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# Evaluation Of Inbred Lines On Growth, Yield And Quality Traits In Tomato (*Solanum Lycopersicum* L.)

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**Abstract**

This study aimed to assess the genotypes derived from the cross between 16P2 and Kashi Hemanth in tomatoes (*Solanum lycopersicum* L.). The evaluation took place in farmers' fields at Kanaykanahalli village, Belur Taluk, Hassan district from 2020 to 2022. A total of 29 advanced breeding lines (ABLs) and five control varieties, namely Arka Rakshak, Arka Apeksha, Arka Samrat, Pusa Ruby and Pusa Rohini, were analyzed using a randomized block design (RBD). Among the 34 genotypes, ABL 68 exhibited the highest pooled mean for plant height, fruit count, fruit weight, fruit length, fruit width, locule number, pericarp thickness, and firmness, while ABL 17 had the lowest. ABL 237 demonstrated the highest lycopene content at 9.67 mg/100g. These results will aid in selecting superior genotypes for future breeding programs.

**Keywords:** Tomato, ABL, evaluation, genotype and lycopene

## Introduction

Tomato (*Solanum lycopersicum* L.) is a crucial solanaceous vegetable crop grown extensively worldwide. It serves multiple culinary purposes, being highly versatile. Ripe tomatoes are enjoyed fresh in salads, cooked dishes, and a variety of processed products such as puree, paste, powder, ketchup, sauce, soup, and canned whole fruits. Additionally, unripe green tomatoes are commonly used for making pickles and chutney.

Tomatoes are rich in lycopene (an antioxidant), ascorbic acid, and β-carotene, which contribute to their color and flavor. While tomatoes are often eaten fresh, over 80% of their consumption comes from processed products like tomato juice, paste, puree, ketchup, and sauce (Takeoka *et al.*, 2001). Research suggests significant health benefits from a diet high in tomatoes and tomato products (Mayeaux *et al.*, 2006). Tomatoes are valued for their carotenoids and polyphenols, which are associated with cancer prevention, with the red color of the fruit attributed to lycopene (Marti *et al.*, 2016; Boileau *et al.*, 2003; Rao *et al.*, 1998).

## Material and methods

Experimental studies were conducted at a farmer's field in Kanaykanahalli, Belurtaluk, Hassan district, over the periods of 2020-2021 and 2021-2022. The research involved 29 selected $F_6$ lines from the cross between 16P2 and Kashi Hemanth, known for their high lycopene content and yield, along with five control varieties: Arka Rakshak, Arka Samrat, Arka Apeksha, Pusa Ruby, and Pusa Rohini. The experiment spanned three seasons: early *rabi*, kharif, and late *rabi.* Statistical analysis was performed using the replication-wise mean data collected during these seasons.

## Results and discussion

ANOVA reported that the mean sum of square due to genotype are significant for all the studied characters during all three seasons of study (Table 1).

**Table 1. ANOVA for various parameters in tomato during first season (early *rabi*) for all characters**

| Source | Df | Plant height | No. of Branches | Days to 50 % flowering | No. of fruits | Fruit length | Fruit width | Fruit weight |
|---|---|---|---|---|---|---|---|---|
| Replication | 1 | 6.08 | 0.31 | 0.04 | 2.12 | 0.29 | 0.14 | 9.589 |
| Treatment | 33 | 1004.06** | 8.43** | 11.42** | 622.38** | 1.61** | 1.62** | 864.20** |
| Error | 33 | 15.74 | 0.14 | 2.55 | 8.08 | 0.10 | 0.10 | 19.76 |

| Source | Df | Yield/plant | No. of locules | TSS | Pericarp thickness | Firmness | Lycopene |
|---|---|---|---|---|---|---|---|
| Replication | 1 | 0.50 | 0.49 | 0.01 | 0.11 | 00 | 0.21 |
| Treatment | 33 | 3.15** | 2.57** | 0.48** | 1.37** | 0.08** | 3.60** |
| Error | 33 | 0.12 | 0.14 | 0.07 | 0.07 | 0.00 | 0.22 |

