**Performance of Different Varieties of Mango in North Gujarat Condition under Different Plant Spacing**

**ABSTRACT**

The study was conducted to evaluate the performance of different varieties of Mango in North Gujarat condition under different plant spacing during 2008-2023 at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. Accordingly, Kesar, Totapuri, Dashehari, Mallika and Amrapali varieties were planted in year 2008 at spacing of 4 m x 4 m, 5 m x 5 m, 6 m x 6 m and 7 m x 7 m. The experiment was laid out in factorial randomized block design with three replications and twenty treatment combinations. The different growth and yield parameters were recorded in terms of plant spread, plant height, plant stem girth, fruit yield plant-1 and fruit yield hectare-1 as observations. The experimental results revealed that, individually, Dashehari variety recorded maximum plant spread (E-W and N-S) (7.05 m and 7.17 m respectively), stem girth (91.92 cm) and Kesar variety recorded maximum plant height (7.54 m), while in case of planting spacing 7 m x 7 m recorded maximum plant spread (E-W and N-S) (7.53 m and 7.55 m respectively), plant height (7.01 m) and stem girth (90.07 cm) after 15th year of planting. With regard to yield parameters, Kesar variety planted at 4 m x 4 m spacing found superior and reported highest fruit yield hectare-1(11875.00 kg) whereas, highest fruit yield plant-1 (32.73 kg) was observed with 7 m x 7 m spacing after 15th year of planting. Hence, kesar variety planted at 4 m x 4 m spacing found suitable for North Gujarat condition.

**KEYWORDS:** *Mangifera indica*, high density planting, variety, mango, spacing

1. **INTRODUCTION**

Mango (*Mangiferaindica* L.), which belongs to the family anacardiaceae, has immense adaptability and grows well in an extensive compass of climatic and soil conditions, making it the best of Indian table fruits (Chakraborti et al., 2022). Mango is cultivated over an area of 2316.8 thousand ha with an annual production of 20386 thousand MT with 8.8 MT/ha productivity in India (Anonymous, 2021). Gujarat is one of the important mango growing states of India and occupies an area of 163.78 thousand ha with production of 997.83 thousand MT with a productivity of 6.09 MT/ha (Anonymous, 2021). The most important mango grown cultivars in Western India are Kesar, Alphonso, Totapuri, Rajapuri, Vanraj, Dashehari, Jamadar, Langra, Neelum, Badami, Amrapali, Mallika, Dadamio and Sardar (Patel et al, 2022). Mango is high in vitamins, minerals and antioxidants and has been associated with a variety of health advantages, including potential anticancer effects, increased immunity, digestive health and eye health. (Anand et al., 2024). Owing to its importance and popularity, now a day several mango varieties are grown in Banaskantha, Sabarkantha and Kutch district of North Gujarat. Despite of higher producer of mango, India is still far behind in productivity. The main reason for low productivity can be attributed to poor orchard management including water and nutrient management, wider tree spacing with dense canopies, experiencing poor sunlight interception, lack of proper ventilation encouraging more pest and disease incidences (Soman et al., 2024). In addition to that, availability of arable land for extending mango cultivation has been a limitation over the years. Hence, intensification of mango production system is the necessity in the coming years. Increasing productivity of mango is possible by establishing high density orchards maximizing the resource use efficiency resulting in at least 2-3 times higher fruit yields than widely spaced orchards (Singh et al., 2001, Dalvi et al., 2010, Chaudhari and Singh, 2019, Kumar et al., 2019, Vidyashree et al., 2021, Soman et al., 2024). A great benefit of this system is the ability to carry out novel manipulations, which are largely impractical in conventional planting system such as ability to easily remove malformed inflorescences, ease in harvest and inter cultural operations (Raj et al., 2017, Oosthuyse et al., 2018). Moreover, planting trees at higher density leads to higher light interception resulting in earlier cropping and higher yields with faster return on investment (Menzel and Lagadec, 2017, Mahmud et al., 2023). In India, release of high yielding, regular bearing mango hybrids viz., Mallika (Gaikwad et al., 2017, Mitra and Bhagwan, 2018, Kumar et al., 2019, Kavitha et al., 2022, Srivastava et al., 2024) and Amrapali (Das and Jana, 2013, Raj et al., 2017, Mitra and Bhagwan, 2018, Vidyashree et al., 2021, Kavitha et al., 2022) gradually paved the way for high density planting in mango. Furthermore, Dashehari (Gaikwad et al., 2017, Raj et al., 2017, Kumar et al., 2019) Kesar (Gaikwad et al., 2017, Kavitha et al., 2018, Kumar et al., 2019, Vidyashree et al., 2021, Kavitha et al., 2022) and Totapuri (Kavitha et al., 2018, Kumar et al., 2019, Vidyashree et al., 2021, Kavitha et al., 2022, Soman et al., 2024) cultivar also found promising for closer planting. The information on varietal evaluation is scanty and no systematic work has been done to evaluate the mango varieties under high density planting in North Gujarat. Thus, the present investigation was carried out to study the performance of different varieties of Mango in North Gujarat condition under different plant spacing.

