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Effect of different combinations of pruning, nutrition and paclobutrazol on fruit quality, shelf life and occurrence of spongy tissue in Alphonso mango

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Abstract
Alphonso is the best table variety of mango and has great demand in the global market owing to its keeping quality, aroma, texture and flavour. Due to its inherent physiological disorders like susceptible to spongy tissue disorder we have not been able to achieve the expected export of the fruit. Keeping this in view, experiment was designed to find out suitable remedial measures by using pruning, nutrition and plant growth regulators. Field investigation was conducted for two consecutive years (2017-18 and 2018-19) in the established mango orchard on 7 years old Alphonso mango trees and maintained at 5 X 5 m spacing at Regional Horticultural Research and Extension Centre, Bengaluru. The treatment T4 recorded higher pulp to peel ratio (5.94) and higher pulp to stone ratio (4.68), higher TSS (20.42^{o}B), lower acidity (0.35%) and the highly significant observations like more number of days (15.68) for shelf life and lesser incidence of spongy tissue (6.67%).

Keywords: Mango *cv.* alphonso, pruning, nutrition, paclobutrazol, AMC (Arka microbial consortium), fruit quality, shelf life and spongy tissue

Introduction
Mango (*Mangifera indica* L.) is a delicious fruit and member of family Anacardiaceae, in the order Sapindales with chromosomal number 2n=4x=40. It is one of the most important tropical fruit of the world and is the national fruit of India and is called 'the King of fruits' due to its wide adaptability, delicious taste, excellent flavor, attractive appearance and richness in phytochemical and nutrient (Purseglove, 1972) [12]. India has traditionally been the world's largest producer of mangoes and having area under cultivation of 22.5 lakh hectares with production 21.82 million tons with a productivity of 8.7 tons/ha (Anon, 2018) [1]. India has a rich wealth of mango germplasm with more than 1000 varieties grown throughout the length and breadth of the country. Among them *cv.* Alphonso tops the list and is used as one of the choicest and prime variety of India. It is nutritionally accepted because of its characteristic sugar-acid blend, attractive colour and shape, pleasant aroma, superior fragrance, highly appreciable flavour, delicious taste and long keeping quality. In spite of these, 'Alphonso' is handicapped by its serious inherited physiological disorders like alternate bearing and occurrence of spongy tissue, which makes the variety as poorest yielder (2.5-3 tons/ha) compared to average Indian productivity (8.7 tons/ha). The occurrence of spongy tissue in ripe mango fruits is nothing but the development of yellowish white corky patches, soft and spongy in nature with or without air pockets accompanied with off flavour, which ultimately deteriorates the quality of fruits (Joshi and Roy, 1985). This disorder is broadly known world wide as internal breakdown or jelly tissue, rise tissue, etc. and has been reported from as many as 23 mango producing countries in the world (Victor and Cracknell, 1996) [25]. The overall losses due to this disorder in Alphonso mango has been estimated to be 30-88% depending upon location, season, age of the tree, time of picking, fruit weight, maturity of fruits, soil and environmental conditions. With this background, the present investigation was aimed to elicit information on the role of combination of pruning, nutrition and paclobutrazol on fruit quality and occurrence of spongy tissue in Alphonso mango.

Material and methods
The experiment was carried out on an uniform trees (7 years) of cultivar Alphonso during2017-18 and 2018-19 which are maintained at 5 X 5 m spacing at Regional Horticultural Research and Extension Centre, UHS campus, GKVK, Bengaluru.

Combinations of different levels of pruning, concentrations of paclobutrazol and levels of nutrition on fruit quality, shelf life and spongy tissue of mango *cv*. Alphonso was investigated. The observations were recorded on three trees for each treatment.