**Table 2. ANOVA for various parameters in tomato during second season (*kharif*) for all characters**

| Source | Df | Plant height | No. of Branches | Days to 50 % flowering | No. of fruits | Fruit length | Fruit width | Fruit weight |
|---|---|---|---|---|---|---|---|---|
| Replication | 1 | 13.33 | 0.056 | 0.13 | 12.04 | 0.02 | 0.10 | 3.23 |
| Treatment | 33 | 1039.21** | 8.11** | 10.83** | 589.77** | 1.58** | 1.61** | 851.85** |
| Error | 33 | 20.54 | 0.22 | 3.25 | 10.84 | 0.06 | 0.09 | 18.44 |

| Source | Df | Yield/plant | No. of locules | TSS | Pericarp thickness | Firmness | Lycopene |
|---|---|---|---|---|---|---|---|
| Replication | 1 | 0.02 | 0.15 | 0.03 | 0.07 | 00 | 0.02 |
| Treatment | 33 | 2.99** | 0.49** | 2.51** | 2.49** | 0.09** | 3.61** |
| Error | 33 | 0.11 | 0.05 | 0.07 | 0.11 | 0.00 | 0.29 |

**Table 3. ANOVA for various parameters in tomato during third season (late *rabi*) for all characters**

| Source | Df | Plant height | No. of Branches | Days to 50 % flowering | No. of fruits | Fruit length | Fruit width | Fruit weight |
|---|---|---|---|---|---|---|---|---|
| Replication | 1 | 0.55 | 0.01 | 3.31 | 14.32 | 0.09 | 0.03 | 18.11 |
| Treatment | 33 | 996.01** | 8.26** | 11.07** | 607.24** | 1.63** | 1.55** | 816.46** |
| Error | 33 | 15.34 | 0.17 | 3.64 | 7.06 | 0.08 | 0.08 | 29.29 |

| Source | Df | Yield/plant | No. of locules | TSS | Pericarp thickness | Firmness | Lycopene |
|---|---|---|---|---|---|---|---|
| Replication | 1 | 0.13 | 0.01 | 0.05 | 0.08 | 0.00 | 0.02 |
| Treatment | 33 | 3.14** | 0.48** | 2.53** | 2.27** | 0.09** | 3.60** |
| Error | 33 | 0.06 | 0.07 | 0.07 | 0.07 | 0.00 | 0.37 |

## Growth parameters

Plant height differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4, Fig.1). The highest pooled mean was recorded by line 68 (153.1) which significantly differed from all other lines. The least plant height was recorded by line 17 (43.8) which also differed significantly from all other lines. The number of branches differed significantly among the recombinant inbreds in all the seasons as well as with respect to pooled mean (Table 4). The analysis of the pooled mean demonstrated that RIL 68 recorded the significantly highest number of branches (15.70) compared to all other RILs. The least was recorded by RIL 129 (4.68) closely followed by RIL 17 (4.78) and 237 (4.93). Statistical analysis revealed significant differences in days to fifty per cent flowering among the ABLs across all seasons, as well as in relation to the pooled mean (refer to Table 4, Fig.1). The highest pooled mean was recorded in ABL 66 recorded the maximum (34.1), closely followed by 362 (34.03), 68 (33.82), 283 (33.68), 294 (33.6), 260 (33.26), 454 (33.10), 315 (32.96), 302 (32.63), 358 (32.26), 477 (32.14), 399 (31.79) and one check Arka Apeksha (32.5) which significantly differed from all other lines. It was lowest in ABL 17 (27.2) which was also significantly different when compared with other ABLs. It was closely followed by 237 (27.3).The results obtained are in consonance with the findings of Olaniyi *et al*. (2010), Kanwar (2011), Richardson (2013), Mehraj *et al*. (2014) and Tsagaye and Alemu (2020).

