Varieties of Myanmar Mangoes and Off-season Fruit production of *MangiferaIndica* L. cv. Sein ta lone

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Abstract

Mango, *Mangiferaindica*L., belongs to the family Anacardiaceae. Of the total 62 species, about 16 are edible and cultivated commercially, while the remaining are either wild species or are non-edible. Mango originated from the Indo-Burma region, northeast India, and northern Burma, and in the foothills of the Himalayas. In 2016, Myanmar Agriculture Department reported that Myanmar has 198 varieties of mango grown in the whole country.Off-season fruit production of mango required the soil drenching of paclobutrazole and then spraying of KNO_3. Upon evaluation the dose of PBZ, 4g PBZ treated trees gave the optimum fruit quality. Among spraying of KNO_3, 3% KNO_3 treated trees resulted the optimum fruit quality. Their interaction treatment also showed that 4g PBZ+ 3%KNO_3 were the best. Therefore, PBZ and KNO_3 had effect on flowering, fruiting and fruit quality. The total cost for per acre Seintalone mango fruit production in off-season gave 8% of net profit.

Keywords: off-season, PBZ and KNO_3, net profit

Background of the study

Mango, botanically named as *Mangiferaindica* L. is regarded as a king of fruit which consists in the family Anacardiaceae. It is an evergreen tree grown under tropical and subtropical areas, between 25°N and 25°S. The trees grow best in lowland tropical forests but can grow in altitudes up to 1200 meters. Mango is the biennial habit, irregular flowering and the pre-mature drop. The cultivation of mango is expanding throughout the world. It native is southern Asia, originated from the border area of North West Myanmar and Eastern India. Growing of mango is only for its large colorful and delicious fruit but also for home landscape **(Ref…???).**

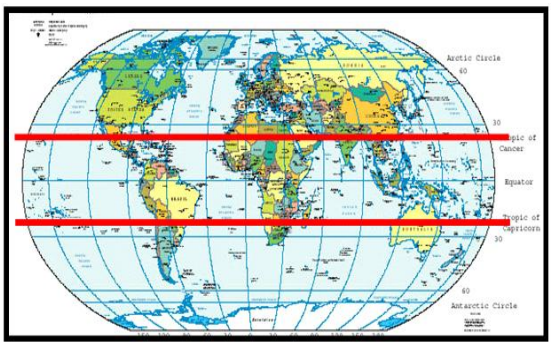

Figure 1. Mango preferable areas in the world

More than 200 varieties of mango in Myanmar (MAS, 2018). Among them, Seintalone is the most popular cultivar in Myanmar owing its taste, flavor, sweet smell and less fiber content. However Nan dawhmine, Yin kwe, MyaKyauk, Padamyar, Thone lone ta daung, etc. are also popular throughout the country (Figure 2).

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Figure 2. Varieties and cultivars of Myanmar mangoes

Regarding to the above facts, the study was aimed to introduce thevarieties of mango, and to observe the off-season fruit production of the famous cultivar, Seintalone mango.

Ideal soil and climatic condition are required for commercial fruit production of mango even it can grow throughout the country. Firstly the desire variety of mango with high production needs to be chosen. Actually mango prefers the elevation of 400 - 600 meter above sea level is good for growing plants but 400 meter is most ideal for better fruit production.The dry, sandy loam soil quite rich in organic matter, the pH of 5.5 -7.5 and good drainage are needed to be prepared before growing of mango.

Materials and methods

Paclobutrazol and potassium nitrate on off-season fruit production of Seintalone mango

Experimental layout and treatments

Eighty, 9 years old Seintalone mango trees which were approximately the same height were selected for the experiment. Four treatments each with 20 replicates each were set up in 2 factor factorial design. Factor A was PBZ treatment while factor B was the KNO_3 treatments. The spacing between row and trees were 300 cm each. Therefore, the total area was 9,900,000cm^2. The treatments of this experiment were as follows:

T_1= 0% KNO_3
T_2= 1% KNO_3
T_3= 2% KNO_3
T_4= 3% KNO_3

Climatic condition

Mango prefers approximately 4 months rainy season (75 – 250 cm) follow by 8 months dry period. The temperature of 30 – 40ºC, direct sun and no powerful wind is preferred for tree growth and fruit production but not for seedling.

