DOI : 10.5958/0974-0112.2019.00057.4

Indian J. Hort. 76(2), June 2019: 358-363

Short communication

Mango under high density planting: A case study from North East India

Sudip K. Dutta[*,], R.S. Akoijam, T. Boopathi, S. Saha, S.B. Singh, S.K. Das[**] and Ashish Yadav[**]**
ICAR RC NEH Region, Kolasib 796081, Mizoram

ABSTRACT

The present study was undertaken to evaluate the effect of high density planting on Amrapali mango trees cultivated in sub-humid warm tropical climate in North-Eastern Indian state of Mizoram. The treatments consisted of three spacing arrangements of plants *viz.*, T_1: 2.5x2.5m (1600 plants/ha), T_2: 3x2.5m (1333 plants/ha) and T_3: 2.5x1.5m (2666 plants/ha). Plant vegetative, reproductive variables and fruit quality parameters were evaluated at second to fourth years after transplantation in the field. Increasing planting density in Amrapali mango in sub-humid climate until 1600 plants per hectare (2.5x2.5 m) increased plant growth, fruit yield and fruit quality parameters per unit area in comparison to the planting densities with 1333 (3x2.5 m) and 2666 (2.5x1.5 m) plants per hectare.

Key words : *Mangifera indica*, Amrapali, Mizoram, HDP, fruit yield.

Mango (*Mangifera indica* L.) is one of the important fruit crops in the Tropical and Subtropical regions of the world. India is the major producer of mango in the world and produces 40.48% of the total world mango production. The North-East Indian state of Mizoram lies on the boundary of this region having a considerable diversity of this crop. Farmers of north-eastern states of India predominantly practice traditional *Jhum* system (slash and burn) of cultivation. The subtropical climate of these states allows the cultivation of a number of fruit crops like *Rubus, Ribes, Prunus, Garcinia, Artocarpus, Phyllanthus, Annona, Averrhoa, Persia, Aegle, Passiflora* and *Tamarindus* etc. Recently, ICAR RC NEH Region, Mizoram Centre in collaboration with KVK, Lawngtlai has identified a chance seedling of mango locally known as *Rangkuai* from the village Sihtlangpui, Lawngtlai district of Mizoram (22.11° N and 92.93° E); this cultivar is indigenous in the state of Mizoram (Dutta *et al*., 2). People world over are interested in high density planting (plantings up to 4000 trees per ha) to increase the productivity and revenue from mango. In spite of suitability of cultivation, north-eastern states of India have very less area of mango and most of the trees are non-descript types; also they are in stray plantation, without any proper spatial management.

To address this constraint, a trial was conducted at the ICAR RC NEH Region, Mizoram centre, Kolasib with three different spacing's during the period 2013 to 2015. High density orcharding (HDO) has been standardized for the major cultivars of this crop (e.g., 2.5 × 2.5 m for 'Amrapali', 6 × 6 m for 'Mallika' and 3.0 × 2.5 m for 'Dashehari) (Ram *et al*., 6). In our experiment, higher number of plants per unit area was accommodated so as to get higher yield from the plantation during the initial period of plantation. Therefore, the present investigation was undertaken to evaluate the effect of three sets of high density on the growth, flowering and fruiting behaviour of cultivar Amrapali during initial years under high-density planting. Therefore the results of this report will give guidance for increasing the area and production of mango in these so called non-traditional areas of mango.

The study was carried out in experimental field of ICAR RC NEH Region, Mizoram Centre, Kolasib district (24.2304° N, 92.6761° E and altitude 888m above mean sea level) of Mizoram, India (Fig. 1). Mizoram has red soil in the order of Entisol, Inceptisol and Ultisols. The characteristic of the soil where experiment was conducted were: pH = 6.28 ±0.17; EC (dS m^{-1}) = 0.984±0.016; Organic C (%) = 1.57±0.25; N (mg/kg) = 74.2±4.20; P (mg/kg) = 23.4±0.59; K (mg/kg) = 123.0±8.50; Cu (mg/kg) = 1.12±0.08; Zn (mg/kg) = 2.51±0.11; Mn (mg/kg) = 42.1±1.90 and Fe (mg/kg) = 21.9±0.07. Kolasib, Mizoram is a warm area with an annual average temperature of 21.6 °C, average temperature at summer lies at 24.5 °C, whereas in winter average temperature drops to 15.9 °C with an annual total precipitation of 2688 mm. The experimental material consisted of grafted 'Amrapali' plants with local seedlings from Tripura which were received from KVK, South Tripura, Birchandramanu, Manpather, South Tripura, Tripura. Grafts were planted during July-August 2012. The treatments were three plant densities *viz*. T_1: 2.5x2.5m (1600 plants/Ha), T_2: 3x2.5m