**Table 4. Mean performance of lines for growth and yield attributes**

| ABLs | Plant height (cm) | No. of Branches | Days to fifty per cent flowering | No. of fruits/plant | Fruit length (cm) | Fruit width (cm) | Fruit weight (g) | Yield per plant (g) |
|---|---|---|---|---|---|---|---|---|
| 17 | 43.8 | 4.78 | 27.2 | 24.51 | 2.60 | 2.36 | 52.66 | 2.72 |
| 23 | 60.2 | 5.60 | 28.3 | 36.20 | 3.55 | 3.65 | 64.09 | 3.66 |
| 25 | 64.5 | 6.01 | 28.3 | 37.29 | 3.96 | 4.13 | 66.65 | 3.67 |
| 41 | 66.2 | 5.90 | 28.8 | 43.92 | 4.05 | 4.29 | 70.19 | 3.96 |
| 66 | 116.4 | 9.64 | 34.1 | 86.64 | 5.49 | 5.88 | 117.37 | 6.78 |
| 68 | 153.1 | 15.70 | 33.8 | 91.85 | 5.62 | 5.99 | 121.73 | 6.76 |
| 129 | 50.3 | 4.68 | 26.8 | 33.78 | 2.73 | 2.64 | 56.64 | 2.92 |
| 175 | 69.0 | 6.80 | 29.2 | 45.22 | 4.11 | 4.48 | 71.09 | 4.44 |
| 237 | 51.1 | 4.93 | 27.3 | 34.18 | 2.74 | 3.01 | 57.08 | 3.55 |
| 260 | 97.0 | 8.49 | 33.3 | 73.29 | 5.47 | 5.44 | 117.52 | 6.53 |
| 275 | 61.8 | 5.66 | 28.1 | 36.40 | 3.54 | 3.71 | 64.41 | 3.72 |
| 283 | 99.3 | 8.54 | 33.7 | 75.62 | 5.37 | 5.57 | 116.58 | 6.46 |
| 290 | 53.3 | 5.51 | 28.0 | 35.16 | 3.44 | 3.60 | 63.17 | 3.59 |
| 294 | 112.2 | 9.73 | 33.6 | 80.46 | 5.58 | 5.53 | 119.38 | 6.67 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **302** | 87.2 | 7.98 | 32.6 | 67.29 | 5.32 | 5.08 | 83.95 | 5.98 |
| **312** | 67.7 | 6.17 | 28.7 | 43.60 | 4.04 | 4.37 | 70.25 | 4.07 |
| **315** | 94.3 | 7.78 | 33.0 | 68.03 | 5.41 | 5.26 | 97.47 | 6.21 |
| **343** | 74.2 | 7.44 | 30.0 | 47.10 | 4.37 | 4.73 | 78.69 | 5.31 |
| **345** | 68.5 | 6.90 | 29.9 | 46.19 | 4.18 | 4.61 | 76.78 | 4.62 |
| **358** | 82.3 | 7.72 | 32.3 | 60.80 | 5.23 | 5.15 | 82.41 | 5.83 |
| **362** | 109.2 | 9.61 | 34.0 | 75.66 | 5.46 | 5.36 | 116.23 | 6.56 |
| **365** | 51.6 | 5.44 | 27.1 | 34.37 | 3.23 | 3.22 | 61.34 | 3.61 |
| **396** | 66.4 | 5.80 | 29.1 | 43.00 | 3.96 | 4.31 | 67.08 | 3.82 |
| **399** | 75.1 | 7.65 | 31.8 | 58.75 | 4.70 | 5.01 | 81.18 | 5.63 |
| **419** | 63.6 | 5.89 | 27.9 | 36.77 | 3.55 | 3.90 | 64.93 | 3.74 |
| **429** | 68.6 | 7.39 | 29.8 | 46.67 | 4.13 | 4.74 | 78.40 | 4.57 |
| **454** | 95.5 | 8.21 | 33.1 | 71.86 | 5.38 | 5.23 | 108.63 | 6.29 |
| **477** | 76.3 | 7.65 | 32.1 | 60.33 | 4.98 | 5.10 | 80.47 | 5.93 |
| **757** | 65.6 | 5.82 | 29.0 | 38.98 | 3.86 | 4.25 | 67.21 | 3.84 |
| **Arka Apeksha** | 86.3 | 7.87 | 32.5 | 66.54 | 5.18 | 5.17 | 83.89 | 5.84 |
| **Arka Rakshak** | 73.8 | 7.61 | 30.3 | 55.03 | 4.46 | 5.04 | 79.67 | 5.35 |
| **Arka Samrat** | 73.2 | 7.41 | 30.6 | 55.71 | 4.37 | 4.91 | 79.22 | 5.26 |
| **Pusa Ruby** | 73.2 | 7.53 | 30.1 | 46.12 | 4.20 | 4.73 | 77.74 | 4.72 |
| **Pusa Rohini** | 69.1 | 6.64 | 29.7 | 44.68 | 4.02 | 4.44 | 71.05 | 4.37 |
| **Means** | 77.1 | 7.25 | 30.4 | 53.00 | 4.36 | 4.55 | 81.33 | 4.91 |
| **CD @ 5 %** | 6.1 | 0.53 | 2.7 | 3.96 | 0.31 | 0.44 | 8.58 | 0.55 |
| **Sem±** | 2.11 | 0.18 | 0.93 | 1.37 | 0.11 | 0.15 | 2.98 | 0.19 |
| **CV** | 3.9 | 3.59 | 4.3 | 3.67 | 3.54 | 4.79 | 5.19 | 5.50 |

