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Influence of combination of different levels of pruning, nutrition and paclobutrazol on soil and leaf nutritional status in mango (*Mangifera indica* L.) *cv*. Alphonso

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Abstract
An experiment was carried out to investigate the influence of pruning, nutrition and paclobutrazol on the availability of nutrients in soil and leaf 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. Among the eleven treatments T4 showed best results. Higher readings for soil nitrogen (413.40 kg/ha), soil phosphorus (48.10 kg/ha), soil potassium (290.03 kg/ha), soil calcium (7.23 meq/100g), soil magnesium (3.61 meq/100g), soil sulphur (13.92 ppm), leaf nitrogen (1.28%), leaf phosphorus (0.20%), leaf potassium (1.04%), leaf calcium (0.63%), leaf magnesium (0.56%) and leaf sulphur (0.11%) are recorded with pruning at 10cm length along with PBZ @ 0.75 g a.i./ m canopy diameter, 75% of RDF, 10 kg vermicompost, 20g of AMC and mango special spray.

Keywords: Pruning, nutrition, paclobutrazol, AMC (Arka microbial consortium), soil nutrients and leaf nutrients

Introduction
The mango (*Mangifera indica* L.) is the most important fruit crop belonging to the botanical family "Anacardiaceae". It is a premier fruit crop of India considering its acreage, production and popularity among the people and therefore it is designated as the "National Fruit of India". Due to its delicate taste, pleasant aroma and high nutritional value it is considered as 'king of fruits', 'heavenly fruit' and 'super fruit', However, the performance of varieties is found to vary under different climatic conditions [12]. The Alphonso is a seasonal fruit, available mid-April through the end of June. The fruits generally weigh between 150 and 300 grams. They have a rich, creamy, tender texture and delicate, non-fibrous, juicy pulp. The skin of a fully ripe Alphonso mango turns bright golden-yellow with a tinge of red which spreads across the top of the fruit. The flesh of the fruit is saffron-colored. These characteristics make Alphonso a favored cultivar. Nutrition of trees is an important part of mango orchard management practices and fertilizer is one of the major inputs accounting for nearly 35 percent of the cost of cultivation. It is reported that when a tree produces heavy crop in one season, it gets exhausted nutritionally and is unable to put forth new flush thereby failing to yield in the following season. However, both regular and biennial cultivars, utilize reserve carbohydrate in addition to current photosynthesis for normal fruit development. Larger amount of carbohydrates withdrawn for fruit development in biennial cultivars could reduce vegetative growth and fruiting in the following year resulting in an "off" year. Nutrient management in the fruit crops constitutes an important aspect of intensive cultivation. An inadequate nutrition and indiscriminate use of chemical fertilizers (imbalance use of nutrients), neglecting organic and bio-fertilizers paved the way for deterioration of soil health which in turn affect the crop. In order to maintain soil health and to obtain optimum yield with better quality fruits, it is essential to adopt integrated nutrient management (INM) approach [3]. INM can be achieved by adopting practices such as application of organic manure like FYM, vermicompost, use of bio-fertilizers, in addition to inorganic fertilizers. The integrated nutrient management is the most appropriate approach for managing the nutrient input. INM system ensures high yields and sustains the available nutrients in the soil at optimum level [4]. An integrated use of the organic manures and chemical fertilizers in combination at appropriate time could help in achieving the goal of obtaining high fruit yield and pave the way for sustainable fruit production. Nutrient management in the fruit crops constitutes an important aspect of intensive cultivation. In current scenario of organic horticulture, biofertilizer more commonly known as microbial inoculants are choice of the farmers [14]. These are artificially multiplied cultures of certain soil microorganisms that can improve soil fertility and crop Productivity.

Bio-fertilizers not only provide growth promoting activity to the plant by enhancing the nutrient uptake but also provide strength against soil borne diseases. In mango, favorable effect of INM system has been reported in increased the number of mango fruit per plant, fruit weight, yield and fruit quality [4, 11]. The management of nutrients through organic and biological sources would be more beneficial and eco-friendly to improve the health of soils, minimize the chemical residues and quality of fruit produce. So, the present investigation was undertaken to find out the combined effect of organic manures, inorganic manures and biofertilizers along with pruning and paclobutrazol application on nutrient status in soil and leaf in mango *cv*. Alphonso.

Material and methods

The experiment was carried out on an uniform trees (7 years) of cultivar Alphonso during 2017-18 and 2018-19 which are maintained at 5 X 5 m spacing at Regional Horticultural Research and Extension Centre, UHS campus, GKVK, Bengaluru.