*Corresponding author's E-mail: sudipiari@rediffmail.com
**ICAR RC NEH Region, Tadong, Gangtok 737102, Sikkim

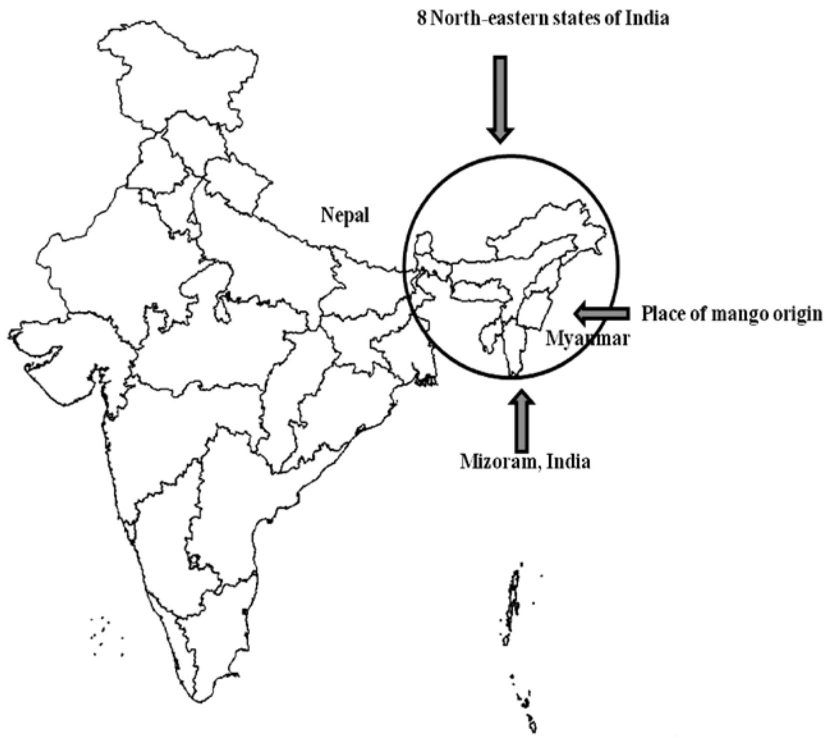

Fig. 1. Map of India depicting the non-conventional areas of mango cultivation and the site of study. Map not to scale.

(1333 plants/Ha) and T_3: 2.5x1.5m (2666 plants/Ha). Morphological parameters were recorded with measuring tape, scale, Vernier callipers and weighing balance for three consecutive years (2013-2015). As the plants were very small and tender during 2nd year of planting (2013), the data was recorded up to flowering stage and deblossoming was done to avoid exhaustion of the plant. The growth parameters were recorded in the month of Jan-Feb, while the fruit parameters were recorded during May-June in all the three years (10 fruits/plant and 10 plants per treatment were randomly selected and averaged). The canopy diameter was measured in NS and EW direction of the canopy. Plant height (cm) was measured from graft union to top of the tree by measuring tape. TSS (°Brix) was calculated with hand held refractometer (Atago N-1α, Japan). Titratable acidity was determined by titrating homogenized pulp (diluted with distilled water), against NaOH solution (0.1N), using phenolphthalein as indicator and results were expressed as percentage of citric acid. The experiment was conducted in a Randomized Block Design (RBD) with three replications in each treatment. Each replication data was obtained from the average values of 10 plants. Statistical analysis was conducted using SAS 9.3.