Treatment details of the experiment

T1 = control (No pruning and only RDF); T2 = Shoot pruning at 10cm length + RDF; T3 = Shoot pruning at 10cm length + PBZ @ 0.75g a.i./ m canopy diameter + 75% of RDF + 5kg vermicompost +20g of AMC + Mango special(spray); T4 = Shoot pruning at 10cm length + PBZ @ 0.75g a.i./ m canopy diameter + 75% of RDF + 10kg vermicompost + 2 g of AMC + Mango special(spray); T5 = Shoot pruning at 10cm length + PBZ @ 1.25g a.i./ m canopy diameter + 75% of RDF + 5kg vermicompost +20g of AMC + Mango special(spray); T6 = Shoot pruning at 10cm length + PBZ @ 1.25g a.i./ m canopy diameter + 75% of RDF + 10kg vermicompost + 20g of AMC + Mango special(spray); T7 = Shoot pruning at 20cm length + RDF; T8 = Shoot pruning at 20cm length + PBZ @ 0.75g a.i./ m canopy diameter + 75% of RDF + 5kg vermicompost + 20g of AMC + Mango special(spray); T9 = Shoot pruning at 20cm length + PBZ @ 0.75g a.i./ m canopy diameter + 75% of RDF + 10kg vermicompost + 20g of AMC + Mango special(spray); T10 = Shoot pruning at 20cm length + PBZ @ 1.25g a.i./ m canopy diameter + 75% of RDF + 5kg vermicompost + 20g of AMC + Mango special(spray); T11 = Shoot pruning at 20cm length + PBZ @ 1.25g a.i./ m canopy diameter + 75% of RDF + 10kg vermicompost + 20g of AMC + Mango special(spray).

Treatment imposition for experiment

This investigation was laid out in randomized complete block design (RCBD) with three replications. Two years data was statistically analysed and pooled data is interpreted here. Pruning was carried out in 3rd week of July of year 2017 and 2018, application of paclobutrazol in the last week of September of year 2017 and 2018 and fertilizer application in 2 split doses (first half dose in July of year 2017 and 2018 along with FYM and AMC, second half dose in October of year 2017 and 2018), mango special 3 sprays (before flowering, after flowering, during fruit setting) in year 2017 and 2018. For quality parameters, ten fruits from each replication were randomly selected and used for analysis.

The peel, pulp and stone of ripened mango fruits was separated and their weight was recorded.The content of total soluble solids (TSS) was determined with the help of digital hand refractometer (Atago®; pocket refractometer) and expressed as degree brix (^{0}Brix). The total titratable acidity and total sugars of mango fruits sample was determined by the method given by Ranganna (1986). Shelf life of five fruits was decided based on the appearance and marketability of the fruits. When the fruits attained beyond edible ripe stage and shrivelled, then those fruits were considered to have reached the end of their shelf life (Turner, 1997) [24].

Spongy tissue (%)

The percent incidence of spongy tissue was determined based on visual scoring of ten ripe fruits from each replication after cutting them open.

$$\text{Spongy tissue (\%)} = \frac{\text{Number of fruits affected}}{\text{Total number of fruits}} \text{X100}$$

Results and discussion

Fruit weight (g), fruit length (cm) and fruit width (cm)

The data related to fruit weight, fruit length and fruit width are presented in Table 1 Data on fruit weight revealed that the different treatments affect the fruit weight significantly during both the years of experiment. The maximum fruit weight (261.35g) was recorded with T1 (control) while minimum fruit weight (235.43 g) was observed with T5.Fruit length was found higher (10.44 cm) with treatment T7. The least fruit length (8.39 cm) was observed in T10. The higher fruit width (8.67cm) was recorded with T7 and the minimum width (7.10cm) was observed with T5. Fruit weight, fruit length and fruit girth are significantly influenced by the treatments. Among the treatments trees which are pruned and treated with paclobutrazol recorded lesser fruit weight, fruit length and fruit width over control. This could be due to the fact that control and non-PBZ treated trees had higher fruit weight and less number of fruits per tree. The increase in length and weight could be due to less number of fruits which helped in better translocation of assimilates for fruit growth and development. A similar decrease in fruit weight and other physical properties due to application of PBZ have been reported by Reddy and Kurian (2008) [18] in Alphonso mango and Vijaykrishna *et al.* (2016) [26] in Banginapally mango.