1. **MATERIALS AND METHODS**

The experiment was laid out in Factorial Randomized Block Design with three replications at Horticulture Demonstration Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). Geographically, Sardarkrushinagar falls in a subtropical climate and is situated at 24.32 °N (latitude) and 72.17 °E (longitude) and about 177 meters above mean sea level. The study was undertaken with an objective to find out the suitable varieties of Mango for commercial cultivation in North Gujarat and to find out the most appropriate plant spacing for maximum production of Mango fruit. The different varieties (V) i.e. V1 (Kesar), V2 (Totapuri), V3 (Dashehari), V4 (Mallika) and V5 (Amrapali) were evaluated as one factor whereas planting spacing (S) i.e. S1 (4 m x 4 m), S2 (5 m x 5 m), S3 (6 m x 6 m) and S4 (7 m x 7 m) were evaluated as another factor. There were total twenty treatment combinations and for each treatment one plant was considered for recording observation. The mango plants propagated through softwood grafting were planted in the monsoon of year 2008. The recommended dosage of fertilizer for Gujarat i.e. 750:160:750 g NPK per plant per year was given and standard package of practices were followed during the year of experimentation. The observations for adult tree were recorded during last week of December to first week of January every year. The different growth and yield parameters were recorded in terms of plant spread (E-W and N-S) (m), plant height (m), plant stem girth (cm), fruit yield plant-1 (kg) and fruit yield hectare-1(kg). Plant height was measured from base of the ground and stem girth was measured from base trunk of the plant. The growth parameters were recorded for 6th (2014), 10th (2018) and 15th (2023) year after planting and 15th year (2023) data is analysed for final interpretation. Whereas yield data were recorded for the year 2019 to 2023 (11th to 15th year after planting) and pooled data were analysed for interpretation. The data were statistically analysed as methods suggested by Panse and Sukhatme (1961).

1. **RESULTS AND DISCUSSION**

**3.1 Effect of spacing on plant growth parameters**

Analysis of data revealed that spacing showed significant effect on plant growth parameters (Table 1 and 2). Data from Table 1 revealed that, plant spread (E-W) and plant spread (N-S) was found significant and maximum plant spread (E-W and N-S) (7.53 m and 7.55 m respectively) were recorded in S4 (7m x 7m) spacing after 15th year of planting (2023). Similar trend was recorded after 6th (2014) and 10th (2018) year of planting. In high density planting natural tendency of the plant is to put forth reduced canopy growth as compare to normal planting spacing, due to several possible reasons viz., lesser available place in between the rows of plants, restrictions of light, increment in competition for water and soil nutrients and decreased plant stem girth. The above results were in agreement with earlier reports of Ibell et al., (2024), Gaikwad et al., (2017), Sousa et al., (2012), Nath et al., (2007), Dalvi et al., (2010), Policarpo et al., (2006) Ram et al., (1997). Likewise, data from Table 2 revealed that significantly maximum plant height (7.01 m) and plant stem girth (90.07 cm) were observed in S4 (7m x 7m) spacing after 15th year of planting. However, S3 (6 m x 6 m) and S2 (5 m x 5 m) spacing were significantly at par with S4 (7 m x 7 m) treatment in case of plant height whereas S3 (6 m x 6 m) treatment was significantly at par with S4 (7 m x 7 m) spacing in case of plant stem girth. The similar trend of reduced growth under high planting density in terms of plant stem girth was reported by Gaikwad et al., (2017), Nath et al., (2007), Dalvi et al., (2010). Plant height may decrease with increase in plant density as observed in Dashehari mango (Ram and Sirohi, 1991) and Kesar mango (Gaikwad et al., 2017) due to reduced trunk girth.

**3.2 Effect of different varieties on growth parameters**

The varieties typically differ in its morphological characters due to varied varietal characters (Shah et al., 2013). Data from Table 1 and 2 were in compliance with it. The plant spread (E-W), plant spread (N-S) and plant stem girth were found significant for different varieties after 15th year of planting (2023). However, plant height was found non-significant. The significantly maximum plant spread (E-W) (7.05 m), plant spread (N-S) (7.17 m) and plant stem girth (91.92 cm) were found in V3 (Dashehari) variety which was at par with V4 (Mallika), V5 (Amrapali) and V1 (Kesar) variety respectively parameter wise. While maximum plant height (7.54 m) was observed in V1 (Kesar) variety after 15th year of planting (2023). These findings are in accordance with those reported by Gaikwad et al., (2017) and Ram and Sirohi, (1991). Dashehari is vigoruous cultivar (Victor et al., 2018, Balasubrahmanyam et al., 2000) which leads to higher plant spread and stem girth whereas Amrapali is a slow-growing cultivar (Oosthuyse et al., 2018). The increase in plant height appears to be due to shading in high density planting and in Kesar. Similar results were recorded by Gunjate et al., (2004), Balasubrahmanyam et al., (2000).