Land preparation

The land must be prepared before rainy season by clean volunteer plants or weeds
to reduce competition on water, nutrients and fertilizers. The soil sample collection was followed by the method of Fery, *et al*. (2018).

Pruning

Water sprout shoots, any out shaped branches, weak branches, dead and diseased branches, narrow and weak crutch branches are needed to be pruned.

Design and distance of planting

Recommended spacing for per hectare cultivationare as follows: 10 x 10m (100 trees); 12 x 12m (70 trees); 14 x 14m (51 trees); 16 x 16m (39 trees), 18 x 18m (31 trees) and 20 x 20m (25 trees).

Planting

Firstly, a hole at least 30 cm wide and 40 cm deep are dug, filled half of the hole with soil mixture. Then the seedling or grafted plant were grown upright in the middle of hole and filled more soil mix to get the plant firm. The base of the plant is immediate watered after planting. When the plant grew, watering was done in every week to enhance photosynthesis especially in dry areas.

Fertilization

The fertilizers were soil drenching once or twice at start or before the end of rainy season. The organic or inorganic fertilizers can be applied for the tree growth (Table 1 and Figure 3).

Table 1. Fertilizer application to the mango trees based on trees's ages

Tree Age (years)	Complete Fertilizer (Split application)	Alternative Fertilization
1	100 g	200 g manure + 200 g Urea
2	200 g	500 g manure + 500 g Urea
3	300 g	1 kg manure + 300 g Urea
4	400 g	2 kg manure + 400 g Complete fertilizer
5 – 6	500 g - 1 kg	3-4 kg manure + 500 g - 1 kg Complete fertilizer
7 – 8	2 kg	4 - 5 kg manure + 2 kg Complete fertilizer
9 -10	3 kg	5 - 6 kg manure + 3 kg Complete fertilizer
11 - 15	5 kg	additional 10 kg manure
16 - 20	6 kg - 7 kg	additional 12 kg manure
> 20	10 kg	additional 15 – 20 kg manure

Figure 3. Watering after soil drenching of fertilizer mix for growing of Seintalone mango

Drenching Paclobutrazole (PBZ)

After emergence of the new flushes, 2g and 4g meter canopy diameter of PBZ were applied to the respective trees.

Spraying of KNO_3

Spraying of 1%, 2% and 3% KNO_3 was done to the whole canopy 4 months after PBZ treatment.

Insects, pests management

The usual infested insects, pests and its management are described in Table 2 and Figure 4.

Table 2. Recommended pesticides for reduction of insects pests for mango

Type of Insects, Pests and Fungus	Type of Application	Recommended Pesticides
Scale insects, Mealy bugs	- Spraying - Bushing - Pruning	- Basudin, Selecron, Malathion - Seven, Tamar, etc. - Soap water, Sodium hypochlorite
Tip borer	- Spraying - Pruning	- Cypermethrin, Carbamates, etc.
Capsid bug, Cecid fly	- Spraying	- Pennant, Blink and Cypermethrin
Anthracnose (*Colletotrichum gloeosporioides*)	- Spraying - Pruning	- Benlate, Benomil, Unizeb, Copper Oxichloride, etc.

Figure 4. Infested pests and diseases on mango

Bagging

Mango fruits became an egg size; the fruits were bagged with paper bags. The wrapping bag should be big enough to allow room for fruit development.

Data Collection

The interaction effect of Paclobutrazole (PBZ) and Potassium nitrate (KNO_3) on plant height, flowering and number of fruits per plant were collected. The qualitative characters of the fruit such as the weight of the whole fruit, peel, pulp and seed, peel and pulp firmness, sweetness, acidity, pH, and fiber content were also recorded.The collected data were statistically analyzed using IRRISTAT software, version 6.2. The treatment mean separation was expressed by least significantly difference at 5% level.

Results

During cultivation, the mean temperature ranges from 24.5 - 30.5°C, the mean rainfall 0 - 20.5 mm, and the mean relative humidity of 64.2 - 93.0 %.

Calendar for off - season fruit production of Seintalone mango

The experimental trees were soil drenched with 2g and 4g PBZ. The PBZ treatment was followed by the experimental design. Four months after PBZ treatment, when the leaves become dark green, 1%, 2%, 3% of KNO_3 was sprayed to the respective trees. Three weeks after KNO_3 sprayed, the flowering was observed in the trees. Six weeks after flowering, the fruit set was observed. The fruits are harvested four months after fruit set (Figure 5).