Stone weight (g), peel weight and pulp weight (g)

The data related to stone weight, pulp weight and stone weight are presented in Table 2. It is revealed from the pooled data that maximum stone weight (41.93g) was observed in control The treatment T4 recorded minimum stone weight (33.91g). The pooled data with respect of peel weight was observed lower (27.47g) with T4 Higher value for peel weight (33.98g) was recorded with control. The maximum pulp weight (160.08g) was recorded with treatment T4. The minimum pulp weight (135.03g) was recorded with control. It was observed in the present investigation that among various properties of fruits studied, stone weight, peel weight and pulp weight differed significantly between treatments. Pruning influences several physiological processes directly or indirectly and restores the balance between root system and above ground parts, which results in better fruit quality. Similar conformational statements were given by Ramasrey (2013) [13] in Amrapali and Singh *et al.* (2010) [23] in Amrapali, Mallika and Dashehari. Who recorded improvement in fruit quality with pruning. Fruit quality improvement with respect to pulp content, in response to PBZ application can be related to the assimilate partitioning in plant. The suppression of vegetative growth causes assimilates demand in unidirectional to the developing fruit, resulting in high quality fruits from PBZ treated plants. These results are in conformity with Sarkar and Rahim (2012) [20] in mango *cv*. Amrapali and Patel *et al*. (2016) [11] in mango *cv*. Alphonso. The quality improvement in fruits, when applied inorganic fertilizers along with organic fertilizers may be due to proper supply of nutrients and induction of growth hormones, which stimulated cell division, cell elongation, increase weight of the fruit. Similar results were reported by Singh and Banik (2011) [22] in mango *cv.* Himsagar and Elshiekh (2016) [5] in mango *cv*. Dabsha.

Pulp to stone ratio and Pulp to peel ratio

The results of pulp to stone ratio presented in Table 3 shows significant variation among the treatments and the pooled mean shows maximum (4.68) pulp to stone ratio was obtained with the T4. The minimum pulp to stone ratio (3.18) was obtained with control. Pulp to peel ratio showed that its maximum value (5.94) was registered with T4, while minimum (4.03) was recorded with control. Similar conformational results were obtained by Singh and Banik

(2011) [22] in mango *cv*. Himsagar and Patel *et al.* (2016) [11] in mango *cv*. Alphonso.

TSS (^{0}B) and acidity (%)

The data related to TSS and acidity is presented in Table 4. The pooled data in respect of TSS was observed higher (20.67^{0}B) with fruits from treatment T11. The lower TSS (18.73^{0}B) was obtained with control (T1). Lower acidity content (0.34%) recorded with the treatment T9, while higher pooled mean with respect to titratable acidity (0.45%) was obtained with control. Increase in TSS could be attributed to higher solutes as a result of enhanced mobilization of carbohydrates in these treatments. The decrease in acidity of fruit may be attributed due to their conversion into sugar and their derivatives by the reaction involving reversal of glycolytic pathway or might be used in respiration or both. The above results were in agreement with Sarkar and Rahim (2012) [20] in Amrapali by pruning, Reddy *et al.* (2014) [19] in mango *cv*. Totapuri by PBZ application, Mohit kumar *et al.* (2018) [9] in Dashehari and Deepasamant *et al.* (2018) [4] in Banganpally by INM.

Total sugars (%), reducing sugars (%) and non- reducing sugars (%)

The data related to total sugars reducing sugars (%) and non-reducing sugars (%) are presented in Table 5. On the basis of pooled data it was observed that the maximum total sugar (14.90%) was found in T4. The minimum total sugar (13.64%) was found with control. Maximum reducing sugars content (3.67%) recorded with the T4 and minimum reducing sugar content was recorded (2.86%) with control. Maximum non-reducing sugar (11.56%) was obtained with T4 and minimum non-reducing sugar (10.74%) was obtained with the control.