**3.3 Interaction effect of spacing and varieties on growth parameters**

Despite of spacing and varieties individually had considerable effect on various growth parameters of mango, the interaction effect was found non-significant for all the growth parameters (Table 1 and 2). This shows that independence of both the factors which were affecting the growth individually.

**3.4 Effect of spacing on fruit yield plant-1:**

Fruit yield is an important parameter to evaluate merit of treatment. The concept of high density planting is based on accommodating more number of plants in unit area without considerable loss in the yield plant-1.The change in the fruit yield plant-1 affected by spacing is presented in Table 3. The results revealed that the S4 (7 m x 7 m) spacing recorded significantly maximum fruit yield plant-1for year 2019 (28.00 kg), 2021 (44.13 kg) and 2023 (37.07 kg). However, it was found non-significant for year 2020, 2022 and in pooled. Most of the commercial Indian mango varieties exhibit alternate cycles of heavy yield in ‘on-year’ followed by reduced or no fruiting in the ‘off-year’. Though essentially a cultivar-specific trait, alternate bearing is also modulated by environmental factors and cultural practices (Chaudhari and Singh, 2019). Although, in pooled, the maximum fruit yield plant-1 (25.16 kg) was observed under S4 (7 m x 7 m) spacing and minimum (16.47 kg) was observed under S1 (4 m x 4 m) spacing. The smaller the area available to plants, the higher the tendency to decrease the number of lower shoots, and the yield of fruit per plant (Gaikwad et al., 2017). Moreover, higher plant spacing provide adequate inter space between plant while provide adequate light penetration inside the canopy resulting in better reproductive growth.

**3.5 Effect of varieties on fruit yield plant-1**

The varieties had remarkable influence on yield. From Table 3, it was noted that fruit yield plant-1 was found significant for all the year but found non- significant for pooled. The highest fruit yield plant-1 was recorded in V2 (33.58 kg), V1 (22.75 kg), V3 (40.08 kg), V4 (16.67 kg), and V3 (37.42) in year 2019, 2020, 2021, 2022 and 2023 respectively. However, in pooled data maximum fruit yield plant-1 (24.83 kg) was in V1 (Kesar) variety whereas minimum fruit yield plant-1 (18.55 kg) was in V5 (Amrapali) variety. The above results were in agreement with those reported by Gaikwad et al., (2017), Joglekar et al., (2013), Gunjate et al., (2009), Gunjate et al., (2004). Balasubrahmanyam et al., (2000) observed that in terms of yield kesar variety maintained its edge over the other commercial varieties in dry region of Maharashtra due to varietal characters i.e. higher fruit weight. It is evident that diverse mango varieties have morphological variations viz., fruit weight (Shah et al., 2013) in addition to that individual cultivar does not grow equally well under different sets of climatic conditions prevailing in various parts of the country. (Chakraborti et al., 2022).

**3.6 Interaction effect of spacing and varieties on fruit yield plant-1**

The interaction effect of spacing and varieties on fruit yield plant-1 was found significant for year 2019, 2023 and pooled (Table 3). The interaction effect is presented in table 4. In year 2019, V2S2 (Totapuri variety at 5 m x 5 m spacing) recorded highest fruit yield plant-1(41.67 kg) which was followed by V2S3 (36.67 kg), V2S4 (36.67 kg), V1S4 (36.67 kg) and V3S4 (31.67 kg) while in year 2023, V3S4 (Dashehari variety at 7 m x 7 m spacing) recorded highest fruit yield plant-1(49.33 kg) which was at par with V1S4 (41.67 kg). However, in pooled (Table 4) maximum fruit yield plant-1 (32.73 kg) was observed in V1S4 (Kesar variety at 7 m x 7 m spacing) which was followed by V3S4 (28.60 kg). These results follow the combine effect of planting density and varieties as observed by Gunjate et al., (2009). While evaluating different mango varieties under high density planting, Vidyashree et al., (2021) observed higher fruit set, fruit weight and yield in kesar mango.

**3.7 Effect of spacing on fruit yield hectare-1(kg)**

With regard to fruit yield hectare-1(kg), S1 (4 m x 4 m) spacing found significant for all the year as well as in pooled (Table 3) noting 10083.33 kg, 7125.00 kg, 14375.00 kg, 7208.33 kg, 12666.67 kg and 10291.67 kg yield in year 2019, 2020, 2021, 2022, 2023 and in pooled respectively. Conversely, minimum fruit yield hectare-1(5132.64 kg) was in S4 (7 m x 7 m) spacing. Higher planting density accommodates more number of trees per unit area. Hence, closure spacing gave higher fruit yield hectare-1. Similar results were observed by Kumar (2019), Srivastava et al., (2024), Soman et al., (2024). Though, it is noteworthy that it generally lower yield per plant.