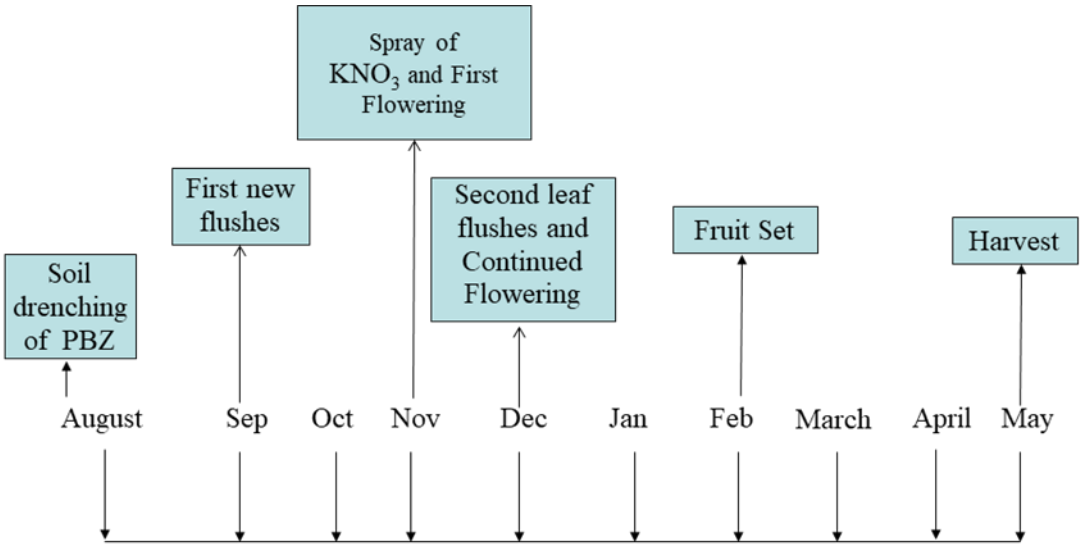

Figure 5. Phenology of Seintalone mango trees upon treated with PBZ and KNO_3

Soil analysis

The result of the soil analysis showed that the texture of cultivated soil was silt loam soil that composed of sand, silt and clay (14.4, 63.5, and 20.0%). The moisture content was 3.07 % and pH was 4.8 that expressed as strong acid. Humus content was 1.134 % and very low organic carbon content (0.66 %). The soil also possessed low nitrogen and potassium contents (0.108 % and 8.04 %), and medium phosphorous content (25.20 ppm) (Table 3).

Table 3. Exchangeable cations, pH and organic carbon levels from soil analysis

Moisture (%)	pH	Texture (%)				Organic carbon (%)	Humus (%)	Total N (%)	K (meg/ 100 g)	Available P (ppm)	Available K_2O mg/100g
		Sand	Silt	Clay	Total						
3.07	4.8 (Strong acid)	14.4	63.5 Silt loam	20.0	97.9	low	1.13	low	0.17	Medium	Low

Flowering and fruiting of Seintalone mango

The statistical analyzed interaction results of factor A (PBZ) and factor B (KNO_3) showed that 2g PBZ had 2 significant effect on highest flowering (48.62%) and fruits (20.5%) when combined with 3% KNO_3. The same results were found in 4g PBZ with 3% KNO_3 (51.02%) and (20.1%) (Table 4 and Figure 6).

Table 4. Flowering and fruiting of Seintalone mango responded to PBZ and KNO_3

FA	FB	Mean Flowering (%) / tree				Mean Fruits (%) / tree
		2WAK	4WAK	8WAK	Mean	
2g PBZ	0% KNO_3	14.05	40.5	45.5	33.35	5.0
	1% KNO_3	18.75	40.5	48.7	35.98	11.0
	2% KNO_3	14.85	34.5	50.25	33.2	13.1
	3% KNO_3	21.1	56.5	68.25	48.62	20.5
4g PBZ	0% KNO_3	12.3	28	39.75	25.35	6.3
	1% KNO_3	22.9	42	61.55	42.15	15.3
	2% KNO_3	11.1	28.5	52.3	30.63	15.6
	3% KNO_3	24.05	53.5	75.5	51.02	20.1
Control$^-$		11.75	24.25	36.62	23.35	4.65
F-test		*	*	**	-	**
$LSD_{0.05}$		20.28	28.43	31.63	-	10.66
cv%		12.4	19.5	16.6	-	17.6