Pruning influences several physiological processes directly or indirectly and restores the balance between root system and above ground parts, which results in better fruit quality. Similar conformational statements were given by Ramasrey (2013) [13] in Amrapali and Singh *et al.* (2010) [23] in Amrapali, Mallika and Dashehari. Who recorded improvement in fruit quality with pruning. PBZ induced fruit quality enhancement was reported by Sarkar and Rahim (2012) [20] in mango *cv*. Amrapali and Reddy *et al.* (2014) [19] in *cv*. Alphonso. Fruit quality improvement with respect to total sugars and reducing sugars in response to PBZ application can be related to the assimilate partitioning in plant. The quality improvement in fruits, when applied inorganic fertilizers along with organic fertilizers may be due to proper supply of nutrients and induction of growth hormones, which stimulated cell division, cell elongation, increase in number and weight of the fruits, better root development and better translocation of water uptake and deposition of nutrients (Ranjan *et al.*, 2006) [15] and also due to enhancement of the conversion of complex polysaccharides into simple sugars (Gautam *et al*. 2012) [6]. The investigated results are in agreement with Mohit kumar *et al*. (2018) [9] in Dashehari and Deepasamant *et al.* (2018) [4] in Banganpally.

Table 1: Effect of combination of different levels of pruning, nutrition and PBZ on physical parameters of fruits of mango *cv.* Alphonso

Treatments	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	278.67	256.03	261.35	10.41	10.36	10.39	8.51	8.43	8.47
T2(P1+RDF)	252.33	238.57	242.45	10.14	10.21	10.18	8.38	8.38	8.38
T3(P1+PBZ1+N1)	237.83	227.33	232.08	8.58	9.33	9.02	7.48	7.53	7.51
T4(P1+PBZ1+N2)	247.67	240.72	244.19	9.32	9.45	9.33	7.50	7.57	7.54
T5(P1+PBZ2+N1)	239.00	224.73	228.03	8.87	8.65	8.92	7.08	7.13	7.10
T6(P1+PBZ2+N2)	239.33	230.57	234.29	9.09	8.96	8.87	7.63	7.65	7.64
T7(P2+RDF)	255.67	245.28	251.47	10.46	10.41	10.44	8.55	8.78	8.67
T8(P2+PBZ1+N1)	241.17	231.22	238.20	8.34	9.21	8.80	7.38	7.49	7.43
T9(P2+PBZ1+N2)	244.50	239.23	240.87	9.10	9.26	9.16	7.72	7.65	7.69
T10(P2+PBZ2+N1)	237.48	233.39	235.43	8.45	8.33	8.39	7.14	7.27	7.21
T11(P2+PBZ2+N2)	238.71	234.83	236.77	9.05	8.36	8.70	7.44	7.45	7.45
S. Em±	11.99	4.64	6.70	0.13	0.17	0.14	0.17	0.12	0.09
CD at 5%	35.38	13.69	19.03	0.37	0.50	0.41	0.50	0.35	0.27

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Table 2: Effect of combination of different levels of pruning, nutrition and PBZ on stone weight, peel weight and pulp weight of mango *cv.* Alphonso