**3.8 Effect of varieties on fruit yield hectare-1(kg)**

From Table 3 it was found that, fruit yield hectare-1(kg) was found significant for year 2019, 2020, 2022 and 2023 recording 11605.83 kg (V2), 8293.75 kg (V2), 13432.42 kg (V1), 5878.92 kg (V4) and 12630.08 kg (V3) yield respectively whereas it was found non-significant for year 2021 and in pooled. Though, in pooled the maximum fruit yield hectare-1(kg) (8696.65 kg) was observed in V1 (Kesar) variety and minimum (6723.82 kg) in V4 (Mallika) variety. It depicts the adaptability of kesar as high yielding variety in particular area. Similar results were recorded by Gaikwad et al., (2017), Joglekar et al., (2013), Gunjate et al., (2009), Gunjate et al., (2004), Balasubrahmanyam et al., (2000).

**3.9 Interaction effect of spacing and varieties on fruit yield hectare-1(kg)**

The interaction Table 3 data showed that significant difference observed for fruit yield hectare-1(kg) in year 2019 and in pooled, while non-significant in rest of the years. The interaction effect is presented in table 4. In year 2019, V5S1 (Amrapali variety at 4 m x 4 m spacing) recorded highest fruit yield hectare-1(14583.33 kg) which was followed by V2S1 (12083.33 kg), V1S1 (11458.33 kg) and V2S3 (10193.33 kg) while in pooled, V1S1 (Kesar variety at 4 m x 4 m spacing) recorded highest fruit yield hectare-1 (11875.00 kg) which was followed by V5S1 (11708.33 kg), V2S1 (10500.00 kg) and V1S2 (9840.00 kg). The data support the suitability of kesar variety under high density planting while recording maximum yield as it accommodate more plants while maintaining higher fruit yield plant-1. These results were in accordance with Kumar et al., (2019), Gaikwad et al., (2017) and Joglekar et al., (2013).

1. **CONCLUSION**

From the above findings, it was clear that among the different varieties and planting spacing evaluated, the variety Kesar is best suited to plant at 4 m x 4 m spacing in high density planting for commercial cultivation of Mango in North Gujarat while sustaining optimal growth in terms of plant stem girth, plant height along with maximum fruit yield plant-1 and fruit yield hectare-1 after 15 year of planting.

1. **REFERENCES**

Anand, M., Kayalvizhi, K., Sankari, A., Karthi, K., Velmurugan, M., Prabhadharshini, M. K., Nanthakumar, S., Pugalendhi, L., 2024. Influence of irrigation and nutrition under ultra-high density planting of mango (*Mangifera indica* L.) cv. “Alphonso.” Folia Horticulturae 36(4), 1-12. DOI: 10.2478/fhort-2024-0032.

Anonymous, 2021. Horticultural Statistics at a Glance 2021. Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, New Delhi, Goverment of India. Available from <https://agriwelfare.gov.in/Documents/Horticultural_Statistics_at__Glance_2021.pdf> Accessed on 8th February, 2025.

Balasubrahmanyam, V.R., Dhake, A.V., Moitro, P., Karangale, B. T., 2000. Performance of mango varieties in marginal lands of Jalgaon. Acta Horticulturae 509, 107-112. DOI: 10.17660/ActaHortic.2000.509.8.

Chakraborti, K., Shah, N. I., and Patil, P., 2022. Juxtaposition of morpho-qualitative traits of mango varieties grown in Mohanpur, West Bengal, and Paria, Gujarat. Journal of Crop and Weed 18(3), 64-70. DOI: 10.22271/09746315.2022.v18.i3.1618

Chaudhari, S. K. and Singh, A., 2019. NRM Interventions for Enhanced Mango Productivity and Quality Advanced Agricultural Research & Technology Journal (IMC 2018 special) III(1), 9-29. eISSN: 2581-3749

Dalvi, N. V., Salvi, B. R., Chavan, S. A., Kandalkar, M. P., 2010. High density planting in mango cv. Alphonso. Journal of Horticultural Sciences 5(2), 117-119.

Das, B., Jana, B. R., 2013. Effect of canopy management on growth and yield of mango cv. Amrapali planted at close spacing. Journal of Food, Agriculture & Environment 11(1), 316-319.

Gaikwad, S. P., Chalak, S. U., Kamble, A. B., 2017. Effect of spacing on growth, yield and quality of mango. Journal of Krishi Vigyan 5(2), 50-53. DOI:10.5958/2349-4433.2017.00011.3.

Gunjate, R.T., Kumbhar, A.R., Thimaiah, I.M., Amin, S.M., 2004. Performance of Some Indian and Exotic Mango Cultivars under High Density Planting in Arid Conditions of Gujarat (India). Acta Horticulturae 645, 347-351. DOI: 10.17660/ActaHortic.2004.645.42.

