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Effect of planting density and mulching on fruit quality traits of mango (*Mangifera indica* L.) cv. Alphonso

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Abstract
Mango (*Mangifera indica* L.) is the leading fruit crop of India, belonging to family Anacardiaceae and the present work was carried out to know the effect of planting density and mulching on fruit quality traits of mango cv. Alphonso The An investigation was done with four different spacing *i.e.* D_1- 2.5 × 2.5 m (1600 plants/ ha), D_2- 5.0 × 2.5 m (800 plants/ ha), D_3- 5.0 × 5.0 m (400 plants/ ha), D_4- 7.5 × 5.0 m (267 plants/ ha) with three different combinations of mulching *i.e.* M_1- Paddy straw mulch, M_2- Plastic mulch (50 micron thickness), M_3- Without mulch (control) and their interaction was studied. The results revealed that, the combined effect of planting density and mulching showed highest fruit volume (270.83 cc), fresh fruit weight (319.83 g), weight of ripe fruit (296.08 g), fruit diameter (7.8 cm), fruit length (9.65 cm), pulp weight (244.92 g), TSS (20.17 °B), titratable acidity (0.6%), ascorbic acid content (41.23 mg/100g), reducing sugars (4.92%) and total sugar (13.78%) in treatment D_3M_2 (plant spacing of 5.0 x 5.0 m with plastic mulch) and minimum was observed in control.

Keywords: Density, mulching, fruit quality traits, mango, *Mangifera indica* L. cv. Alphonso

Introduction
Mango (*Mangifera indica* L.) is one of the major fruit crop cultivated in tropical and subtropical regions of the world. It is considered to be a King of fruits because of its delicious taste, excellent flavor and attractive fragrance. Besides, it is rich in vitamin A and C. In India, mango occupies per cent of the total area under fruits comprising of 2.26 million hectares, with a total production of 19.69 million tonnes. Although, India is the largest mango producing country, accounting about 60 per cent of the world production (Anon., 2017) [2], the export of fresh fruit is mainly depending on Alphonso and Dashehari varieties. India's share in the world mango market is about 15 per cent and accounts for 40 per cent of the total fruit export from the country. The demand for mango fruit is growing annually and the requirement is not met with existing rate of production. So, there is good scope for increasing the area and productivity of mango in the country. One of the strategies to achieve this is by adopting high density planting, to increase the productivity per unit area without compromising the fruit quality parameters. Hence, an investigation was carried out to know the effect of planting density and mulching on fruit physical and biochemical quality parameters of mango cv. Alphonso.

Material and Methods
The investigation to know the effect of planting density and mulching on fruit physical and quality parameters of mango cv. Alphonso was carried out in the mango orchard of the Regional Horticulture Research and Extension Center, Dharwad (University of Horticultural Sciences, Bagalkot) during July-2013 to June- 2015. The Regional Horticultural Research and Extension Center is situated at 15^0-16' Northern latitude, 70°- 07' Eastern longitude and at an altitude of 678 m above the mean sea level. The soil of the experimental plot is red sandy loam, reddish brown colour, well drained having moderate water holding capacity. Dharwad has a transitional type of climate, which received the total rainfall of 733.8 mm during the year 2013-2014, whereas the rainfall was 761.3 mm during the period of study 2014 - 2015.
Three year old mango orchard cv. Alphonso established during 2010 was selected for the experiment.

The Experimental design followed was Factorial randomized design with twelve treatments namely Factor - I - Plant density **(**D_1- 2.5 × 2.5 m (1600 plants/ ha), D_2- 5.0 × 2.5 m (800 plants/ ha), D_3- 5.0 × 5.0 m (400 plants/ ha), D_4- 7.5 × 5.0 m (267 plants/ ha)) and Factor - II - Mulching (M_1- Paddy straw mulch, M_2- Plastic mulch (50 micron thickness) and M_3- Without mulch (control) with three replication in 1.5 hectare net experimental plot area.