Treatments	Stone weight (g)			Peel weight (g)			Pulp weight (g)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	41.75	42.12	41.93	34.07	33.89	33.98	137.00	133.06	135.03
T2(P1+RDF)	40.26	40.41	40.34	33.39	33.38	33.39	151.82	149.47	150.65
T3(P1+PBZ1+N1)	37.41	37.04	37.23	29.04	27.98	28.51	155.86	152.12	153.99
T4(P1+PBZ1+N2)	34.22	33.59	33.91	28.82	26.12	27.47	160.60	159.55	160.08
T5(P1+PBZ2+N1)	36.48	35.67	36.07	31.31	28.61	29.96	152.00	151.91	151.96
T6(P1+PBZ2+N2)	35.93	35.82	35.88	28.24	29.29	28.76	158.94	154.67	156.80
T7(P2+RDF)	40.12	40.08	40.10	32.99	32.00	32.49	143.74	140.09	141.92
T8(P2+PBZ1+N1)	36.34	35.71	36.03	31.77	31.55	31.66	153.67	153.41	153.54
T9(P2+PBZ1+N2)	35.12	34.19	34.65	27.98	27.92	27.95	160.93	158.80	159.87
T10(P2+PBZ2+N1)	36.59	36.11	36.35	30.83	31.26	31.05	154.04	150.52	152.28
T11(P2+PBZ2+N2)	36.13	35.42	35.78	27.38	27.96	27.67	153.67	150.26	151.96
S. Em±	0.86	0.85	0.55	0.71	0.83	0.56	1.81	1.66	1.15

CD at 5%	2.54	2.52	1.56	2.10	2.43	1.59	5.35	4.91	3.27

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Table 3: Effect of combination of different levels of pruning, nutrition and PBZ on pulp to peel ratio and pulp to stone ratio of mango *cv.* Alphonso

Treatments	Pulp to peel ratio			Pulp to stone ratio		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	4.01	4.05	4.03	3.13	3.23	3.18
T2(P1+RDF)	4.57	4.54	4.56	3.30	3.32	3.31
T3(P1+PBZ1+N1)	5.34	5.37	5.35	4.15	4.20	4.18
T4(P1+PBZ1+N2)	5.93	5.95	5.94	4.64	4.71	4.68
T5(P1+PBZ2+N1)	4.83	4.82	4.83	4.24	4.28	4.26
T6(P1+PBZ2+N2)	5.48	5.45	5.46	4.12	4.24	4.18
T7(P2+RDF)	4.64	4.66	4.65	3.52	3.64	3.58
T8(P2+PBZ1+N1)	4.98	4.96	4.97	4.19	4.18	4.19
T9(P2+PBZ1+N2)	5.71	5.68	5.69	4.47	4.38	4.42
T10(P2+PBZ2+N1)	5.13	5.11	5.12	4.28	4.14	4.21
T11(P2+PBZ2+N2)	5.26	5.20	5.23	4.14	4.12	4.13
S. Em±	0.05	0.03	0.03	0.14	0.13	0.09
CD at 5%	0.13	0.09	0.07	0.43	0.40	0.26

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Table 4: Effect of combination of different levels of pruning, nutrition and PBZ on TSS and acidity of mango fruit *cv.* Alphonso

Treatments	TSS (^{0}B)			Acidity (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	18.73	18.85	18.73	0.44	0.45	0.45
T2(P1+RDF)	18.93	18.99	18.93	0.43	0.42	0.43
T3(P1+PBZ1+N1)	20.10	20.17	20.13	0.33	0.31	0.32
T4(P1+PBZ1+N2)	20.30	20.63	20.42	0.34	0.32	0.33
T5(P1+PBZ2+N1)	20.10	20.40	20.25	0.36	0.36	0.36
T6(P1+PBZ2+N2)	20.20	20.52	20.37	0.36	0.35	0.36
T7(P2+RDF)	19.23	19.43	19.33	0.43	0.41	0.42
T8(P2+PBZ1+N1)	20.13	20.27	20.20	0.36	0.34	0.35
T9(P2+PBZ1+N2)	20.28	20.33	20.30	0.34	0.30	0.31
T10(P2+PBZ2+N1)	20.34	20.37	20.35	0.35	0.34	0.34
T11(P2+PBZ2+N2)	20.57	20.68	20.67	0.36	0.34	0.35
S. Em±	0.51	0.47	0.31	0.01	0.01	0.01
CD at 5%	1.52	1.32	0.89	0.04	0.04	0.03

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Table 5: Effect of combination of different levels of pruning, nutrition and PBZ on fruit quality attributes of mango *cv.* Alphonso during 2017-19