Gunjate, R.T., Kumbhar, A.R., Thimaiah, I.M., Amin, S.M., 2009. Growth and Fruiting of Some Mango Cultivars under High Density Plantation in Arid Conditions of Gujarat (India). Acta Horticulturae 820, 463-468. DOI: 10.17660/ActaHortic.2009.820.57.

Ibell, P.T., Normand, F., Wright, C.L., Mahmud, K., Bally, I.S.E., 2024. The effects of planting density, training system and cultivar on vegetative growth and fruit production in young mango (*Mangifera indica* L.) trees. Horticulturae, 10, 937. p.1-23. DOI: 10.3390/horticulturae10090937.

Joglekar, V., Chivate, D., Pujari, K.H., 2013. High Density Planting Technique in Dry Region for ‘Kesar’ Mango Cultivation – a Savlaj Pattern. Acta Horticulturae 992, 233-235. DOI: 10.17660/ActaHortic.2013.992.30.

Kavitha, R., Nataraja, K. H., Nagesh, N., Mahanthesha, B. N., N. and Kantharaju, V. 2022. Performance of different mango (*Mangifera indica* L.) varieties for flowering and fruiting attributes under high density planting. The Pharma Innovation Journal 11(3), 168-171. DOI: 10.22271/tpi.2022.v11.i3c.11162.

Kavitha, R., Nataraja, K.H., Naik, N., Kantharaju, V., Ramanagouda, S. H. and Mahanthesha, B. N., Naika, A., 2018. Study on quality characters of different mango (*Mangifera indica* L.) varieties grown under high density planting. International Journal of Chemical Studies 6(5), 2062-64.

Kumar, N., 2019. High density planting system in mango – prospects and problems. International Journal of Innovative Horticulture 8(2):101-107. DOI: 10.5958/2582-2527.2019.00003.4.

Mahmud, K. P., Ibell, P. T., Wright, C. L.; Monks, D., Bally, I. 2023. High-density espalier trained mangoes make better use of light. Agronomy 13,2557,1-14. DOI: 10.3390/agronomy13102557.

Menzel, C. M., Lagadec, M. D. L., 2017. Can the productivity of mango orchards be increased by using high-density plantings? Scientia Horticulturae 219,222–263. DOI: 10.1016/j.scienta.2016.11.041.

Mitra, S., Bhagwan, A., 2018. Mango cultivation practices in the tropics: good agricultural practices to maximize sustainable yields. In: Galan Sauco, V., and Lu, P. (Eds.). Achieving sustainable cultivation of mangoes (1st ed.). Burleigh Dodds Science Publishing, p.149-163. eBook ISBN: 9781351114431. DOI: 10.19103/AS.2017.0026.08.

Nath, V., Das, B., Rai, M., 2007. Standardization of high-density planting in mango (*Mangifera indica*) under sub-humid alfisols of eastern India. Indian Journal of Agricultural Sciences 77(1), 3-7.

Oosthuyse, S. A., 2018. Management of an ultra-high-density mango orchard and benefits of the small-tree system. In: Galan Sauco, V., and Lu, P. (Eds.). Achieving sustainable cultivation of mangoes (1st ed.). Burleigh Dodds Science Publishing, p.205-228. eBook ISBN: 9781351114431. DOI: 10.19103/AS.2017.0026.11.

Panse, V. G., Sukhatme, P. V., 1961. Statistical methods for agricultural workers. (2nd Ed.). Indian Council of Agricultural Research, New Delhi, India. p.100-128

Patel, K. A., Pandey, A. K., Khalasi, D. N., Gurjar T., Dwivedi, S. K., 2022. Assessment of rejuvenated mango cultivars for yield and quality under south Gujrat condition Progressive Horticulture 54(1), 68-75 DOI : 10.5958/2249-5258.2022.00008.2.

Policarpo, M., Talluto, G., Bianco, R. L., 2006. Vegetative and productive responses of ‘Conference’ and ‘Williams’ pear trees planted at different in-row spacings. Scientia Horticulture 109, 322–331. DOI: 10.1016/j.scienta.2006.06.009.

Raj, A., Patel, V.B., Kumar, R., Barman, K., Verma, R.B., Sashikant, Pathak, S.K., 2017. Effect of high density planting systems on physiological and biochemical status of rejuvenated mango plants of cv. Amrapali. Indian Journal of Horticulture 74(3), 351-356. DOI: 10.5958/0974-0112.2017.00070.6.

Ram, S., Singh, C. P., Kumar, S., 1997. A success story of high density orcharding in mango. Acta Horticulturae 455, 375–382. DOI:10.17660/actahortic.1997.

Ram, S., Sirohi, S.C., 1991. Feasibility of high density orcharding in dashehari mango. Acta Horticulturae 291, 207-212. DOI: 10.17660/ActaHortic.1991.291.23

Shah, N. I, Patel, C. R., Patel, V. K., Attar, S., Patel, A. A., 2013. Morphological description of mango varieties under agro climatic conditions of Gujarat (part-1), Pub. AICRP (STF), CISH, Lucknow, India.