The fruits from five tagged plants were used to record the observations. The mean of physical and quality parameters of ten fruits was recorded. Fruit volume was determined by the conventional water displacement method, and the mean was computed. Immediately after the harvest of the fruit the stalk was removed and the weight of raw fruit was recorded and later the ripe fruit weight was recorded. Matured fruits from each treatment were collected and kept for storage under ambient conditions. Physiological loss in weight was calculated by using the formula**.**

$$\text{Physiological loss in weight} = \frac{\text{Fresh fruit weight - ripe fruit weight}}{\text{Fresh fruit weight}} \times 100$$

Fruit diameter was measured at the widest portion of fruit and the length of the fruit from stalk end to the apex was determined with digital vernier calipers. The pulp, peel and stone were separated and then weighed and expressed in gram (g/fruit). The juice extracted by crushing the ripe pulp from the two halves of each fruit was strained through muslin cloth and used for measuring total soluble solids. TSS was determined by Voisny Erma hand refractometer (0°to 32°range) and expressed in °Brix. Ascorbic acid content was estimated in mature fruits by 2, 6-dichlorophenolindophenol visual titration method and the values were expressed in milligrams per 100 gram fresh edible portion at mature stage (Anon, 1984) [1]. Reducing sugar in the fruit sample preserved in 80 per cent alcohol was estimated as per the Dinitro Salicylic acid (DNSA) method reference. The value obtained was expressed as per cent on fresh weight basis and expressed in percentage (Miller, 1959) [9]. The per cent of non-reducing sugar was obtained by subtracting the values of reducing sugar from that of total sugar and multiply the same with 0.95 as correction factor and expressed in percentage. The total sugar in the sample was estimated by same method as that of reducing sugar after inversion of the non-reducing sugar using dilute hydrochloric acid and expressed in percentage (Anon, 1984) [1].

Results and discussion

The plants with low density spacing showed better results compared to high density planting with respect to fruit physical parameters. The trees spaced at 5.0 x 5.0 m showed highest fruit volume (249.78 cc), fresh fruit weight (293.72 g), weight of ripe fruit (270.19 g), fruit diameter (7.20 cm), fruit length (9.33 cm) and pulp weight (216.47 g) which was on par with the spacing 7.5 x 5.0 m (Table 1). Similar results were noticed in the investigations of Meena *et al.* (2005) [8] and Singh *et al.* (2007) [19] in guava who reported that fruit weight decreased with increasing plant density. Such production of small sized fruits in closely spaced plants is linked with the competition for water, light and soil nutrients which reduced the harnessing of photosynthetically active radiation (PAR) in closely spaced trees than medium and low density orchards (Singh *et al.*, 2007) [19].

The plastic mulching resulted in highest fruit volume (248.83 cc), fresh fruit weight (296.25 g), weight of ripe fruit (271.95 g), fruit diameter (7.36 cm), fruit length (9.12 cm) and pulp weight (9.12 cm) followed by paddy mulching (Table 1). The black polyethylene mulch mitigates negative effects of water stress, enhanced the concentrations of nutrients which improved fruit size, fruit weight, fruit colour and pulp weight in the stressed treatments in field-grown strawberry, particularly in semi-arid situations (Kirnak *et al.*, 2001) [5]. Plastic mulching stimulated the lateral root growth in nutrient-rich upper soil layer in particular. The anatomical structure of roots of mulched trees showed more unicellular and tubular root hairs with prominent conductive tissue compared to non-mulched ones (Singh and Rajan, 2009) [17] in mango. Similar results were observed by (Gordon *et al.*, 1997) [4] and Leib *et al.* (2000) [6] in tomato.

