2200 $^{\circ}\text{C}$, requiring 2200-2400 $^{\circ}\text{C}$ and requiring more than 2400 $^{\circ}\text{C}$ of growing degree days for fruit maturity. The maturity of fruits had rich diversity starting from 17 May (Rani Pasand) to 15 August (Kataki). Hence, based on the date of maturity the cultivars have also been classified into five different groups viz. Very early, early, medium, late and very late.

INTRODUCTION

The mango (*Mangifera indica* L.) is the most important fruit crop of the country. For fetching higher price in the market, production of high quality produce is of utmost importance. Apart from orchard management, cultural practices and post harvest treatment, proper time of harvesting play an important role for quality production and planning for commercial marketing. Harvesting at the optimum stage of maturity reduces the different kinds of pre and post harvest losses. Being a climacteric fruit, the mango fruits have to be harvested at physiological maturity, before ripening. For attaining desirable quality after ripening, harvesting at proper maturity stage is of utmost importance. Different criteria are being used for determining the stage of maturity in mango fruits. Tree ripe fruit drop, proper development of shoulder, specific gravity, skin colour are some of the criteria used for deciding the harvesting time in mango. However, computation of heat unit accumulation during the fruit growth and development has been used as an easy and feasible criterion for determining the fruit maturity. This method has been found beneficial for predicting the maturity in ber (Singh *et al.*, 1998), grapes (Jacob, 1950) and litchi (Rai *et al.* 2002) since long. However, in mango

the information pertaining to heat unit summation for fruit maturity is not available. Hence, an effort was made to determine the Growing Degree Days requirement of different mango cultivars/hybrids under sub humid plateau region of eastern India.

MATERIALS AND METHODS

The experiment was conducted on well established mango orchard at Ranchi located at 23 $^{\circ}$ 25' N and 85 $^{\circ}$ 20' E and 620 m above MSL, during 2000-2001. The region receives an annual rainfall of 1400 mm. Observations were recorded from 71 mango cultivars/hybrids planted at a spacing of 5 x 10m. Daily maximum and minimum temperatures were recorded from agro-meteorological observatory located near the orchard.

The heat unit summation in terms of Growing Degree Days (GDD) was calculated using the formula:

$$GDD = \sum_{t_s}^{t_m} \{ (T_{max} + T_{min})/2 - T_b \}$$

Where, t_s and t_m is the time of fruit setting and fruit maturity, respectively. T_{max} and T_{min} is the maximum and minimum ambient temperatures, respectively. T_b is the base temperature below which fruit growth is stopped. The GDD was worked out

Table 1: Degree days requirement of mango cultivars for maturity under Ranchi conditions during 200-01.

Cultivar	Date of fruit set	Date of maturity	Total Degree days (°C)	TSS/acid ratio
1. Rani Pasand	10 th Feb	17 th May	1679.37	45.61
2. Gopal Bhog	11 th Feb	19 th May	1706.9	125.1
3. Bombay Green	20 th Feb	23 rd May	1681.95	69.2
4. Gulab Khus	17 th Feb	23 rd May	1716.24	65.6
5. Krishna Bhog	22 nd Feb	24 th May	1678.57	33.67
6. Gaurjeet	15 th Feb	24 th May	1758.58	45.55
7. Mithua	27 th Feb	26 th May	1660.38	104.28
8. Wazeer pasand	12 th Feb	26 th May	1831.83	50.0
9. Makkhan	26 th Feb	27 th May	1691.29	52.25
10. Himsagar	17 th Feb	28 th May	1813.64	75.3
11. Safeda Malihabad	28 th Feb	29 th May	1707.39	35.95
12. Nayab	26 th Feb	29 th May	1730.25	59.16
13. Zardalu	18 th Feb	29 th May	1821.69	49.71
14. Rataul	25 th Feb	31 st May	1780.64	44.44
15. Dashehari	17 th Feb	31 st May	1872.08	63.57
16. Alphonso	2 nd March	1 st June	1719.97	26.37
17. Raspuri	15 th Feb	2 nd June	1913.14	46.28
18. Amin Prince	28 th Feb	6 th June	1837.35	87.85
19. Amin Anguri	18 th Feb	6 th June	1951.65	75.71
20. Benazir	28 th Feb	8 th June	1873.75	55.71
21. Daima	4 th March	8 th June	1817.47	28.16
22. Safeda maldah	28 th Feb	8 th June	1873.75	40.0
23. Lucknow Safeda	3 rd March	8 th June	1832.42	52.41
24. Langra maldah	1 st March	8 th June	1862.32	57.85
25. Nasik Pasand	17 th Feb	8 th June	1999.48	57.5
26. Jahangir	17 th Feb	8 th June	1999.48	86.66
27. Khasul Khas	1 st March	9 th June	1865.57	39.37
28. Langra	28 th Feb	10 th June	1910.15	80.95
29. Champa	19 th Feb	12 th June	2049.42	40.32
30. Fazri Zafrani	16 th Feb	16 th June	2156.51	47.36
31. Elaichi	13 th Feb	18 th June	2227.2	28.10
32. Calcutta maldah	17 th Feb	18 th June	2181.48	30.61
33. Swarna Guddi	17 th Feb	18 th June	2181.48	50.31
34. Mallika	12 th Feb	18 th June	2238.63	90.0
35. Kumar Pahar	25 th Feb	20 th June	2126.44	52.0