Singh, S., Yadav, G. S., Singh, J., Hoda, M. N., 2001. High density planting system in 'Amrapali' mango (*Mangifera indica*). Indian Journal of Agricultural Sciences 71(6), 381-383.

Soman, P., Chaudhari, A. U., Krishna, B., Balasubramanyam, V. R., 2024. Intensive cultivation of mango using ultra-high density planting (UHDP), and drip and fertigation technologies for higher productivity. In: Marcello Iriti (Eds.). Research Advances and Challenges in Agricultural Sciences Vol.1. B P International, p.88-102. ISBN: 978-81-969009-6-0. DOI: 10.9734/bpi/racas/v1/7229C.

Sousa C. A. F., Cavalcanti M. I. L.G., Da Silva J. A. L., 2012. ‘Tommy Atkins’ mango trees subjected to high density planting in sub humid tropical climate in north eastern Brazil. Pesquisa Agropecuária Brasileira (Brazilian Journal of Agricultural Research) 47(1), 36-43. DOI: 10.1590/S0100-204X2012000100006

Srivastava, K. K., Kumar, D., Shukla, P. K. 2024. Transforming conventional mango orchard to high density planting for high productivity and quality mango production. Indian Horticulture (July-August), 22-24.

Victor, M. M., Jaime E. R., Gil V. E. P., 2018. In: Galan Sauco, V., and Lu, P. (Eds.). Achieving sustainable cultivation of mangoes (1st ed.). Burleigh Dodds Science Publishing, p.229-268. eBook ISBN: 9781351114431. DOI:10.19103/AS.2017.0026.12.

Vidyashree, K., Sabarad, A. I., Nataraja, K. H., Naik, N., Bhat, A. S., Gorabal, K., Lakshmidevamma, T. N., 2021. Performance of mango (*Mangifera indica* L.) varieties for flowering and yield under high density planting. Journal of Pharmacognosy and Phytochemistry 10(1), 2331-2333.

|  |
| --- |
| Table 1: Effect of plant spacing and varieties on plant spread (E-W & N-S) (m) of mango |
|  | Plant spread (E-W) (m) | Plant spread (N-S) (m) |
| Spacing | 6th Year (2014) | 10th Year (2018) | 15th Year (2023) | 6th Year (2014) | 10th Year (2018) | 15th Year (2023) |
| S1 | 3.36 | 4.81 | 5.61 | 3.36 | 4.89 | 5.79 |
| S2 | 3.98 | 4.89 | 5.90 | 3.99 | 4.96 | 6.21 |
| S3 | 4.03 | 5.36 | 6.42 | 4.03 | 5.31 | 6.23 |
| S4 | 4.22 | 6.45 | 7.53 | 4.34 | 6.45 | 7.55 |
| SEm± | 0.12 | 0.18 | 0.19 | 0.12 | 0.19 | 0.21 |
| CD (*p*=0.05) | 0.36 | 0.51 | 0.55 | 0.36 | 0.54 | 0.58 |
| Variety |  |  |  |  |  |  |
| V1 | 3.51 | 5.34 | 6.15 | 3.62 | 5.25 | 6.08 |
| V2 | 3.75 | 5.11 | 6.01 | 3.89 | 4.91 | 6.03 |
| V3 | 4.12 | 6.03 | 7.05 | 4.08 | 5.95 | 7.17 |
| V4 | 3.95 | 4.98 | 6.64 | 4.05 | 4.75 | 6.43 |
| V5 | 4.16 | 5.44 | 5.98 | 4.00 | 5.59 | 6.52 |
| SEm± | 0.14 | 0.20 | 0.22 | 0.14 | 0.22 | 0.23 |
| CD (*p*=0.05) | 0.40 | 0.57 | 0.62 | NS | 0.60 | 0.65 |
| S x V |  |  |  |  |  |  |
| CD (*p*=0.05) | NS | NS | NS | NS | NS | NS |
| CV% | 12.34 | 12.77 | 11.77 | 12.21 | 13.81 | 12.20 |