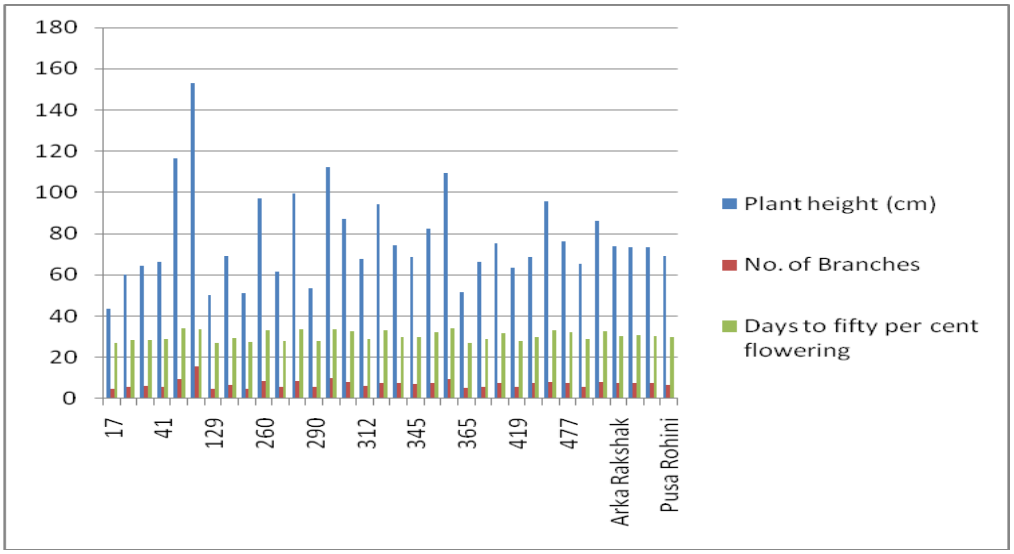


**Fig.1. Mean Performance of ABLs for growth parameters**

**Yield parameters**

The number of fruits differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4, Fig.2). The analysis of the pooled mean demonstrated that ABL 68 recorded a significant maximum number of fruits (91.85). It was lowest in ABL 17 (24.51) which also differed significantly from all other ABLs. Fruit weight differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4, Fig.2). The highest pooled mean was recorded by ABL 68 (121.73), closely followed by 66 (117.37), 260 (117.52), 283 (116.58), 294 (119.38) and 362 (116.23) which significantly differed from all other ABLs for this trait. The least fruit weight was recorded by ABL 17 (52.66) which also differed significantly from all other lines.Yield per plant differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4). The analysis of the pooled mean demonstrated that yield per plant was the highest in ABL 66 and recorded the maximum fruit yield (6.78) which significantly differed from all other ABLs except 68 (6.76), 260 (6.53), 283 (6.46), 294 (6.67), 362 (6.56) and 454 (6.29). It was lowest in ABL 17 (2.72) and also showed a significant difference from other ABLs.

