Assessment of Tamarind (Tamarindus indica L.) Varieties for Growth, Flowering, Fruiting, Yield and Quality

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A B S T R A C T

A field trail in a complete Randomized Design was conducted at Bidhan Chandra Krishi Viswavidyalaya, West Bengal during 2010-2011 to assess the growth, flowering, fruiting, yield and quality of tamarind of five varieties namely PKM-1, Urigam, Vantoor, Red and Sweet. The results indicated superiority of variety PKM-1 with plant height (445.33-569 cm), East-west canopy expansion (458.67-604.00 cm), number of fruit retention panicles¹ (4.33%), TSS (48.0 Brix), total sugar (40.33 g) with lower acidity (6.7 mg). The variety Urigam exhibited better performance with the characters like canopy expansion in North South direction (491.00-612.00 cm), trunk girth (39-52 cm), number of flowers panicle¹ (14.33), number of fruit set panicle¹ (10.33), fruit length (20.67 cm) and diameter (25.30 mm), fruit weight (17.77 g) and fruit yield tree⁻¹ (1388 g). Varieties Urigam and PKM-1 may be introduced in West Bengal for commercial cultivation.

Introduction

Tamarind (Tamarindus indica L.) is one of the most important multipurpose tree species in the Indian sub-continent. India is the world’s largest producer of tamarind product. Production in India is mainly concentrated in the drier southern states and the produce is collected by the villagers and sold in the open market.

Tamarind has a low water content and high level of protein, carbohydrates (60 – 72%) and minerals. The soluble solids content varies from 54 -69.9⁰ Brix (Benero et al., 1974; Baragano de Mosqueda, 1980). In West Bengal tamarind is still not grown as a commercial crop rather it is naturally grown as a commercial crop rather it is naturally grown in scattered manner. The available varieties are sour in taste and as such scope exists on varietal replacement with high yielding varieties of both sweet and less sour taste as a first step towards commercialization.

Materials and Methods

An experiment was carried out at Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during the month of fruiting, yield and quality of tamarind. The experiment was laid out in
Complete Randomized Design with 5 treatments (varieties) having 3 replication. The age of the plant was 6 years and have started bearing fruits. The varieties were: PKM-1, Urigam, Vantoor, Red and Sweet. Normal cultivation practices were adopted with NPK (20:20:20) @ 500 g plant$^{-1}$ with FYM @ 5 kg plant$^{-1}$. Observation were recorded on various growth characters viz., Plant height, Canopy growth, Girth, Days for flowering to fruiting, flowers, fruit set, fruit retention panicle$^{-1}$, fruit drop and days from flowering to maturity. Yield and yield attributes (Fruit length, diameter, weight and number of seeds fruit$^{-1}$) along with quality parameters (Total sugar, Acidity and TSS) were estimated (Ranjana, 2000).

**Results and Discussion**

Growth, flowering, fruit set, fruit drop, fruit retention: Amongst the varieties PKM-1 registered maximum (445.33 cm) plant height while Vantoor was least vigorous (Table 1).

The annual growth rate recorded was 22.13%, 29.7%, 36.68%, 26.0% and 27.78% for Sweet, Red, Vantoor, Urigam and PKM-1 respectively. The annual canopy expansion (East-West) of varieties Sweet, Red, Vantoor, Urigam and PKM-1 was @ 48.38%, 40.18%, 47.48%, 33.0% and 31.69% respectively and in the north-south direction these were 29.16%, 30.37%, 42.16%, 39.30% and 31.06% respectively. Trunk girth increased gradually with the increase in age and it was different with the varieties. The annual growth rate of the varieties was 26.23%, 23.17%, 17.45%, 33.33% and 33.34% respectively for Sweet, Red, Vantoor, Urigam and PKM-1. It was observed that growth of the plant in all respect was maximum during June–July while the growth rate was slow during November to March. It is clear from the growth data that the growth of tamarind remained slow during winter months as the temperature appears to be non-congenial for luxuriant growth. From April onwards the growth took up rapid stride with the rise in temperature favouring the physiological activities of the tree. It may be mentioned that Verheij and Coronel, (1991) indicated 33°- 37°C as ideal for growth of tamarind. The varieties showed variation with respect to days require from flowering to fruiting (Table 5). Variety Red was the earliest to set fruits (57 days) and PKM-1 took maximum time (82.33 days) for fruit set. Number of flowers panicle$^{-1}$ was recorded highest in Urigam (14.33) followed by PKM-1 (7.33), Vantoor (6.67), Red (5.67) and Sweet (4.00).