Some of the plant growth and reproductive parameters like trunk diameter, panicle length, female flower percentage exhibited significant differences for the effect of spacing treatment ($p < 0.05$); while, number of leaves, male flower percentage, flowers with unusual stamens and hermaphrodite flowers showing unusual ovary showed highly significant ($p < 0.01$) differences for spacing treatment (Fig. 2). Plant height recorded a significant increase over the years, while treatment had insignificant effect on the same. Trunk diameter was 145.3% and 143.2% higher in T2 compared to T1 and T3 (Fig. 2), respectively. Here, T1 and T3 density recorded higher trunk diameter; similar pattern was found in Amrapali elsewhere with five planting systems, viz., (i) square system (I600 plants/ha), ii) hedge row system (2670 plants/ha), (iii) double hedgerow system (3556 plants/ha), (iv) paired planting (2133 plants/ha) and (v) cluster planting (2844 plants/ha) (Singh *et al.*, 7). We have found significant differences in panicle length; panicle length of T2 and T3 was 139.2 and 132.1% higher than T1 (Fig. 2). Female flower percentage was least in T3 followed by T2 (1.08 fold higher than T3) and T1 (1.12 fold higher than T3). Number of leaves per plant was highest in T1 followed by T2 and T3 (Fig. 2). Close spacing had an adverse effect on the number of leaves; similar kind of findings was evident from the study with other mango varieties (Nath *et al.*, 4; Ram and Sirohi, 5). In close spacing's, plants encounter competition for