Fruit length trait differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4). The highest pooled mean was recorded by ABL 68 (5.62), closely followed by 294 (5.58), 66 (5.49), 260 (5.47), 362 (5.46), 315 (5.41), 283 (5.37), 302 (5.32) which significantly differed from all other advanced breeding lines. The least fruit length was recorded by ABLs 17 (2.60), 129 (2.73) and 237 (2.74) which also differed significantly from all other ABLs. Fruit width differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 4). The pooled mean analysis revealed that ABL 68 recorded the significantly highest fruit width (5.99) followed by 66 (5.88) and 283 (5.57) when compared with other ABLs. It was lowest in ABL 17 (2.36), closely followed by 129 (2.64) which also differed significantly from all other ABLs. The results obtained are in consonance with the findings of Mehraj *et al.* (2014) and Tsagaye and Alemu (2020).

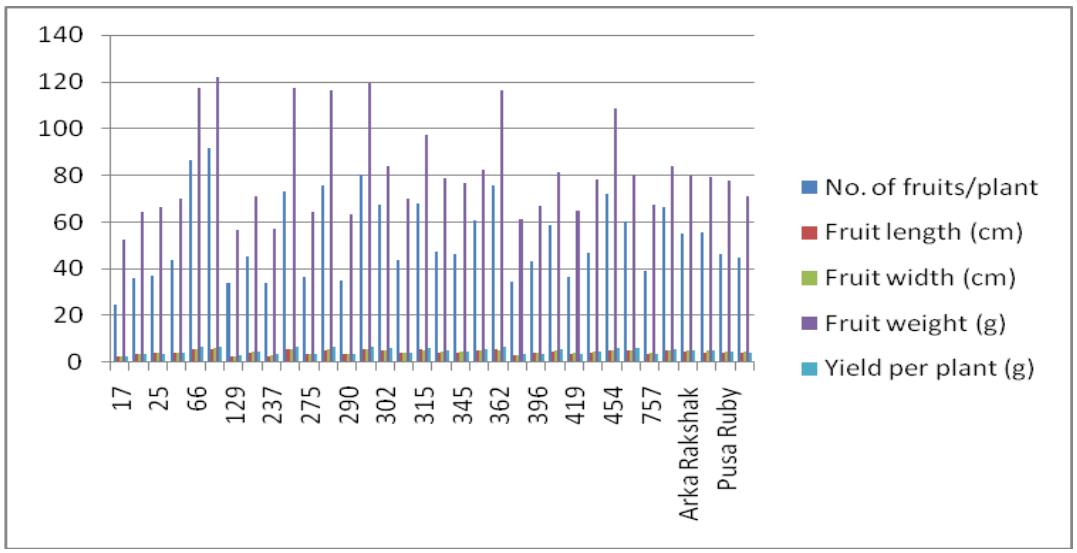


**Fig.2. Mean Performance of ABLs for yield parameters**

**Quality parameters**

The number of locules differed significantly among the RILs in all the seasons as well as with respect to pooled mean (Table 5, Fig.3). The analysis of the pooled mean demonstrated that ABL 68 recorded the significantly highest number of locules (5.05) when compared with other ABLs, except 260 (4.86), 283 (4.90), 294 (4.88), 315 (4.78), 362 (4.89) and 454 (4.82). The lowest number of locules was recorded by ABL 17 (2.41) which also differed significantly from other ABLs. Pericarp thickness differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 5). The analysis of the pooled mean demonstrated that for pericarp thickness the ABLs differed significantly and 68 was with maximum pericarp thickness across all the seasons with a mean value of 5.76 mm. It was closely followed by 66 (5.60), 283 (5.60), 362 (5.57), 294 (5.52) and 315 (5.40). ABL 17 recorded the least pericarp thickness (2.75), closely followed by 25 (3.51) which also differed significantly from other lines.