Significant variation was recorded with fruit set panicle$^{-1}$ and it was highest (10.33) with variety Urigam and was lowest (2.00) with both Red and Sweet (Table 5). Fruit drop panicle$^{-1}$ was total for variety Red and Sweet (100%) while the percentage was 70.96, 66.80 and 55.67 for Urigam, Vantoor and PKM-1 respectively (Table 5). Number for fruits retained panicle$^{-1}$ was 44.33% in PKM-1, 33.25% in Vantoor and 29.04% in Urigam (Table 5). The variety PKM-1 was the vigorous and took maximum time for flowering to fruit set possibly due to utilization of energy and food for growth purpose and thus required more time.

Similar trend was noticed with maturity also. The earliness of the flowering may also be attributed to the inherent potentialities of the varieties. It is interesting to note that varieties producing acidic fruits appear to be more productive whereas varieties with comparatively sweet in taste were shy in flower production. Variety Vantoor required 261 days from flowering to harvesting followed by Urigam (300.67 days) and PKM-1 (326.33 days). Urigam produced fruits with maximum (20.67 cm) length, diameter (25.30 mm), 17.77 g), maximum seeds fruit$^{-1}$ (20.67) and fruit yield (1383 g tree$^{-1}$).
### Table 1: Plant height of different varieties

| MONTH       | VARIETY | GM  | SE(m) | CD (0.05) |
|-------------|---------|-----|-------|-----------|
| DECEMBER 10 | SWEET   | 427.67a | 367.00c | 325.33d | 400.00b | 445.33a | 393.07 | 8.37 | 25.39 |
|             | RED     | 359.00d | 433.00ab | 376.33cd | 400.00bc | 400.00bc | 458.67a | 405.40 | 11.41 | 34.60 |
| JANUARY 11  | VANTOOR | 367.67d | 436.00ab | 383.67cd | 406.00bc | 406.00bc | 464.00a | 411.47 | 11.27 | 34.17 |
| FEBRUARY 11 | URIGAM  | 381.67c | 446.00ab | 393.00c | 415.00bc | 415.00bc | 472.00a | 420.93 | 11.15 | 33.82 |
| MARCH 11    | PKM-1   | 394.00c | 458.00ab | 407.67c | 424.00bc | 424.00bc | 479.33a | 432.60 | 11.31 | 34.31 |
| APRIL 11    | SWEET   | 378.67c | 446.00ab | 393.00c | 415.00bc | 415.00bc | 472.00a | 446.47 | 11.55 | 35.03 |
|             | RED     | 409.33c | 472.00ab | 423.67c | 437.00bc | 437.00bc | 490.33a | 446.47 | 11.55 | 35.03 |
| MAY 11      | VANTOOR | 425.00c | 484.00ab | 439.67c | 448.00bc | 448.00bc | 501.33a | 459.60 | 12.06 | 36.57 |
| JUNE 11     | URIGAM  | 441.00c | 501.00ab | 465.33bc | 461.00bc | 461.00bc | 517.00a | 477.07 | 12.23 | 37.09 |
| JULY 11     | PKM-1   | 466.33b | 531.00a | 488.33b | 487.00b | 487.00b | 543.00a | 503.13 | 12.88 | 39.08 |
| AUGUST 11   | SWEET   | 487.67b | 559.00a | 511.67b | 499.00b | 499.00b | 567.33a | 524.93 | 12.77 | 38.73 |
|             | RED     | 507.67b | 588.00a | 534.67b | 514.00b | 514.00b | 588.67a | 546.60 | 12.44 | 37.72 |
| SEPTEMBER 11| VANTOOR | 529.00b | 602.00a | 550.33b | 528.00b | 528.00b | 599.67a | 561.80 | 12.76 | 38.71 |
| OCTOBER 11  | URIGAM  | 532.67b | 607.00a | 555.00b | 532.00b | 532.00b | 604.00a | 566.13 | 12.83 | 39.93 |
| NOVEMBER 11 | PKM-1   | 532.67b | 607.00a | 555.00b | 532.00b | 532.00b | 604.00a | 566.13 | 12.83 | 39.93 |