|  |
| --- |
| Table 2: Effect of plant spacing and varieties on plant height (m) and plant stem girth (cm) of mango |
|  | Plant height (m) | Plant stem girth (cm) |
| Spacing | 6th Year (2014) | 10th Year (2018) | 15th Year (2023) | 6thYear (2014) | 10thYear (2018) | 15thYear (2023) |
| S1 | 4.22 | 4.81 | 6.11 | 45.23 | 64.67 | 74.13 |
| S2 | 4.64 | 5.11 | 6.67 | 51.47 | 66.33 | 79.40 |
| S3 | 4.57 | 5.30 | 6.79 | 52.60 | 73.00 | 85.00 |
| S4 | 4.32 | 5.31 | 7.01 | 54.57 | 73.27 | 90.07 |
| SEm± | 0.13 | 0.11 | 0.14 | 1.61 | 3.32 | 1.95 |
| CD @ 5% | NS | 0.32 | 0.41 | 4.64 | NS | 5.58 |
| Variety |  |  |  |  |  |  |
| V1 | 5.13 | 5.88 | 7.54 | 55.46 | 78.33 | 89.00 |
| V2 | 4.16 | 4.73 | 6.12 | 47.04 | 63.33 | 75.25 |
| V3 | 4.44 | 5.41 | 6.83 | 53.83 | 72.42 | 91.92 |
| V4 | 4.02 | 4.49 | 6.37 | 46.79 | 60.83 | 77.75 |
| V5 | 4.43 | 5.15 | 6.38 | 51.71 | 71.67 | 76.83 |
| SEm± | 0.14 | 0.12 | 0.16 | 1.81 | 3.71 | 2.18 |
| CD (*p*=0.05) | 0.41 | 0.36 | 0.46 | 5.19 | 10.60 | 6.24 |
| S x V |  |  |  |  |  |  |
| CD (*p*=0.05) | NS | NS | NS | NS | NS | NS |
| CV% | 11.01 | 8.44 | 8.40 | 12.27 | 18.53 | 9.20 |

|  |
| --- |
| Table 3: Effect of spacing and varieties on fruit yield plant-1 (kg) and fruit yield hectare-1 (kg) of mango |
|  | Fruit yield plant-1 (kg) | Fruit yield hectare-1 (kg) |
| Spacing | 2019 | 2020 | 2021 | 2022 | 2023 | Pooled | 2019 | 2020 | 2021 | 2022 | 2023 | Pooled |
| S1 | 16.13 | 11.40 | 23.00 | 11.53 | 20.27 | 16.47 | 10083.33 | 7125.00 | 14375.00 | 7208.33 | 12666.67 | 10291.67 |
| S2 | 24.33 | 9.20 | 30.27 | 7.87 | 26.87 | 19.71 | 9733.33 | 3680.00 | 12106.67 | 3146.67 | 10746.67 | 7882.67 |
| S3 | 24.53 | 8.73 | 38.07 | 12.60 | 34.73 | 23.73 | 6820.27 | 2761.47 | 10582.53 | 3502.80 | 9655.87 | 6664.59 |
| S4 | 28.00 | 7.53 | 44.13 | 9.07 | 37.07 | 25.16 | 5712.00 | 1536.80 | 9003.20 | 1849.60 | 7561.60 | 5132.64 |
| SEm± | 1.81 | 1.48 | 2.46 | 2.19 | 1.22 | 2.22 | 1991.95 | 2114.53 | 2644.02 | 2404.89 | 1279.12 | 931.94 |
| CD (*p*=0.05) | 5.17 | NS | 7.06 | NS | 3.48 | NS | 695.91 | 738.73 | 923.72 | 840.18 | 446.88 | 334.00 |
| Variety |  |  |  |  |  |  |  |  |  |  |  |  |
| V1 | 26.25 | 22.75 | 33.42 | 11.83 | 29.92 | 24.83 | 8870.42 | 8293.75 | 11613.17 | 4685.00 | 10020.92 | 8696.65 |
| V2 | 33.58 | 13.42 | 31.25 | 8.00 | 25.00 | 22.25 | 11605.83 | 5957.67 | 10447.58 | 2943.42 | 8429.50 | 7876.80 |
| V3 | 19.67 | 3.25 | 40.08 | 4.67 | 37.42 | 21.02 | 6489.58 | 1836.58 | 13432.42 | 1753.50 | 12630.08 | 7228.45 |
| V4 | 16.33 | 2.92 | 36.33 | 16.67 | 26.67 | 19.68 | 5437.83 | 909.58 | 12175.83 | 5878.92 | 9214.42 | 6723.82 |
| V5 | 20.42 | 3.75 | 28.25 | 10.67 | 29.67 | 18.55 | 8032.50 | 1881.50 | 9915.25 | 4373.42 | 10493.58 | 6939.25 |
| SEm± | 2.02 | 1.66 | 2.76 | 2.44 | 1.36 | 2.79 | 778.05 | 825.93 | 1032.75 | 939.35 | 499.62 | 991.82 |
| CD (*p*=0.05) | 5.78 | 4.74 | 7.90 | 6.99 | 3.89 | NS | 2227.07 | 2364.11 | NS | 2688.75 | 1430.10 | NS |
| S x V |  |  |  |  |  |  |  |  |  |  |  |  |
| CD (*p*=0.05) | 11.55 | NS | NS | NS | 7.77 | 5.26 | 4454.14 | NS | NS | NS | NS | 2083.87 |
|  | Y x S | Y x V | Y x S x V |  |  |  | Y x S | Y x V | Y x S x V |  |  |  |
| S.Em± | 1.89 | 2.11 | 4.22 |  |  |  | 746.84 | 834.99 | 1669.99 |  |  |  |
| CD (*p*=0.05) | 5.26 | 5.88 | NS |  |  |  | NS | 2329.837 | NS |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| CV% | 30.06 | 62.19 | 28.22 | 82.42 | 15.82 | 34.35 | 33.33 | 75.77 | 31.06 | 82.87 | 17.04 | 38.60 |