Total soluble solids differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 5, Fig.3). The analysis of the pooled mean demonstrated that ABL 294 recorded the higher total soluble solids (5.48 ° B) across all the seasons and it was followed by ABLs 66 (5.45), 315 (5.43), 362 (5.42), 283 (5.41), 68 (5.40), 260 (5.36) and 454 (5.32) and across all three periods of evaluation. TSS was least in ABL 17 with a mean value of 2.20, which differed significantly from all other ABLs.

Firmness differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 5). The analysis of the pooled mean demonstrated that the advanced breeding line 68 had significantly the highest firmness across all the environments with a mean value of 1.27 kg/cm$^2$ when compared with other ABLs. It was the least in ABL 17 (0.35), closely followed by 129 (0.37), 237 (0.38) and 365 (0.40) which also differed significantly from other ABLs.

Lycopene content differed significantly among the ABLs in all the seasons as well as with respect to pooled mean (Table 5, Fig.3). The analysis of the pooled mean demonstrated that all the ABLs differed significantly in lycopene content. Arka Apeksha recorded the lycopene content across all the seasons with the mean value of 11.21 mg/100g which differed significantly from all other ABLs. It was the least in Pusa Ruby (4.36 mg/100g), closely followed by Pusa Rohini (4.61 mg/100g), which also differed significantly from other ABLs. Among advanced breeding lines maximum lycopene content was recorded with ABL 237 (9.67 mg/100g) but on par with ABLs 17, 23, 41, 68, 129, 175, 275, 283, 290, 302, 315, 345, 365, 396, 399, 454, 477 and 757. The results obtained are in consonance with the findings of Sucheta *et al*. (2004), Kuti and Konuru (2005),

Markovie *et al*. (2006), Satesh *et al.* (2007), Cantore *et al*. (2008), Lekshmi and Celine (2015), Sureshkumara *et al*. (2017), Venkadeswaran *et al.* (2018) and Chandni *et al*., (2020).

**Table 5. Mean performance of lines for quality attributes**

| ABLs | No. of locules | Pericarp thickness (mm) | TSS (° Brix) | Firmness (kg/cm²) | Lycopene (mg/100g) |
|---|---|---|---|---|---|
| **17** | 2.41 | 2.75 | 2.20 | 0.35 | 9.06 |
| **23** | 3.18 | 2.99 | 3.12 | 0.45 | 9.22 |
| **25** | 3.69 | 3.51 | 3.79 | 0.50 | 8.21 |
| **41** | 3.80 | 3.76 | 3.84 | 0.56 | 9.32 |
| **66** | 5.01 | 5.60 | 5.45 | 0.96 | 8.12 |
| **68** | 5.05 | 5.76 | 5.40 | 1.27 | 8.64 |
| **129** | 2.84 | 2.91 | 2.89 | 0.37 | 8.78 |
| **175** | 3.89 | 3.54 | 3.89 | 0.55 | 9.56 |
| **237** | 3.11 | 2.96 | 3.03 | 0.38 | 9.67 |
| **260** | 4.86 | 5.37 | 5.36 | 0.84 | 8.44 |
| **275** | 3.22 | 2.77 | 3.13 | 0.44 | 9.30 |
| **283** | 4.90 | 5.60 | 5.41 | 0.91 | 8.52 |
| **290** | 3.2 | 2.90 | 3.11 | 0.44 | 9.36 |
| **294** | 4.88 | 5.52 | 5.48 | 0.94 | 7.84 |
| **302** | 4.49 | 4.62 | 4.69 | 0.77 | 8.73 |
| **312** | 3.87 | 3.65 | 3.89 | 0.54 | 7.54 |
| **315** | 4.78 | 5.40 | 5.43 | 0.79 | 8.52 |
| **343** | 4.45 | 4.49 | 4.67 | 0.65 | 8.23 |
| **345** | 3.86 | 3.64 | 3.98 | 0.59 | 9.14 |
| **358** | 4.41 | 4.69 | 4.68 | 0.72 | 8.40 |
| **362** | 4.89 | 5.57 | 5.42 | 0.89 | 7.55 |
| **365** | 3.14 | 2.74 | 3.05 | 0.40 | 8.78 |
| **396** | 3.7 | 3.56 | 3.83 | 0.54 | 8.79 |
| **399** | 4.39 | 4.48 | 4.65 | 0.71 | 9.10 |
| **419** | 3.58 | 3.66 | 3.74 | 0.48 | 7.59 |
| **429** | 4.01 | 3.59 | 4.00 | 0.60 | 7.86 |
| **454** | 4.82 | 5.44 | 5.32 | 0.81 | 8.74 |
| **477** | 4.41 | 4.54 | 4.72 | 0.72 | 9.11 |
| **757** | 3.7 | 3.46 | 3.83 | 0.53 | 9.11 |
| **Arka Apeksha** | 4.47 | 4.68 | 4.76 | 0.75 | 11.21 |
| **Arka Rakshak** | 4.41 | 4.37 | 4.67 | 0.68 | 6.04 |