Treatments	Reducing sugars (%)			Non reducing sugars (%)			Total sugars (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	2.84	2.88	2.86	10.79	10.69	10.74	13.55	13.72	13.64
T2(P1+RDF)	2.88	2.89	2.89	10.90	10.95	10.93	13.83	13.92	13.87
T3(P1+PBZ1+N1)	3.45	3.46	3.45	11.07	11.07	11.07	14.52	14.87	14.69
T4(P1+PBZ1+N2)	3.72	3.63	3.67	11.58	11.53	11.56	14.85	14.95	14.90
T5(P1+PBZ2+N1)	3.45	3.52	3.49	10.71	10.61	10.66	14.68	14.80	14.74
T6(P1+PBZ2+N2)	3.68	3.65	3.66	10.82	10.89	10.86	14.57	14.59	14.58
T7(P2+RDF)	3.00	2.96	2.98	11.15	10.75	10.95	13.76	13.91	13.84
T8(P2+PBZ1+N1)	3.27	3.32	3.30	11.36	11.42	11.39	14.70	14.72	14.71
T9(P2+PBZ1+N2)	3.50	3.41	3.45	11.56	11.36	11.46	14.78	14.81	14.80
T10(P2+PBZ2+N1)	3.15	3.12	3.13	11.24	11.26	11.25	14.33	14.80	14.57
T11(P2+PBZ2+N2)	3.66	3.58	3.62	11.16	11.28	11.22	14.72	14.76	14.74
S. Em±	0.16	0.15	0.10	0.21	0.21	0.16	0.19	0.18	0.12
CD at 5%	0.48	0.48	0.29	0.62	0.62	0.46	0.57	0.54	0.35

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Table 6: Effect of combination of different levels of pruning, nutrition and PBZ on spongy tissue appearance and shelf life of mango *cv*. Alphonso

Treatments	Spongy tissue (%)			Shelf life (days)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	30.00	26.67	28.33	9.80	10.17	9.98
T2(P1+RDF)	26.67	23.33	25.00	11.13	11.13	11.13
T3(P1+PBZ1+N1)	16.67	6.67	11.67	14.80	15.20	15.00
T4(P1+PBZ1+N2)	10.00	3.33	6.67	15.27	16.10	15.68
T5(P1+PBZ2+N1)	13.33	10.00	11.67	14.67	14.83	14.75
T6(P1+PBZ2+N2)	13.33	6.67	10.00	14.63	14.67	14.65
T7(P2+RDF)	23.33	23.33	23.33	10.77	11.10	10.93
T8(P2+PBZ1+N1)	16.67	6.67	11.67	14.87	14.97	14.92
T9(P2+PBZ1+N2)	13.33	3.33	8.33	15.40	15.37	15.38
T10(P2+PBZ2+N1)	16.67	6.67	11.67	14.97	14.77	14.87
T11(P2+PBZ2+N2)	13.33	6.67	10.00	15.10	15.43	15.27
S. Em±	3.84	2.82	2.27	0.36	0.27	0.21
CD at 5%	11.33	8.33	6.45	1.06	0.81	0.60

P1 - Shoot pruning at 10cm length; P2 - Shoot pruning at 20cm length.
PBZ1 - @ 0.75 g a.i. / m canopy diameter; PBZ2 - @ 1.25 g a.i. / m canopy diameter.
N1 -75% of RDF + 5Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray);
N2 -75% of RDF + 10Kg Vermi compost + 20 g Arka microbial consortium + Mango special (spray).