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 analyzed 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. The samples were collected from three trees for each treatment. Recently matured leaves (5th leaf from top) from mid position of 4 to 5 months old shoots were collected at the beginning of experiment and at the time of harvest, likewise, 30 leaves per tree were collected and oven dried at 65°C for 48 hours. The dried samples were powdered, stored in air tight plastic container and utilized for analysis. Similarly soil samples were collected before initiation of experiment and at the time of harvest. The soil analysis and leaf analysis results before the initiation of experiment are presented in Table1.

Table 1: Soil and leaf (mango *cv*. Alphonso) nutrient status before initiation of experiment.

Nutrients	Soil sample	Leaf sample
Nitrogen	375.55 kg/ha	0.76%
Phosphorus	38.45 kg/ha	0.07%
Potassium	236.55 kg/ha	0.58%
Calcium	5.35 meq/100g	0.49%
Magnesium	2.61meq/100g	0.32%
Sulphur	13.44 ppm	0.04%

Results and Discussion

Nutrient analysis of soil

The data pertaining to available nutrients in soil measured after mango fruit harvesting. The available nutrients was influenced significantly by different combinations of pruning, nutrition and PBZ during both the years of investigation and are presented in Table 2 and 3. The pooled data with respect of available nutrients showed significant variation among treatments and maximum available nitrogen (413.40 kg ha^{-1}), maximum available phosphorus (48.10 kg ha^{-1}), maximum available potassium (290.03 kg ha^{-1}), maximum content of available calcium (7.33 meq 100 g^{-1}), maximum available magnesium (3.61 meq 100 g^{-1}) and maximum available sulphur (13.92 ppm) were recorded with the T4. The minimum available nitrogen content (378.46 kg ha $^{-1}$), minimum available phosphorus content (39.03 kg ha^{-1}), minimum (237.70 kg ha^{-1}) available potassium, minimum available calcium content (5.57 meq 100 g^{-1}), minimum available magnesium (2.62 meq 100 g^{-1}) was recorded with control. The minimum available sulphur (13.45 ppm) was recorded in T8. The analysed data related to the soil nutrients status revealed that the available 9 per cent more nitrogen, 23 per cent more phosphorus, 21 per cent more potassium, 29 per cent more calcium, 37 per cent more magnesium and 3 per cent more sulphur are recorded from the treatment, pruning at 10cm along with the application of PBZ @ 0.75 a.i. / m canopy diameter of tree, 75% RDF , 10kg vermicomposting, 25kg FYM, 20g of AMC and micronutrient spray (mango special) compared with control. Treatment which receive only chemical fertilizers showed not appreciably improvement on the available nutrient status of the soil but it was profoundly influenced by integrated nutrient management and was appreciably higher compared to the initial status. The experiment also revealed that the use of these nutrient sources not only supplemented inorganic nitrogen but also upgraded the overall nitrogen level of the soil for sustainable use. In respect of phosphorus, the application of organic manure and biofertilizer significantly reduces the fixation of added as well as native phosphorus and making them more available to plants. The increased phosphorus availability may be due to the action of organic acids from the organic matter complex [10]. The soil potassium, calcium, magnesium and sulphur increased in treatments which include INM, may be due to increase of soil organic matter content therefore enhancing the cation exchange capacity of the soil. These findings are in confirmatory with results in strawberry [17], in aonla [13], in mango *cv*. Himsagar [12] and in mango *cv.* Amrapali [8, 18].

Nutrient analysis of leaf

Data presented in Table 4 and 5 on leaf nutrients content were found significant during both the years of investigation. The pooled leaf nitrogen content of two years showed that there