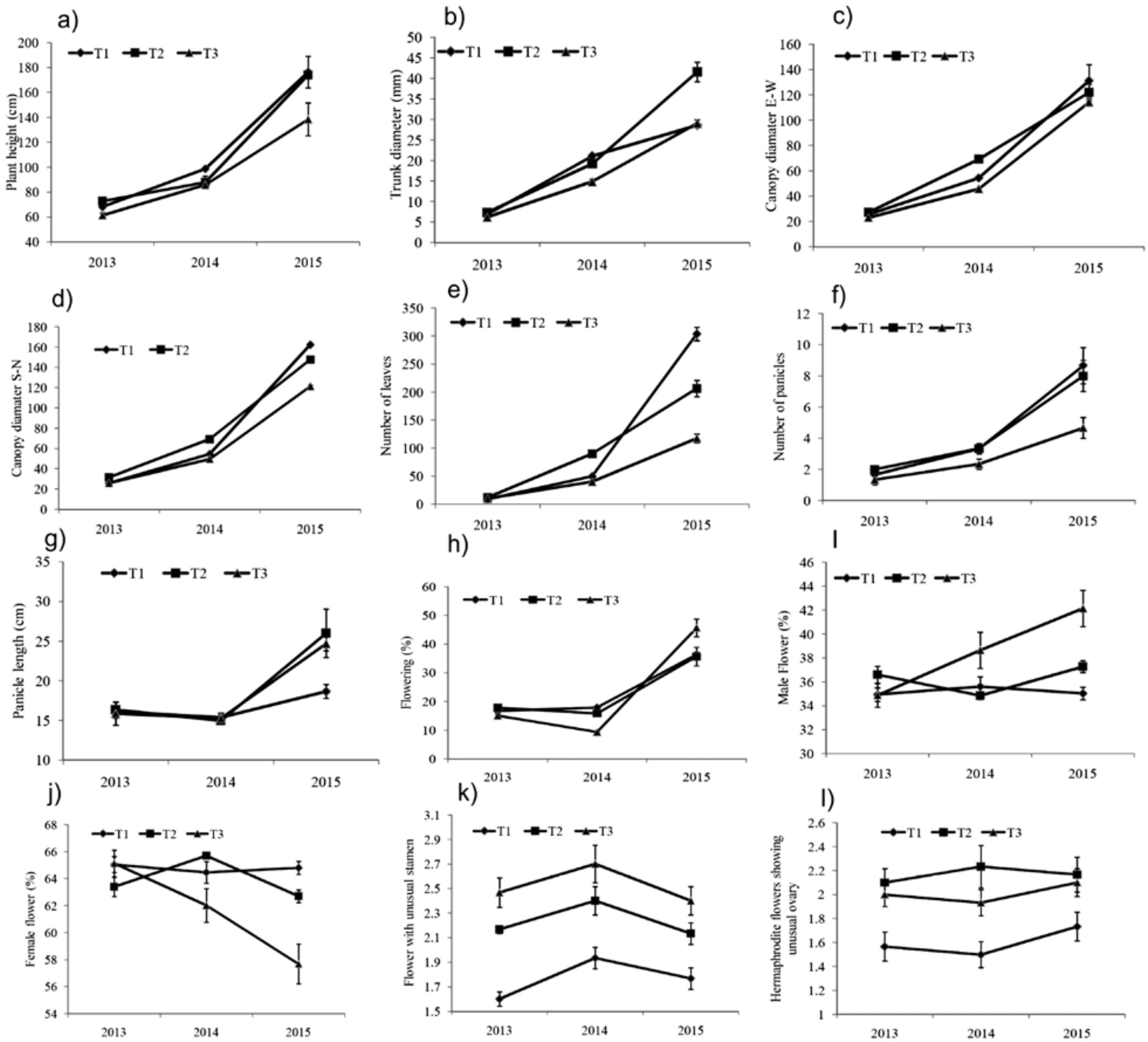

Fig. 2. Morphological and floral traits of mango cv. Amrapali grown under high density planting. (T_1: 2.5x2.5m (1600 plants/ha), T_2: 3x2.5m (1333 plants/ha) and T_3: 2.5x1.5m (2666 plants/ha).

water, nutrients and more importantly light which reduces the synthesis of carbohydrates necessary for growth. Male flower percentage increased while female flower percentage decreased with the increase in plant densities; increased crowding leads to higher sex ratio as found in pruning experiment in 'Amrapali' mango (Sharma and Singh, 8). Flowers with unusual stamens and hermaphrodite flowers showing unusual ovary was recorded highest in close spacing (T3) followed by T2 and T1 (Fig. 2). Though, there is no report in the literature to support our results, but we suspect that it may be due to differences in canopy temperature; comparatively high male flowers are found in high densities, and they tend to be malformed than those that appear in the less densities.

There were significant (p<0.05) and highly significant (p<0.01) effect on fruit morphological and biochemical parameters due to spacing treatments. We observed insignificant differences in fruit length and fruit width (Fig. 3a, 3b and Table 1). A similar finding was found in high density planting in mango cv. Alphonso at Agriculture Research Station, Mulde, Sindhudurg District, Maharashtra State, where spacing had no effect on fruit length and breadth (Dalvi *et al.*, 1). Fruit weight, fruit per tree and fruit yield per tree showed highly significant differences (p<0.01) with spacing treatment (Fig. 3c, 3d, 3e

Table 1. ANOVA of the parameters studied.

Factors	PH	TD	CD E-W	CD S-N	NL	NP	PL	FP	MFP	FFP	FUS	HFUO	FL	FW	Fwt	FPT	FYPT	TSS	AP	PP
Year	**	**	**	**	**	**	**	**	NS	NS	*	NS	NS	NS	NS	**	**	NS	NS	NS
Trt	NS	*	NS	NS	**	NS	*	NS	**	*	**	**	NS	NS	**	**	**	*	*	**
Year*T	NS	**	NS	NS	**	NS	NS	NS	*	*	NS	NS	NS	NS	NS	*	**	NS	NS	NS
LSD (p< 0.05)	17.8	3.2	15.9	15.4	22.1	1.3	4.4	10.0	1.9	2.0	0.1	0.2	1.2	0.4	10.9	2.2	305.5	1.4	0.01	1.9

Plant height (PH), trunk diameter (TD), canopy diameter East-West (CD E-W), canopy diameter South-North (CD S-N), no. of leaves (NL), no. of panicles (NP), panicle length (PL), flowering percentage (FP), male flower percentage (MFP), female flower percentage (FFP), flowers with unsual stamens (FUS), hermaphrodite flowers showing unusual ovary (HFUO), fruit length (FL), fruit width (FW), fruit weight (Fwt), fruit per tree (FPT), fruit yield per tree (FYPT), total soluble solids (TSS), acidity percentage (AP), pulp percentage (PP), **(p < 0.01), * (p < 0.05), NS (non significant).