Conditions

Table 1: Cont.....

acid	Cultivar	Date of fruit set	Date of maturity	Total Degree days (°C)	TSS/acid ratio
	36. Hybrid 14	22 nd Feb	20 th June	2160.73	128.57
31	37. Paharpur Sinduria	2 nd March	21 st June	2083.97	72.38
1.1	38. Mehmood Bahar	28 th Feb	21 st June	2224.65	25.86
2	39. Prabha Shankar	17 th Feb	21 th June	2236.08	69.1
6	40. Intimax	14 th Feb	21 th June	2270.37	74.28
37	41. Amrapalli	18 th Feb	23 rd June	2261.05	131.42
55	42. Jalmarai	12 th Feb	24 th June	2347.83	90.47
28	43. Alif laila	27 th Feb	24 th June	2176.38	53.57
0	44. Vanraj	25 th Feb	24 th June	2199.24	44
25	45. Pulihara	12 th Feb	24 th June	2347.83	54.64
3	46. Latra	15 th Feb	25 th June	2343.17	40.0
35	47. Sahabale Pasand	12 th Feb	26 th June	2384.23	80.52
6	48. Litchi	9 th Feb	26 th June	2428.52	31.02
71	49. Hur	10 th Feb	26 th June	2407.09	38.88
14	50. Taimuria	3 rd March	27 th June	2178.22	42.26
57	51. Darbare kalam	24 th Feb	27 th June	2265.27	28.57
17	52. Benishan	26 th Feb	28 th June	2260.61	24.48
8	53. Chausa	26 th Feb	29 th June	2278.81	90.3
35	54. Neeluddin	17 th Feb	29 th June	2381.68	46.85
1	55. Alampur Benisan	15 th Feb	29 th June	2404.54	64.16
1	56. Neel Goa	15 th Feb	29 th June	2404.54	91.42
6	57. Sipiya	3 rd March	1 st July	2232.82	44.37
0	58. Fazali	27 th Feb	1 st July	2285.58	45.55
1	59. Sesar	16 th Feb	2 nd July	2427.5	67.61
5	60. Neelum	18 th Feb	2 nd July	2404.64	50
3	61. Sahabale	14 th Feb	2 nd July	2450.36	80.50
6	62. Totapuri	18 th Feb	3 rd July	2420.83	4055
7	63. Hybrid 7/165	17 th Feb	3 rd July	2432.26	68.7
55	64. Bhoordas	23 rd Feb	4 th July	2379.87	81.90
2	65. Papaya Khas	25 th Feb	10 th July	2454.15	45.71
6	66. Hybrid 51	16 th Feb	12 th July	2589.4	42.85
0	67. Hamlet	24 th Feb	15 th July	2417.01	62.3
1	68. Aswania	12 th Feb	18 th July	2554.17	33.80
11	69. Alfazli	17 th Feb	18 th July	2675.11	38.70
31	70. Bhatuhi	19 th Feb	18 th July		
	71. Katakai	8 th March	15 th August	3222.25	48.2

Table 2: Classification of mango cultivars based on maturity group and requirement of Growing Degree Days.