$^-$ neither of PBZ nor KNO_3 treatment * = significant ** = highly significant

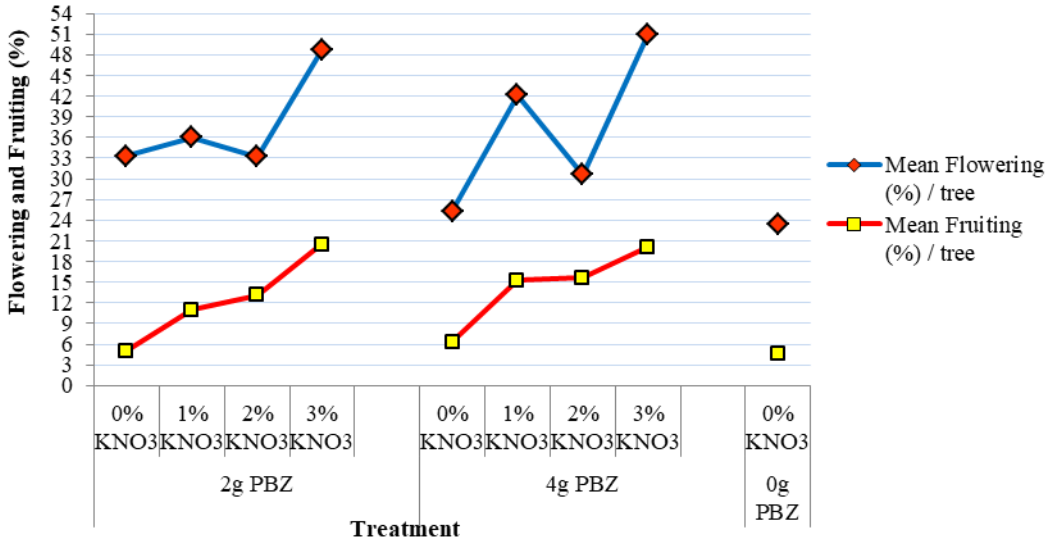

Figure 6. Flowering and fruiting of Seintalone mango from interaction treatment of PBZ and KNO_3

Qualitative characters of Seintalone mango

Ninety days after fruit set, the mature fruits are harvested. The qualitative characters of harvested mature fruits were shown in the following table and figure.

Fruit weight, pulp weight, peel weight, seed weight and length and width of seed

The interaction results of factor A (PBZ) and factor B (KNO_3) showed that the largest fruit weight (300 g) was found in 4g PBZ + 2% KNO_3 and 3% KNO_3. The second largest weight (283.33 g) was obtained from 2g PBZ + 3% KNO_3 and 4g PBZ + 0% KNO_3. The highest pulp weight (141.33g) and relatively smaller peel weight (51 g) were observed in 2g PBZ + 3% KNO_3 while 4g PBZ with 3% KNO_3 had the highest pulp weight (105.35 g), and medium peel weight (65.36 g). However, both of these treatments had the medium seed weights (44.22 in 2g PBZ + 3% KNO_3 and 42.25 g in 4g PBZ + 3% KNO_3). According to the statistical results, weight of fruit, pulp, peel and seed were not significantly different among treatments. The results of seed length and width showed that 4g PBZ + 1% KNO_3 had the shortest length (7.09 cm) and narrowest width (4.04cm), followed by 2g PBZ + 0% KNO_3 (7.24 cm and 4.22 cm), then 2g PBZ + 1% KNO_3 (7.62 cm), while 2g PBZ + 3% KNO_3 possessed the narrowest seed width (4.43 cm) were observed from this experiment. The treatments of 2g PBZ + 3% KNO_3 and 4g PBZ + 3% KNO_3 possessed the medium seed length and width (7.79 cm & 4.43 cm and 8.91 cm & 5.03 cm). The statistical results showed that treatments were non-significant (Table 5 and Figure 7, 8).

TSS, TA, and pH

The interaction results of factor A (PBZ) and factor B (KNO_3) revealed that 4g PBZ + 3% KNO_3 were the sweetest (16.31 °Brix), followed by 2g PBZ + 3% KNO_3 (16.16 °Brix). The acid content of the fruits gave the sour taste to fruit. The higher the titriable acidity (TA) content, the more sour the pulp. However, the lesser content of acid did not give the preferable taste of the fruit. The results of the titriable acidity (TA) content, and pH from both treatments were the medium (0.26 % and 0.25 % in TA; 5.31 and 5.25 pH). In statistical analysis, sweetness, acidity, and pH were significant at 0.05% level but the sweetness was non-significant (Table 5 and Figure 9).