The combined effect of planting density and mulching showed that fruit the highest fruit volume (270.83 cc), fresh fruit weight (319.83 g), weight of ripe fruit (296.08 g), fruit diameter (7.8 cm), fruit length (9.65 cm) and pulp weight (244.92 g) was observed in treatment D_3M_2 (plant spacing of 5.0 x 5.0 m with plastic mulch). Whereas (D_2M_2) plant spacing of 5.0 x 2.5 m with plastic mulch showed lowest physiological loss in weight (6.01%). The higher values for fruit characters may be due to more availability of natural recourses *viz* soil, water, light which might have helped for higher values of fruit characters in wider spacing coupled with mulching. Mulching also helps in more conservation of water which helps in better growth of fruits. Similar results were also reported by Pan *et al.* (2003) [11], Roshan *et al.* (2011) [14], Meena *et al.* (2005) [8] and Singh (2007) [19] in guava.

The quality parameters were found significant with different plant densities. According to Policarpo *et al.* (2006), under high planting density, besides the changes in the quantity and quality of intercepted light, the partitioning of assimilates between vegetative and reproductive shoots may be responsible for the effects on fruit quality. The TSS (19.31 °B), titratable acidity (0.56%), ascorbic acid (39.77 mg/100g), reducing sugars (4.68%) and total sugars (13.24%) were highest in fruits produced in plants at spacing of 5.0 x 5.0 m which was on par with the spacing of 7.5 x 5.0 m (Table 2). Increased planting density did not significantly change the fruit quality. Low planting density had little influence on fruit quality as reported in other studies with mango (Ram & Sirohi, 1991; Nath *et al.*, 2007) [19] and similar results were also reported by Singh (2007) [19] and Singh (1980) [15] in mango.

In different mulches, plastic mulching showed maximum TSS (19.44 °B), acidity (0.54%), ascorbic acid (39.96 mg/100g), total sugars (13.26%), reducing sugars (4.65%) and non-reducing sugars (8.61%). It may be because of the fact that reduced nutrient losses due to weed control and improved hydrothermal regimes of the soil. Similar results were also observed by Chakaraborty and Sadhu (1994), Singh (2005) [16] in tomato and Singh *et al.* (2009) [17] in mango.

The combined effect showed that the treatment D_3M_2 (plant spacing of 5.0 x 5.0 m with plastic mulch) showed highest TSS (20.17 °B), titratable acidity (0.6%), ascorbic acid content (41.23 mg/100g), reducing sugars (4.92%) and total sugar (13.78%). This may be due to under high planting density, besides the changes in the quantity and quality of intercepted light, the partitioning of assimilates between vegetative and reproductive shoots may be responsible for the effects on fruit quality and because of mulch there will be

reduced nutrient losses, weed growth and improved hydrothermal regimes of soil. Similar results were observed in Pan *et al.* (2003) [11], Roshan *et al.* (2011) [14], Meena *et al.* (2005) [8] and Majumdar and Sharma (1985) [7]. In conclusion, use of plastic mulch in high density planting systems will help to improve physical and biochemical qualities of the mango fruits which helps to boost the export potential.

Table 1: Effect of planting density and mulching on fruit physical parameters of mango cv. Alphonso