and Table 1). Highest fruit weight was observed in T3 followed by T1 and T2; in our case increased plant population exhibited higher fruit weight. These results were in contrast to other studies where one researcher (Dalvi *et al.*, 1) found decreased fruit weight with increased plant density and another researcher (Singh *et al.*, 7) recorded non significant effect of spacing on fruit weight. Although fruit weight was higher in T3 but, fruit per tree and fruit yield per tree exhibited opposite trend (Fig. 3d and 3e). There was a significant difference in TSS and acidity percentage between the spacing treatments (Fig. 3f and 3g). Treatment T1 reported highest TSS followed by T2 and T3. Most of the other studies have found insignificant differences in TSS and acidity percentage due to spacing treatment (Dalvi *et al.*, 1; Singh *et al.*, 7), but our differences may have been due to adoption of very closer spacing treatments. Pulp percentage differed significantly in our spacing treatments; in our case T1 recorded maximum followed by T2 and T3 (Fig. 3h and Table 1). There are varying results for pulp percentage in literature which are both contrary and in congruence with our finding. In studies elsewhere, the results on the effect of increased plant densities are inconsistent; increasing planting density did not change significantly most variables related to fruit quality, such as fruit and pulp weight, fruit length, dorsal fruit diameter, soluble solids (^{o}Brix), titratable acidity and pH (Moreira *et al.*, 3; Nath *et al.*, 4; Ram and Sirohi, 5; Singh *et al.*, 7).

As we know that, the centre of origin for mango is within the region between north-east India and Myanmar, but there are no reports of commercial mango plantations in these areas. Our research is the first research about high density planting of mango at its centre of origin. Increasing planting density of Amrapali' mango in subhumid climate of north-east India until 1600 plants per hectare (2.5x2.5 m) significantly increased plant growth, fruit yield and fruit quality parameters per unit area in comparison to the planting densities with 1333 (3x2.5 m) and 2666 (2.5x1.5 m) plants per hectare. We suggest that similar trials may be taken up in other states of this region with some more varieties to see the suitability of mango HDP at its centre of origin. Moreover, research need to be conducted for locally adaptable dwarfing rootstocks and canopy management for mango to make mango a commercially viable option in north-east India.

ACKNOWLEDGEMENTS

This research was supported financially by Indian Council of Agriculture Research (ICAR), New Delhi, India (Project code: IXX09795). The