Firmness of peel and pulp and fiber content of fruits

The highest pulp firmness was observed in 4g PBZ + 3% KNO_3 (0.39 Kg cm^{-2}) followed by 2g PBZ + 3% KNO_3 (0.38 Kg cm^{-2}). The lowest pulp firmness (0.26 Kg cm^{-2}) was resulted from 2g PBZ + 2% KNO_3 treatment. Regarding to the peel firmness, the highest peel firmness (0.56 Kg cm^{-2}) was also obtained from 4g PBZ + 3% KNO_3 treatment followed by 2g PBZ + 2% KNO_3 treatment (0.53 Kg cm^{-2}) while 4g PBZ + 0% KNO_3 treatment had the least firmness (0.29 Kg cm^{-2}). When observed to the fiber content, 2g PBZ + 2% KNO_3 treatment had the lowest fiber content (0.84%) while 4g PBZ + 2% KNO_3 treatment had the highest fiber content (1.33%). The other treatments had the medium contents (Table 5 and Figures 10).

Table 5. Single fruit characteristics of Seintalone mango resulted from the interaction treatments of PBZ and KNO_3

FA (PBZ)	FB (KNO3 sprays)	Single Fruit Characteristics											
		Fruit weight (g)	Pulp weight (g)	Peel weight (g)	Seed weight (g)	Seed length (cm)	Seed width (cm)	TSS (°Brix)	TA (%)	pH	Fiber content (g)	Pulp Firmness (Kg cm^2)	Peel firmness (Kg cm^2)
2g PBZ	0% KNO_3	266.67	127.94	50.66	47.28	7.24	4.22	12.92	0.26	5.31	0.95	0.28	0.35
	1% KNO_3	266.67	134.72	49.69	46.86	7.62	4.69	14.03	0.58	5.91	1.16	0.37	0.45
	2% KNO_3	266.67	101.00	80.78	35.22	7.66	4.69	16.08	0.36	5.48	0.84	0.26	0.53
	3% KNO_3	283.33	141.33	51.00	44.22	7.79	4.43	16.16	0.34	5.33	0.98	0.38	0.50
4g PBZ	0% KNO_3	283.33	91.10	83.50	56.44	7.84	4.74	15.84	0.25	5.25	1.02	0.32	0.29
	1% KNO_3	270.00	103.33	67.22	41.69	7.09	4.04	11.42	0.26	5.31	0.96	0.33	0.40
	2% KNO_3	300.00	104.33	68.67	43.67	8.43	4.63	15.10	0.39	5.57	1.33	0.34	0.43
	3% KNO_3	300.00	125.35	65.36	42.25	8.91	5.03	16.31	0.35	5.42	1.10	0.39	0.56
Control*		266.67	108.06	70.33	56.67	7.59	4.73	12.18	0.53	5.16	1.38	0.35	0.37
F-test		ns	ns	ns	ns	ns	ns	ns	*	*	*	ns	ns
5%LSD		61.849	48.318	34.375	23.726	2.851	1.581	4.995	0.242	0.126	0.381	0.260	0.314
cv%		10.2	23.1	29.6	25.3	16.6	15.4	18	40.8	14.9	22.9	34.3	36.1