Treatments	Fruit volume (cc)	Fresh fruit weight (g)	Ripe fruit weight (g)	Physiological loss in weight (%)	Fruit diameter (cm)	Fruit length (cm)	Pulp weight (g)	Peel weight (g)	Stone weight (g)
D_1	209.28	261.66	233.41	9.08	6.99	8.77	182.28	25.79	3.48
D_2	234	267.65	252.54	6.98	7.08	8.1	202.21	21.44	3.33
D_3	249.78	293.72	270.19	8.05	7.2	9.33	216.47	25	3.6
D_4	247.78	288.91	265.39	8.13	7.05	9.05	208.89	26.33	3.3
S.Em±	1.51	2.96	1.42	0.24	0.03	0.04	2.71	0.46	0.05
CD @ 5%	4.41	8.68	4.17	0.72	0.09	0.13	7.95	1.37	0.13
Mulching									
M_1	248.5	288.38	266.02	7.7	7.18	8.57	206.96	27	3.48
M_2	248.83	296.25	271.95	8.02	7.36	9.12	9.12	23.68	3.33
M_3	208.29	249.33	228.18	8.47	6.71	8.75	175.75	23.24	3.47
S.Em±	1.3	2.56	1.23	0.21	0.03	0.04	2.34	0.41	0.04
CD @ 5%	3.82	7.52	3.61	0.62	0.08	0.11	6.88	1.18	0.12
Interaction									
D_1M_1	234	270.86	251.09	7.16	7.2	8.8	192.83	27	3.3
D_1M_2	204.67	279.3	237.71	10.26	7.02	8.88	195.13	28.7	3.43
D_1M_3	189.17	234.84	211.42	9.83	6.75	8.63	158.86	21.67	3.7
D_2M1	245	282.96	262	7.38	7	8.85	205	24	3.4
D_2M_2	250	272.99	267.33	6.01	7.5	8.95	226	17	3.3
D_2M_3	207	246.98	228.29	7.56	6.75	8.82	175.63	23.31	3.28
D_3M_1	260	302.27	277.5	8.19	7.2	9.65	220.5	28	3.9
D_3M_2	270.83	319.83	296.08	7.43	7.8	9.65	244.92	23.5	3.3
D_3M_3	218.5	259.07	237	8.52	6.6	8.7	184	23.5	3.6
D_4M_1	255	297.44	273.49	8.05	7.3	9.3	209.5	28.99	3.3
D_4M_2	269.83	312.86	286.67	8.37	7.1	9	232.67	25.5	3.3
D_4M_3	218.5	256.43	236	7.97	6.75	8.85	184.5	24.5	3.3
CV	9.13	9.19	10.73	8.97	8.67	11.51	15.33	7.21	7.48
S.Em±	2.61	5.12	2.46	0.42	0.05	0.08	4.34	0.81	0.08
CD @ 5%	7.65	15.03	7.22	1.24	0.15	0.23	13.77	2.37	0.23

Table 2: Effect of planting density and mulching on fruit quality parameters of mango cv. Alphonso

Treatments	TSS (°B)	Titratable Acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugars (%)	Reducing sugars (%)	Total sugar (%)
Spacing (D)						
D_1	18.16	0.41	38.01	4.58	7.93	12.29
D_2	18.58	0.5	38.58	4.52	8.22	12.71
D_3	19.31	0.56	39.77	4.68	8.56	13.24
D_4	19.15	0.51	39.44	4.53	8.58	13.1
S.Em±	0.08	0.01	0.39	0.04	0.04	0.1
CD @ 5%	0.23	0.03	1.13	0.11	0.13	0.3
Mulching (M)						
M_1	19	0.52	39.03	4.53	8.49	12.82
M_2	19.44	0.54	39.96	4.65	8.61	13.26
M_3	17.95	0.45	37.86	4.54	7.88	12.42
S.Em±	0.07	0.01	0.33	0.03	0.33	0.09
CD @ 5%	0.2	0.03	0.98	0.09	0.98	0.26
Interaction						
D_1M_1	18.42	0.37	38.14	4.54	8.05	11.92
D_1M_2	18.56	0.51	38.73	4.62	8.12	12.74
D_1M_3	17.5	0.34	37.14	4.57	7.62	12.2
D_2M1	18.8	0.54	38.8	4.49	8.45	12.84
D_2M_2	19.1	0.54	39.13	4.45	8.49	12.94
D_2M_3	17.84	0.43	37.8	4.63	7.73	12.36
D_3M_1	19.44	0.55	39.71	4.67	8.7	13.37
D_3M_2	20.17	0.6	41.23	4.92	8.86	13.78
D_3M_3	18.32	0.52	38.38	4.44	8.13	12.58
D_4M_1	19.36	0.51	39.46	4.4	8.76	13.17
D_4M_2	19.95	0.52	40.74	4.63	8.97	13.6
D_4M_3	18.15	0.52	38.12	4.57	8.02	12.52
CV	16.98	8.99	16.58	10.84	8.73	13.26
S.Em±	0.13	0.02	0.67	0.06	0.08	0.18
CD @ 5%	NS	0.05	NS	0.18	NS	NS