### Table 2: Canopy expansion (East West)

| MONTH       | VARIETY | GM  | SE(m) | CD (0.05) |
|-------------|---------|-----|-------|-----------|
| DECEMBER 10 | SWEET   | 359.00d | 433.00ab | 376.33cd | 400.00bc | 400.00bc | 458.67a | 405.40 | 11.41 | 34.60 |
|             | RED     | 367.67d | 436.00ab | 383.67cd | 406.00bc | 406.00bc | 464.00a | 411.47 | 11.27 | 34.17 |
| JANUARY 11  | VANTOOR | 378.67c | 446.00ab | 393.00c | 415.00bc | 415.00bc | 472.00a | 420.93 | 11.15 | 33.82 |
| FEBRUARY 11 | URIGAM  | 394.00c | 458.00ab | 407.67c | 424.00bc | 424.00bc | 479.33a | 432.60 | 11.31 | 34.31 |
| MARCH 11    | PKM-1   | 409.33c | 472.00ab | 423.67c | 437.00bc | 437.00bc | 490.33a | 446.47 | 11.55 | 35.03 |
| APRIL 11    | SWEET   | 425.00c | 484.00ab | 439.67c | 448.00bc | 448.00bc | 501.33a | 459.60 | 12.06 | 36.57 |
|             | RED     | 441.00c | 501.00ab | 465.33bc | 461.00bc | 461.00bc | 517.00a | 477.07 | 12.23 | 37.09 |
| MAY 11      | VANTOOR | 466.33b | 531.00a | 488.33b | 487.00b | 487.00b | 543.00a | 503.13 | 12.88 | 39.08 |
| JUNE 11     | URIGAM  | 487.67b | 559.00a | 511.67b | 499.00b | 499.00b | 567.33a | 524.93 | 12.77 | 38.73 |
| JULY 11     | PKM-1   | 507.67b | 588.00a | 534.67b | 514.00b | 514.00b | 588.67a | 546.60 | 12.44 | 37.72 |
| AUGUST 11   | SWEET   | 529.00b | 602.00a | 550.33b | 528.00b | 528.00b | 599.67a | 561.80 | 12.76 | 38.71 |
|             | RED     | 532.67b | 607.00a | 555.00b | 532.00b | 532.00b | 604.00a | 566.13 | 12.83 | 39.93 |
Table 3: Canopy expansion (North South)

| MONTH        | VARIETY     | GM   | SE(m) | CD (0.05) |
|--------------|-------------|------|-------|-----------|
| SWEET RED VANTOOR URIGAM PKM-1 | SWEET RED VANTOOR URIGAM PKM-1 | SWEET RED VANTOOR URIGAM PKM-1 |
| DECEMBER 10 | 365.67c 428.00b 342.33c 491.00a 429.33b | 411.27 9.07 27.51 |
| JANUARY 11  | 370.00c 432.00b 346.67c 496.00a 435.00b | 415.93 9.31 28.24 |
| FEBRUARY 11 | 374.67c 439.00b 353.33c 502.00a 441.67b | 422.13 9.26 28.10 |
| MARCH 11    | 383.67c 447.00b 362.00e 510.00a 449.33b | 430.40 9.37 28.41 |
| APRIL 11    | 392.33c 457.00b 373.33c 520.00a 460.00b | 440.53 9.25 28.05 |
| MAY 11      | 400.67c 470.00b 385.00c 530.00a 469.33b | 451.00 8.88 26.92 |
| JUNE 11     | 413.00c 488.00b 399.67c 546.00a 483.67b | 466.07 9.30 28.20 |
| JULY 11     | 429.33c 506.00b 423.00c 560.00a 503.00b | 484.27 9.44 28.63 |
| AUGUST 11   | 446.00c 529.00b 447.33c 588.00a 529.33b | 507.93 9.65 29.26 |
| SEPTEMBER 11| 460.00c 545.00b 468.67c 598.00a 549.33b | 524.20 10.10 30.63 |
| OCTOBER 11  | 468.33c 554.00b 482.00c 608.00a 559.33b | 534.33 9.72 29.49 |
| NOVEMBER 11 | 472.33c 558.00b 486.67c 612.00a 562.67b | 538.33 9.78 29.67 |