Shelf life

Data presented in Table 6 on shelf life of mango *cv*. Alphonso fruits which are stored at room temperature showed significant results during both the years of investigation (2017-18 and 2018-19). The pooled data in regards of shelf life revealed that the maximum value for shelf life (15.68 days) was recorded with T4 and the minimum duration of shelf life (9.98 days) was recorded with control. Yashpal singh *et al.* (2017) [27] found that the increase in shelf life of mango fruits might be due to increase in concentration of boron of middle lamella of cell wall which provide physical strength to cell wall and improve fruit colour development and appearance. These findings are in accordance with the findings of Sau *et al.* (2017) [21] in mango *cv*. Himsagar and Ravikiran *et al.* (2018) [16] in mango *cv*. Banganapally. Luna *et al.* (2014) [8] reported that the use of PBZ reduced the production of ethylene and in consequence the respiration rate and processes of physical and chemical ripening. Fruit firmness from trees treated with PBZ was higher during post-harvest storage of Manila mangoes. The PBZ can affect the electronic transport, this could promote the accumulation of $NADH^{+}$ and H^{+}, in fruit cell, being able to reduce the activity of isocitrate dehydrogenase, allosteric enzyme involved in the regulation of Krebs cycle and diminished the CO_2 production. These effects demonstrate that PBZ has a suppressor effect on fruit ripening and an important effect on post harvest life. Similar conformational statements were also being given by Naleo *et al.* (2018) [10].

Spongy tissue (%)

The data related to spongy tissue are presented in Table 5. Maximum incidence of spongy tissue (28.33%) was observed in control followed by T2 (25.00%). The treatment T4 showed minimum spongy tissue incidence (6.67%). Lower incidence of spongy tissue in paclobutrazol treated trees could be attributed to higher uptake of Ca and its relocation to fruits as rate of leaf transpiration is significantly reduced, thus could favour the supply of Ca towards the fruit. Moreover, significant increase in Ca uptake of Alphonso mango trees under paclobutrazol application has been reported by Dabke *et al.* (1999) [3]. A similar decrease in the occurrence of spongy tissue due to paclobutrazol was reported by Burondkar *et al.* (2009) [2] and Ravindra (2015) [17].

Conclusion

The study revealed that combination of pruning, nutrition and paclobutrazol is more effective in increasing the quality and reducing the incidence of spongy tissue in Alphonso mango compared to control.

References

1. Anonymous. Indian Horticulture Database. National Horticulture Board, Gurgaon, Haryana, 2018.
2. Burondkar MM, Jadhav BB, Chettia MB. Effect of plant growth regulators, polyamine and nutrients on fruit quality and occurrence of spongy tissue in Alphonso mango. Proc. VIIIth Int. Mango Symposium Ed.: S.A. Oosthuyse. Acta Hort, 2009, 820.
3. Dabke DJ, Chandelkar AB. Burondkar MM and Mehta VB. Nutrient dynamics in Alphonso mango orchard treated with paclobutrazol. VI International Mango Symposium, Pattaya, Thailand, 1999, p241.
4. Deepasamant Kishore K, and Singh HS. Assessing effectiveness of 'Arka Mango Special' for improving yield and quality of mango variety 'Banganpalli' in lateritic soils of Odisha, India. Int. J Curr. Microbiol. App. Sci. 2018; 7(1):168-173.
5. Elshiekh AFD. Agricultural production: improving "Dabsha" mango trees productivity and fruit quality by biological fertilizers. Amer. J Agri. Forestry. 2016; 4(6):163-167.
6. Gautam US, Singh R, Tiwari N, Gurjar PS, Kumar A. Effect of integrated nutrient management in mango *cv*. Sunderja. Indian J Hort. 2012; 69(2):151-155.
7. Joshi GD, Roy SK. Spongy tissue in mango: A physiological disorder. Indian Hort. 1985; 29(4):21-22.
8. Luna AV, Castellanos GM, Domínguez ER, Sobac RD. Effect of pre-harvest application of paclobutrazol on postharvest quality of mango fruit (*Mangifera indica*) *cv*. Manila. J. Agri. Env. Sci. 2014; 3(3):63-72.
9. Mohit kumar, Kumar R, Singh R, Kumar L. Effect of Organic manures on physical and chemical characteristics of mango *cv*. Dashehari at ambient storage conditions. Int. J Curr. Microbiol. App. Sci. 2018; 7(1):31-39.
10. Naleo S, Sema A, Mait CS. Effect of plant growth regulators and packaging on flowering, fruit quality and shelf life in mango cv. Amrapali. J Exp. Agri. Int. 2018; 20(6):1-8.
11. Patel GD, Patel BN, Desai KD, Patel NK, Patel BB. Influence of paclobutrazol for earliness in mango *cv*. Alphonso. Int. J Sci. Envi. Tech. 2016; 5(5):2713-2718.
12. Purseglove JW. Mangoes west of India. Acta. Hort. 1972; 24:107-174.
13. Ramasrey S, Patel VB, Barman Pal KRK. Pruning affects fruit yield and post harvest quality in mango (*Mangifera indica* L.) cv. Amrapali. Fruits. 2013; 68:367-380.
14. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Second edn. Tata McGraw-Hill Pub. Co. Ltd., New Delhi, India, 1986.
15. Ranjan Tarai, Ghosh SN. Integrated nutrient management in sweet orange cv. Mosambi (*Citrus sinensis* Osbeck). Orissa J. Hort. 2006; 34:72-75.