* neither of PBZ nor KNO_3 treatment, ns = non- siginificant, * = siginificant

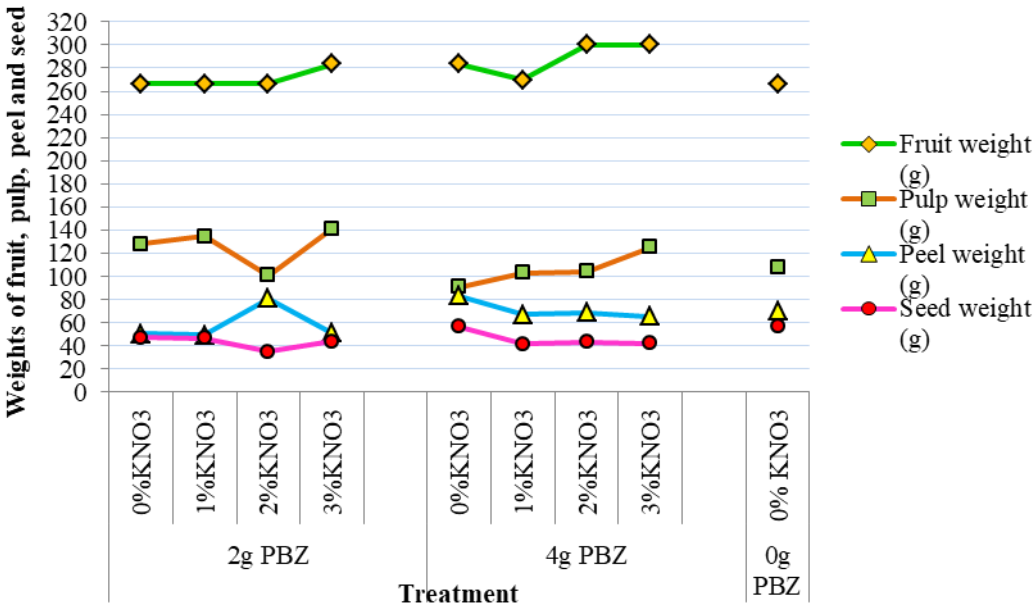

Figure 7. Fruit, peel, pulp and seed weight of Seintalone mango from interaction treatments of PBZ and KNO_3

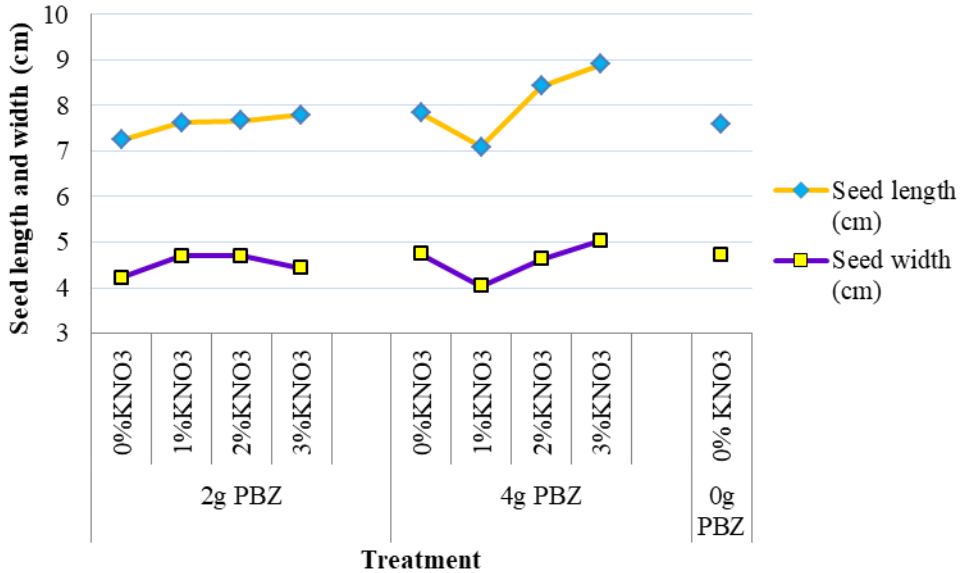

Figure 8. Effects of interaction treatments of PBZ and KNO_3 on seed length and width of Seintalone mango