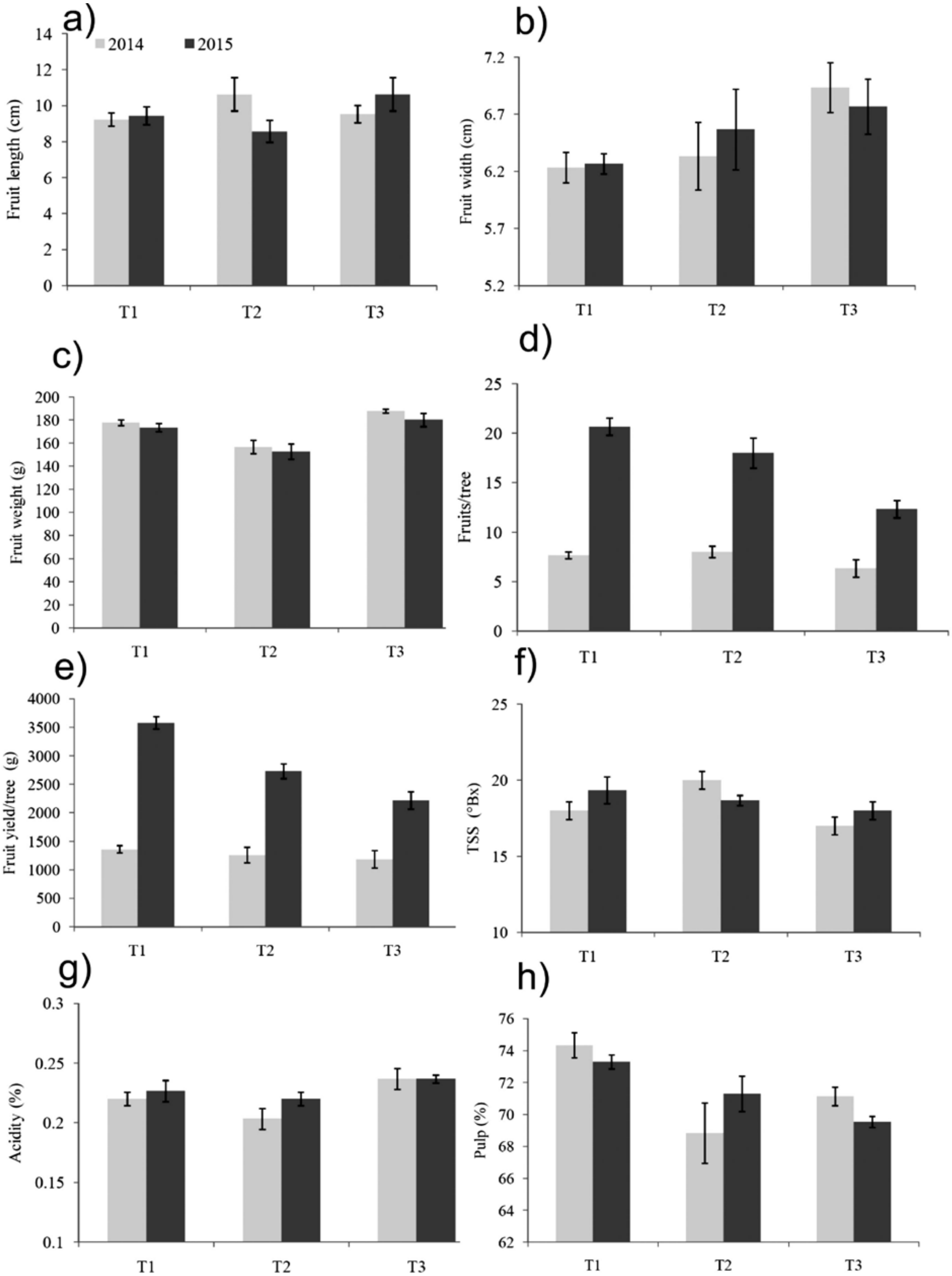

Fig. 3. Fruit morphological and quality traits of mango cv. Amrapali grown under high density planting. (T_1: 2.5x2.5m (1600 plants/ha), T_2: 3x2.5m (1333 plants/ha) and T_3: 2.5x1.5m (2666 plants/ha).

authors acknowledge Director, ICAR RC NEH Region, Umiam, Meghalaya for his technical assistance and providing necessary facilities. We sincerely acknowledge the officers of Department of Horticulture and Department of Agriculture, Government of Mizoram for their assistance during mango survey conducted at Saiha and Lawngtlai districts of Mizoram. There is no conflict of interest in any form with anyone for this work.

REFERENCES

1. Dalvi, N.V., Salvi, B.R., Chavan, S.A. and Kandalkar, M.P. 2010. High density planting in mango cv. Alphonso. *J. Hort. Sci.* **5**: 117-19.

2. Dutta, S.K., Singh, S.B., Boopathi, T., Akoijam, R.S., Lallawmkimi, M.C., Saha, S., Lungmuana, Vanlalhmangaiha and Chowdhury, S. 2017. *Rangkuai*: A Local Mango variety from Indo-Burma frontier. *ICAR News*, **23**: 19-20.

3. Moreira, A., Heinrichs, R., Pereira, J.C.R., 2007. Densidade de plantio na produtividade e nos teores de nutrientes nas folhas e frutos da bananeira cv. Thap Maeo. *Revista Brasileira de Fruticultura*, **29**: 626-31.

4. Nath, V., Das, B. and Rai, M. 2007. Standardization of high-density planting in mango (*Mangifera indica*) under sub-humid Alfisols of Eastern India. *Indian J. Agri. Sci*. **77**: 3-7.

5. Ram, S. and Sirohi, S.C. 1991. Feasibility of high density orcharding in Dashehari mango. *Acta Hort*. **291**: 207-12.

6. Ram, S., Singh, C.P., and Kumar, S. 1997. A success story of high density orcharding in mango. *Acta Hort*. **455**: 375-82.

7. Singh, S., Yadav, G.S, Jayant, S. and Boon, M.N. 2001. High density planting system in 'Amrapali' mango (*Mangifera indica*). *Indian J. Agric. Sci.* **71**: 381-83.

8. Sharma, R. and Singh, R. 2006. Pruning intensity modifies canopy microclimate, and influences sex ratio, malformation incidence and development of fruited panicles in ‘Amrapali’mango (*Mangifera indica* L.). *Sci. Hort*. **109**: 118-22.

Received : February, 2019; Revised : May, 2019;
Accepted : May, 2019