| | | | | | |
|---|---|---|---|---|---|
| **Arka Samrat** | 4.35 | 4.42 | 4.65 | 0.66 | 6.70 |
| **Pusa Ruby** | 4.37 | 4.44 | 4.67 | 0.62 | 4.36 |
| **Pusa Rohini** | 3.88 | 3.58 | 3.91 | 0.56 | 4.61 |
| **Means** | 4.06 | 4.14 | 4.25 | 0.64 | 8.31 |
| **CD @ 5 %** | 0.36 | 0.36 | 0.30 | 0.05 | 1.18 |
| **Sem±** | 0.13 | 0.13 | 0.10 | 0.02 | 0.41 |
| **CV** | 4.37 | 4.28 | 3.43 | 3.96 | 6.96 |

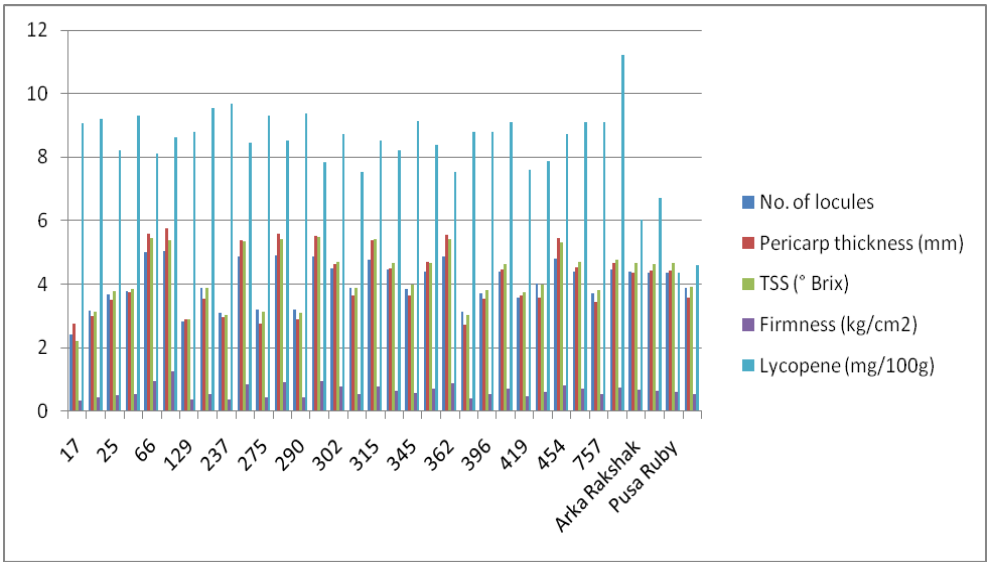


**Fig.3. Mean Performance of ABLs for quality parameters**

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