was maximum nitrogen content (1.28%), maximum phosphorus content (0.20%), maximum potassium content (1.05%), maximum calcium content (0.64%), maximum leaf magnesium content (0.56%) and maximum leaf sulphur content (0.11%) in the treatment T4. The minimum leaf nitrogen (0.95%) content was found with T2 (shoot pruned at 10cm length + RDF) followed by T1 (0.96%). The minimum value for leaf phosphorus (0.09%) minimum content of leaf potassium (0.60%), minimum leaf calcium content (0.51%), minimum magnesium in leaf (0.35%) and minimum available sulphur content (0.04%) were obtained with control. With respect to leaf nutrient status, the analyzed data shows that the significant effect of NPK fertilizers in combination with organic manure and biofertilizer was noted on the nitrogen, phosphorus, potassium, calcium, magnesium and sulphur content in leaves. Highest values for available 33 per cent more nitrogen, 55 per cent more phosphorus, 73 per cent more potassium, 21 per cent more calcium, 60 per cent more magnesium and 63 per cent more sulphur recorded for trees which are pruned at 10cm, along with the application of PBZ @ 0.75 a.i. / m canopy diameter of tree, 75% RDF, 10kg vermicompost, 25kg FYM, 20g of AMC and micronutrient spray (mango special) compared with control. Accumulation of any nutrient in the leaves depends considerably on the uptake of the nutrient from the soil. Microbes present in the soil solubilize the fixed phosphorus and make it easily available to the plant [5, 16]. Increased leaf phosphorus content might be due to more solubilization of phosphorus by AMC thus making more phosphorus available to the plant and also maximizes availability of soil nutrients. Nitrogen fixing biofertilizer secretes PGRs in rhizosphere, which might have lowered the pH of the soil and thereby making K, Ca, Mg and S available to the plant easily. Bio-fertilizers increases mineralization, uptake of mineral nutrients and improves nutrient conversion (mobilization) from organic & inorganic sources. The results were in close confirmatory with studies in mango seedlings [7], in Guava [1], in mango *cv*. Himsagar [12], and in mango *cv*. Amrapali [8].

Table 2: Effect of combination of different levels of pruning, nutrition and PBZ on soil nitrogen, phosphorus and potassium of mango *cv*. Alphonso during 2017-19.

Treatments	Soil Nitrogen (Kg/ha)			Soil Phosphorus (Kg/ha)			Soil Potassium (Kg/ha)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	377.99	378.92	378.46	38.55	39.50	39.03	238.02	238.68	238.35
T2(P1+RDF)	380.62	380.77	380.69	39.37	39.70	39.53	238.04	237.37	237.70
T3(P1+PBZ1+N1)	388.48	391.63	390.06	42.65	43.54	43.10	268.92	269.41	269.17
T4(P1+PBZ1+N2)	412.98	414.82	413.40	47.49	48.71	48.10	288.73	291.32	290.03
T5(P1+PBZ2+N1)	392.04	394.67	393.35	43.21	43.54	43.37	276.11	279.26	277.69
T6(P1+PBZ2+N2)	406.96	408.70	407.83	44.48	44.55	44.31	281.70	283.70	282.70
T7(P2+RDF)	381.26	381.34	381.20	39.91	40.18	40.05	237.89	238.11	238.00
T8(P2+PBZ1+N1)	389.53	391.53	390.53	43.47	43.68	43.58	280.48	282.48	281.48
T9(P2+PBZ1+N2)	409.37	411.95	410.66	45.20	45.70	45.45	284.58	285.54	285.06
T10(P2+PBZ2+N1)	390.48	394.49	392.49	41.93	42.45	42.19	279.45	281.88	280.67
T11(P2+PBZ2+N2)	404.43	408.34	406.38	43.12	43.19	43.15	283.10	283.37	283.24
S. Em±	0.90	1.41	0.82	0.32	0.30	0.22	1.36	1.53	0.97
CD at 5%	2.64	4.17	2.32	0.95	0.89	0.64	4.01	4.51	2.76

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 soil calcium , magnesium and sulphur of mango *cv*. Alphonso during 2017-19.

Treatments	Soil Calcium (meq /100g)			Soil Magnesium (meq /100g)			Soil Sulphur (ppm)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	5.42	5.75	5.58	2.59	2.65	2.62	13.36	13.58	13.47
T2(P1+RDF)	5.52	5.62	5.57	2.79	2.81	2.80	13.45	13.63	13.54
T3(P1+PBZ1+N1)	6.37	6.65	6.51	3.10	3.12	3.11	13.48	13.88	13.68
T4(P1+PBZ1+N2)	7.23	7.42	7.33	3.55	3.67	3.61	13.59	14.26	13.92
T5(P1+PBZ2+N1)	6.44	6.46	6.45	3.08	3.16	3.12	13.70	13.80	13.74
T6(P1+PBZ2+N2)	6.40	6.52	6.46	3.10	3.16	3.13	13.68	13.86	13.77
T7(P2+RDF)	5.55	5.62	5.59	2.90	2.98	2.94	13.55	13.62	13.59
T8(P2+PBZ1+N1)	6.80	6.81	6.81	3.08	3.14	3.11	13.45	13.45	13.45
T9(P2+PBZ1+N2)	7.15	7.30	7.23	3.52	3.55	3.54	13.51	14.00	13.76
T10(P2+PBZ2+N1)	6.19	6.22	6.20	3.09	3.11	3.10	13.48	13.59	13.53
T11(P2+PBZ2+N2)	6.34	6.44	6.39	3.12	3.15	3.14	13.71	13.81	13.75
S. Em±	0.10	0.13	0.08	0.05	0.05	0.03	0.14	0.17	0.11
CD at 5%	0.30	0.40	0.23	0.13	0.15	0.08	0.40	0.51	0.32