Table 4: Trunk girth

| MONTH        | VARIETY     | GM   | SE(m) | CD (0.05) |
|--------------|-------------|------|-------|-----------|
| SWEET RED VANTOOR URIGAM PKM-1 | SWEET RED VANTOOR URIGAM PKM-1 | SWEET RED VANTOOR URIGAM PKM-1 |
| DECEMBER 10 | 27.33d 41.00a 36.33b 39.00a 33.50c | 35.43 0.83 2.53 |
| JANUARY 11  | 27.62c 41.50a 36.33b 39.50a 33.83b | 35.76 0.89 2.71 |
| FEBRUARY 11 | 28.17c 42.00a 36.67b 40.00a 34.33b | 36.23 0.94 2.85 |
| MARCH 11    | 28.17c 42.00a 37.17b 41.50a 35.33b | 36.83 0.98 2.98 |
| APRIL 11    | 28.33c 43.00a 37.67b 42.00a 36.50b | 37.50 1.05 3.17 |
| MAY 11      | 29.17c 43.50a 38.33b 43.00a 37.50b | 38.30 1.11 3.36 |
| JUNE 11     | 30.17c 45.00a 39.50b 44.50a 39.00b | 39.63 1.20 3.64 |
| JULY 11     | 31.33c 46.50a 40.33b 47.00a 40.83b | 41.20 1.36 4.13 |
| AUGUST 11   | 32.83c 48.00a 41.50b 49.00a 42.67b | 42.80 1.41 4.28 |
| SEPTEMBER 11| 33.67d 48.50a 42.17c 50.50a 43.67c | 43.70 1.62 4.91 |
| OCTOBER 11  | 34.17d 49.00a 42.67c 51.50a 44.33c | 44.33 1.70 5.15 |
| NOVEMBER 11 | 34.50d 49.50a 42.67c 52.00a 44.67c | 44.67 1.68 5.09 |

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Table 5  Days for flowering to fruiting, harvesting, number of flowers/panicle, fruits set/ panicle fruits drop / panicle, fruits retention / panicle of tamarind varieties

| VARIETY          | GM  | SE(m) | CD (0.05) |
|------------------|-----|-------|------------|
| SWEET RED VANTOOR URIGAM PKM-1 |
| FLOWERING TO FRUITING DAYS | 65.33 | 57.00 | 73.67 | 68.33 | 82.33 | 69.33 | 1.87 | 5.89 |
| FLOWERING TO HARVESTING DAYS | 0.0 | 0.0 | 261.00 | 300.67 | 326.33 | 296.00 | 1.32 | 4.57 |
| NUMBER OF FLOWERS/ PANICLE | 4.00 | 5.67 | 6.67 | 14.33 | 7.33 | 7.60 | 0.60 | 1.88 |
| NUMBER OF FRUITS SET/PANICLE | 2.00 | 2.00 | 4.00 | 10.33 | 3.00 | 4.27 | 0.60 | 1.88 |
| NUMBER OF FRUITS DROP / PANICLE | 2.00 | 2.00 | 2.67 | 7.33 | 1.67 | 3.13 | 0.45 | 1.41 |
| NUMBER OF FRUITS RETAIN / PANICLE | 0.0 | 0.0 | 1.33 | 3.00 | 1.33 | 1.13 | 0.43 | NS  |

Table 6  Days for flowering to fruiting, fruits set/ panicle and fruits drop / panicle of tamarind varieties

| VARIETY          | GM  | SE(m) | CD (0.05) |
|------------------|-----|-------|------------|
| SWEET RED VANTOOR URIGAM PKM-1 |
| FLOWERING TO FRUITING DAYS | 65.33 | 57.00 | 73.67 | 68.33 | 82.33 | 69.33 | 1.87 | 5.89 |
| NUMBER OF FRUITS SET/PANICLE | 2.00 | 2.00 | 4.00 | 10.33 | 3.00 | 4.27 | 0.60 | 1.88 |
| NUMBER OF FRUITS DROP / PANICLE | 2.00 | 2.00 | 2.67 | 7.33 | 1.67 | 3.13 | 0.45 | 1.41 |

Table 7  Fruit yield/ tree, total sugar, total acidity, total soluble solids (TSS)

| VARIETY          | GM  | SE(m) | CD (0.05) |
|------------------|-----|-------|------------|
| SWEET RED VANTOOR URIGAM PKM-1 |
| YIELD (gm/plant) | NIL | NIL | 722.67 | 1383.00 | 923.33 | 1009.67 | 19.88 | 68.80 |
| Total sugar per 100gm of edible pulp | NIL | NIL | 33.67 | 29.33 | 40.33 | 34.44 | 1.00 | 3.46 |
| Total acid per 100 gm of edible pulp (mg) | NIL | NIL | 7.67 | 8.60 | 6.73 | 7.67 | 0.12 | 0.43 |
| TSS (ºBrix) | NIL | NIL | 39.33 | 35.33 | 48.00 | 40.89 | 0.72 | 2.49 |
It may be that the growth of variety Urigam was comparatively higher than other four varieties and provided higher amount of photosynthetic assimilates to produce higher yield. Quality characters indicated PKM-1 with higher TSS (48° Brix) and total sugars (40.33 g) and these obtained lowest (35.33° Brix and 29.33 g) with variety Urigam (Table 7). The acidity recorded highest (8.60) with Urigam and lowest with PKM-1.

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