Reference

1. Anonymous, 1984, Official Method of Analysis. Ed. Sidney Williams, Association Official Analytical Virgnia, 14th Edition. 424-462.
2. Anonymous, 2017, Indian data base http://www.data.gov.in/apedawebsite/Announcements/List horticultural crops pdf.
3. Chakaraborty, Sadhu. Effect of mulch type and colour on growth and yield of tomato. Indian J Agri. Sci. 1994; 64:608-612.
4. Gordon H, Niekerk WV, Johnson MA. Mulching and potassium relationship in Hass avocado to increases yield and fruit size. South Afr. Avocado Graves Assoisiation Year Book. 1997; 14:110-114.
5. Kirnak H, Cengiz K, David H, Sinan G. A long-term experiment to study the role of mulches in the physiology and macro-nutrition of strawberry grown under water stress Australian Journal of Agricultural Research. 2001; 52(9):937-943.
6. Leib BG, Jarrett AR, Orzolek MD, Mumma RO. Drip chemigation of imidacloprid under plastic mulch increased yield and decreased leaching caused by rainfall. Transactions of the ASAE. 2000; 43(3):615-622.
7. Majumdar PK, Sharma DK. 2nd International Symposium on mango, India. Abst. 1985; 3(9):20.
8. Meena RP, Mohammed S, Lakhawat SS. Effect of foliar application urea and zinc sulphate on fruit quality and yield of pruned guava trees (*Psidium guajava* L.) cv. 'Sardar' under high density planting systems. Udyanika. 2005; 11(2):90-93.
9. Miller GL. Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugar Anal. Chem. 1959; 31(3):426-428.
10. Nath JC. Effect of pruning intensity on growth, yield and quality of Assam lemon (*Citrus limon* Burm). Haryana J. Hort. Sci. 1994; 23(4):281-285.
11. Pan XY, Wang GX, Chan XP. Elevated growth redundancy and size inequality in spring of wheat population mulch with clear plastic film. J Agri. Sci. 2003; 40(2):193-204.
12. Policarpo M, Talluto G, Bianco RL. Vegetative and productive responses of 'Conference' and 'Williams' pear trees planted at different in-row spacings. Scienta, 2006.
13. Ram S, Singh CP, Kumar S. Comparative Performance of Dashehari and Amrapali Mangoes in High Density Orcharding. Indian J Horti. 1997; 54(3):27-31.
14. Roshan R, Singh R, Singh D, Gupta R. Influnce of covers and mulching of leaf interaction of leaf physiology, fruit yield and albinium incidence in sweet charles strawberry. 2011; 63(2):103-110
15. Singh RN. Mango: In MR. Sethurag AS. Raghavendra (eds.). Tree crop physiology, Elsevier, Amsterdam, 1980, 287-318.
16. Singh R. Influence of mulching on growth and yield of tomato (*Lycopersicon esculentum*) in north India plains. VegeTable Sci. 2005; 32(1):55-58.
17. Singh VK, Rajan S. Changes in photosynthetic rate, specific leaf weight and sugar contents in mango (*Mangifera indica* L.). Open Horticulture J. 2009; 2:40-43.
18. Singh BK, Tiwari KN, Chourasia SK, Mandal S. Crop water requirement of guava (*Psidium guajava*.) cv. kg/kaji under drip irrigation and plastic mulch.
19. Singh HP, Singh G, Samuel JC, Pathak RK, (Eds.) NCPAH, DAC, MOA, PFDC, CISH, Lucknow, 2007, 75-91.