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 leaf nitrogen , phosphorus and potassium of mango *cv*. Alphonso during 2017-19**.**

Treatments	Leaf Nitrogen (%)			Leaf phosphorus (%)			Leaf potassium (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	0.94	0.97	0.96	0.09	0.09	0.09	0.59	0.61	0.60
T2(P1+RDF)	0.95	0.98	0.97	0.10	0.11	0.11	0.64	0.64	0.64
T3(P1+PBZ1+N1)	1.04	1.06	1.05	0.14	0.15	0.15	0.76	0.77	0.76
T4(P1+PBZ1+N2)	1.27	1.30	1.28	0.19	0.21	0.20	1.03	1.07	1.05
T5(P1+PBZ2+N1)	1.06	1.08	1.07	0.13	0.13	0.13	0.79	0.81	0.80
T6(P1+PBZ2+N2)	1.08	1.09	1.08	0.15	0.16	0.15	0.79	0.80	0.79
T7(P2+RDF)	0.96	0.99	0.97	0.12	0.14	0.13	0.67	0.68	0.68
T8(P2+PBZ1+N1)	1.07	1.08	1.08	0.15	0.15	0.15	0.82	0.82	0.82
T9(P2+PBZ1+N2)	1.24	1.28	1.26	0.18	0.19	0.19	1.01	1.04	1.03
T10(P2+PBZ2+N1)	1.01	1.04	1.03	0.13	0.14	0.14	0.79	0.80	0.80
T11(P2+PBZ2+N2)	1.07	1.09	1.08	0.16	0.18	0.17	0.82	0.85	0.83
S. Em±	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.08	0.07	0.05	0.02	0.03	0.02	0.03	0.02	0.02

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 leaf calcium, magnesium and sulphur of mango *cv*. Alphonso during 2017-19.

Treatments	Leaf Calcium (%)			Leaf Magnesium (%)			Leaf Sulphur (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
T1(control)	0.51	0.52	0.52	0.35	0.35	0.35	0.04	0.05	0.04
T2(P1+RDF)	0.53	0.54	0.53	0.37	0.39	0.38	0.04	0.05	0.05
T3(P1+PBZ1+N1)	0.58	0.60	0.59	0.41	0.43	0.42	0.06	0.08	0.07
T4(P1+PBZ1+N2)	0.63	0.66	0.64	0.55	0.57	0.56	0.11	0.12	0.11
T5(P1+PBZ2+N1)	0.56	0.57	0.56	0.42	0.43	0.42	0.07	0.09	0.08
T6(P1+PBZ2+N2)	0.58	0.59	0.58	0.42	0.42	0.42	0.08	0.09	0.08
T7(P2+RDF)	0.51	0.52	0.52	0.37	0.40	0.39	0.04	0.04	0.04
T8(P2+PBZ1+N1)	0.54	0.54	0.54	0.46	0.48	0.47	0.05	0.05	0.05
T9(P2+PBZ1+N2)	0.61	0.63	0.62	0.51	0.52	0.51	0.09	0.10	0.10
T10(P2+PBZ2+N1)	0.54	0.56	0.55	0.43	0.44	0.44	0.06	0.08	0.07
T11(P2+PBZ2+N2)	0.55	0.57	0.56	0.47	0.49	0.48	0.07	0.09	0.08
S. Em±	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.00
CD at 5%	0.02	0.03	0.03	0.02	0.03	0.01	0.03	0.02	0.01

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).

PBZ had not showed much effect on leaf nutrient status [2, 19]. Moreover, significant increase in Ca uptake of Alphonso mango trees under paclobutrazol application has been reported [6].

Conclusion

On the basis of experimental findings, it can be concluded that among the different treatment combinations the treatment pruning at 10cm length in association with the soil drenching of PBZ @ 0.75g a.i./ m canopy diameter and application of 75% of RDF, 10kg vermicomposting, 20g of AMC and mango special spray is most suitable for good content of nutrients in soil and plants. It may increases productivity and quality of fruit.

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