Maturity group	Cultivar/hybrid	Growing degree days requirement	Cultivar/hybrid
Very early (maturing before 31 st May)	Gopal Bhog, Bombay Green, Mithua, Himsagar, Makkhan Krishna Bhog, Gulab Khus, Safeda Malihabad, Nayab, Wazeer Pasand, Rataul, Gaurjit, Dashehari, Zardalu	Less than 1800 °C	Alphonso, Rani pasand, Gopal Bhog, Bombay Green, Mithua, Makkhan, Krishna Bhog, Gulab Khus, Safeda Malihabad, Nayab, Rataul, Gaurjit
Early (maturing between 1 st June to 15 th June)	Alphonso, Raspuri, Amin Prince Safeda maldah, Langra Maldah, Amin Anguri, Benazir, Dalma, Langra Lucknow Safeda, Nasik Pasand, Champa, Jahangir, Khasul Khus	1800-2000 °C	Dashehari, Zardalu, Himsagar, Raspuri, Amin Prince, Safeda maldah, Langra Maldah, Amin Anguri, Benazir, Dalma, Langra, Lucknow Safeda, Nasik Pasand, Jahangir, Khasul Khus, Wazeer Pasand
Medium (maturing between 16 th June to 30 th June)	Latra, Taimuria, Calcutta maldah, Amrapalli, Paharapur sinduraja, Prabha Shankar, Chausa, Mallika, Darbare Kalam, Sahabale Pasand, Litchi, Kumar Pahar, Vanraj, Hur, Benishan, Alif Laila, Fazri, Zafrani, Neeluddin, Elaichi, Intemax, Pulihara, Alampur Benishan, Hybrid 14, Swarna Guddi, Neelgoa, Mahmood Bahar, Jalmarai	2000-2200 °C	Hybrid 14, Champa, Fazri Zafrani, Taimuria, Calcutta Maldah, Paharapur sinduria, Kumar Pahar, Vanraj, Alif Laila, Swarna Guddi
Late (maturing between 1 st July to 15 th July)	Fazli, Sipiya, Sahabale, Sesar, Bhoordas, Papaya Khus, Hybrid 7/165, Neelum, hamlet, Hybrid 51, Totapari	2200-2400 °C	Intemax, Pulihara, Elaichi, Neeluddin Jalmarai, Benishan, Sahabale Pasand, Darbare Kalam, Mallika, Chausa, Prabha Shankar, Amrapalli, Latra, Fazli, Mahmood Bahar, Sipiya, Sahabale, Sesar, Bhoordas, Papaya Khus, Hybrid 7/165, Neelum, Hamlet, Hybrid 51, Totapari
Very late (after 15 th July)	Bhatuhi, Alfazli, Aswania, Katak	More than 2400 °C	Litchi, Hur, Alampur Benishan, Neelgoa, Bhatuhi, Alfazli, Aswania, Katak

at $T_0 = 10^\circ\text{C}$ (Rai *et al.* 2002).

For determination of fruit quality, the samples comprised of 20 fruits from different bunches located in periphery of each tree were collected. The total soluble solids were measured using a hand refractometer. The titrable acidity was determined by titrating the juice against 0.1 N NaOH and expressed as citric acid equivalent (AOAC, 1977). Based on these values, the TSS: Acid ratio was worked out.

RESULTS AND DISCUSSION

Growing Degree Days received by different mango cultivars/hybrids during 2000-2001 have been presented in the Table 1. Among the cultivars the Growing Degree Days requirement ($^\circ\text{C}$) ranged from 1660.38 in Mithua to 3222.25 in Katak. The wide variation in GDD was due to the varied maturity period of different cultivars (Table 1). The observation are in full agreement with the findings of Singh *et al.* (1998) which indicates that each genotype needs certain amounts of accumulation of heat units for completion of different phenophases which cause the variation in maturity period. The average number of days from flowering to maturity has been considered as a maturity criterion in mango by different workers (Sengupta *et al.* 1996). However, Ananthanaryayan and Pillai (1968) indicated role of climatic parameters like heat, RH and rainfall as the other parameters influencing fruit maturity in mango.

Based on date of maturity the different cultivars under study can be classified into five maturity groups viz. Very early (maturing before 31st May), Early (Maturing between 1st June to 15th June), Medium (maturing between 16th June to 30th June), Late maturing between 1st July to 15 July), Very late (after 15th July). Accordingly the cultivars, Gopal Bhog, Bombay Green, Mithua, Himsagar, Makkhan, Krishna Bhog, Gulab Khus, Safeda Malihabad, Nayab, Wazeer Pasand, Rataul, Gaurjit, Dashehari and Zardalu can be considered very early maturing whereas, the cultivars Bhatuhi, Alfazli, Aswania and Ktaksi can be considered as very late maturing (Table 1). However, based on the growing degree days requirement the different cultivars can also be divided in to five different groups viz. requiring less than 1800 $^\circ\text{C}$, requiring

1800-2000 $^\circ\text{C}$, requiring 2200-2400 $^\circ\text{C}$ and requiring more than 2400 $^\circ\text{C}$ of Growing Degree Days for fruit maturity. Based on this the cultivars, Alphonso, Rani pasand, Gopal Bhog, Bombay Green, Mithua, Makkhan, Krishna Bhog, Gulab Khus, Safeda Malihabad, Nayab, Rataul and Gaurjit require the minimum amount of growing degree days for fruit maturity whereas the cultivars litchi, Hur, Alampur Benishan, Neelgoa, Bhatuhi, Alfazli, Aswania, Katak require the maximum Growing Degree Days for attaining fruit maturity (Table 1).

Ratio of Total soluble solids (TSS) and acidity is one of the most important criterions used for determination of fruit quality in mango. Rai *et al.* (2002) had indicated possible correlation between TSS/ acidity ratio and accumulation of degree days in different litchi cultivars. The data on TSS/ acid ratio attended at ripening by the different mango cultivars is presented in Table 1. The growing degree days requirement did not show any relationship with the TSS / acidity ratio of different mango cultivars/ hybrids in the present study.

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