|  |
| --- |
| Table 4: Interaction effect of spacing and varieties on yield plant-1 (kg) of mango |
|  | 2019 | 2023 | Pooled |
|  | V1 | V2 | V3 | V4 | V5 | Mean | V1 | V2 | V3 | V4 | V5 | Mean | V1 | V2 | V3 | V4 | V5 | Mean |
| S1 | 18.33 | 19.33 | 10.33 | 9.33 | 23.33 | 16.13 | 18.33 | 15.33 | 23.67 | 19.67 | 24.33 | 20.27 | 19.00 | 16.80 | 14.67 | 13.13 | 18.73 | 16.47 |
| S2 | 21.67 | 41.67 | 23.33 | 15.00 | 20.00 | 24.33 | 29.00 | 20.67 | 35.67 | 23.33 | 26.67 | 26.87 | 24.60 | 22.27 | 18.33 | 17.87 | 15.47 | 19.71 |
| S3 | 20.33 | 36.67 | 13.33 | 21.00 | 23.33 | 24.53 | 30.67 | 38.00 | 41.00 | 30.33 | 33.67 | 34.73 | 23.00 | 25.87 | 22.46 | 24.33 | 22.99 | 23.73 |
| S4 | 36.67 | 36.67 | 31.67 | 20.00 | 15.00 | 28.00 | 41.67 | 26.00 | 49.33 | 33.33 | 35.00 | 37.07 | 32.73 | 24.07 | 28.60 | 23.40 | 17.00 | 25.16 |
| Mean | 26.25 | 33.58 | 19.67 | 16.33 | 20.42 |  | 29.92 | 25.00 | 37.42 | 26.67 | 29.67 |  | 24.83 | 22.25 | 21.02 | 19.68 | 18.55 |  |
| Factor | S.Em± | CD (*p*=0.05) | CV % |  |  |  | S.Em± | CD (*p*=0.05) | CV % |  |  |  | S.Em± | CD (*p*=0.05) | CV % |  |  |  |
| Spacing | 1.80 | 5.17 | 30.06 |  |  |  | 1.22 | 3.48 | 15.82 |  |  |  | 2.22 | NS | 34.35 |  |  |  |
| Variety | 2.02 | 5.78 |  |  |  |  | 1.36 | 3.89 |  |  |  |  | 2.78 | NS |  |  |  |  |
| S x V | 4.04 | 11.55 |  |  |  |  | 2.72 | 7.78 |  |  |  |  | 1.89 | 5.26 |  |  |  |  |

|  |
| --- |
| Table 5: Interaction effect of spacing and varieties on fruit yield hectare-1 (kg) of mango |
|  | 2019 | Pooled |
|  | V1 | V2 | V3 | V4 | V5 | Mean | V1 | V2 | V3 | V4 | V5 | Mean |
| S1 | 11458.33 | 12083.33 | 6458.33 | 5833.33 | 14583.33 | 10083.33 | 11875.00 | 10500.00 | 9166.73 | 8208.33 | 11708.33 | 10291.67 |
| S2 | 8666.67 | 16666.67 | 9333.33 | 6000.00 | 8000.00 | 9733.33 | 9840.00 | 8906.66 | 7333.33 | 7146.67 | 6186.66 | 7882.67 |
| S3 | 7876.67 | 10193.33 | 3706.67 | 5838.00 | 6486.67 | 6820.27 | 6394.00 | 7190.93 | 6579.33 | 6766.66 | 6394.00 | 6664.59 |
| S4 | 7480.00 | 7480.00 | 6460.00 | 4080.00 | 3060.00 | 5712.00 | 6677.60 | 4909.60 | 5834.40 | 4773.60 | 3468.00 | 5132.64 |
| Mean | 8870.42 | 11605.83 | 6489.58 | 5437.83 | 8032.50 |  | 8696.65 | 7876.80 | 7228.45 | 6723.82 | 6939.25 |  |
| Factor | S.Em± | CD (*p*=0.05) | CV % |  |  |  | S.Em± | CD (*p*=0.05) | CV % |  |  |  |
| Spacing | 695.91 | 1991.95 | 33.33 |  |  |  | 334.00 | 931.94 | 38.60 |  |  |  |
| Variety | 778.05 | 2227.07 |  |  |  |  | 991.82 | NS |  |  |  |  |
| S x V | 1556.10 | 4454.14 |  |  |  |  | 746.84 | 2083.87 |  |  |  |  |