16. Ravikiran Y, Nayak MH, Veenajoshi, Naik DS. Effect of integrated nutrient management and micronutrients on post harvest quality parameters and shelf life of mango (*Mangifera indica* L.) cv. Banganapalli under high density planting. Int. J Chem. Studies. 2018; 6(6):858-861.
17. Ravindra V. Recent understanding of spongy tissue problem in 'Alphonso' mango - A review. Acta. Hort. 2015; 1066:169-175.
18. Reddy YTN, Kurian RM. Commulative and residual effects of paclobutrazol on growth, yield and fruit quality of 'Alphonso' mango. J Hort. Sci. 2008; 3:119-122.
19. Reddy YTN, Upreti KK, Shivu prasad SR. Response of paclobutrazol treatment on flowering, fruit maturity, yield and quality of mango (*Mangifera indica* L.) *cv*. Totapuri. Indian J. Agic. Sci. 2014; 84(10):1231-1235.
20. Sarker BC, Rahim MA. Vegetative growth, harvesting time, yield and quality of mango (*Mangifera indica* L.) as influenced by soil drench application of paclobutrazol. Bangladesh J. Agril. Res. 2012; 37(2):335-348.
21. Sau S, Mandal P, Sarkar T, Das K, Datta P. Influence of bio-fertilizer and liquid organic manures on growth, fruit quality and leaf mineral content of mango *cv*. Himsagar. J. Crop and Weed. 2017; 13(1):132-136.
22. Singh SR, Banik BC. Response of integrated nutrient management on flowering, fruit setting, yield and fruit quality in mango (*Mangifera indica* L.) cv. Himsagar. The Asian J. of Hort. 2011; 6(1):151-155.
23. Singh SS, Singh SK, Sharma RR. Pruning alters fruit quality of mango cultivars (*Mangifera indica* L.) under high density planting. J Tropical Agric. 2010; 48(1-2):55-57.
24. Turner DW. Bananas and Plantains, In (ed.) Mitra, S. K., Postharvest physiology and storage of tropical and subtropical fruits, CAB International, 1997.
25. Victor GS, Cracknell T. Soft nose in mango. V International Mango Symposium. Tel Aviv, Israel, September, 1996.
26. Vijaykrishna GV, Bhagwan A, Kumar MR, Shankar AS. Effect of flower enhancing plant growth regulators and fruit set improving chemicals on flowering and fruit set of mango (*Mangifera indica*) *cv*. Banganpalli. Int. J. Sci. and nature. 2016; 7(1):81-88.
27. Yashpal singh, Prakash S, Prakash O, Kumar D. Effect of organic and inorganic sources of nutrients on available soil nutrients in Amrapali mango (*Mangifera indica* L.) under high density planting. Int. J Pure App. Bio sci. 2017; 5(4):93-98.