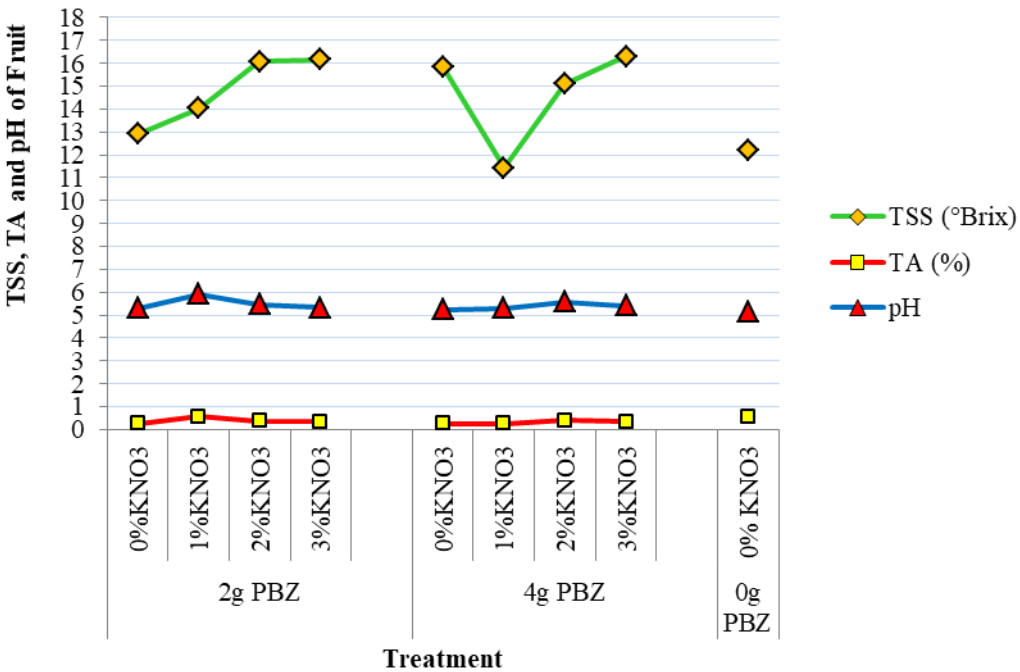

Figure 9. TSS, TA, pH and fiber contents of fruits from interaction treatments of PBZ and KNO_3

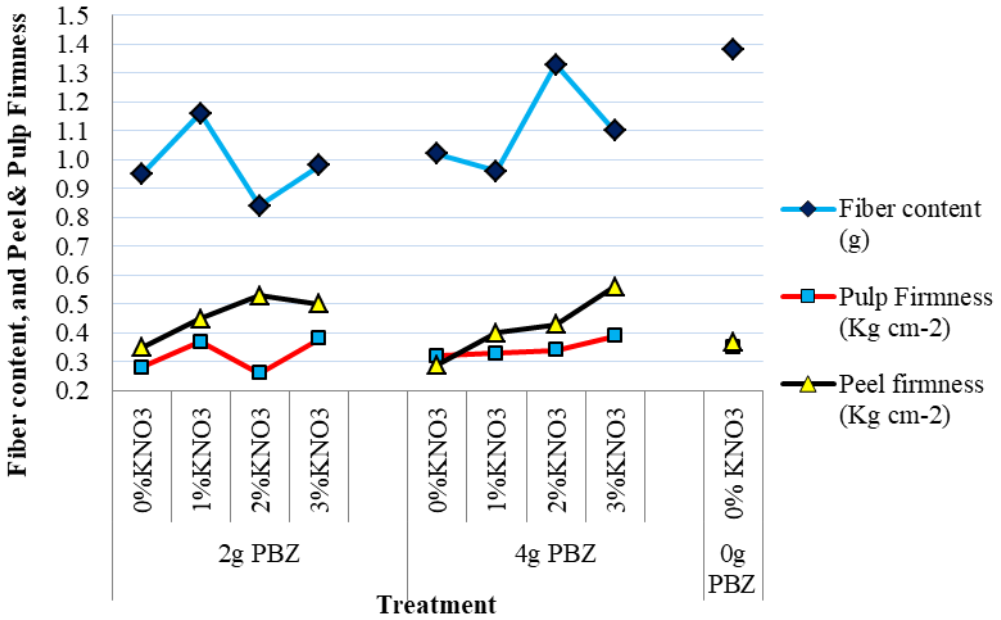

Figure 10. Pulp and peel firmness from interaction treatments of PBZ and KNO_3

Discussion and Conclusion

The effective methods such as drenching of 2 and 4 g PBZ and spraying of KNO_3 to the selected 9 years old Seintalone mango trees were tested in this experiment. The experiment was carried out in 2 factors factorial of CRD. Factor A (FA) was PBZ drenching and that of factor B (FB) was KNO_3 spraying. The average temperature of the cultivation area was 27.61 °C, average rainfall of 5.57 mm, and the relative humidity of 79.24%. The results showed that 2 g PBZ drenched with 3% KNO_3 sprayed trees had the higher flowering and fruiting (48.62 %). In this experiment, 4g PBZ drenched and 3% KNO_3 sprayed trees also possessed the highest flowering (51.02 % and 20.1 %) and higher fruiting (20.5 %). The results of 4 g PBZ drenched with 3% KNO_3 sprayed trees were some points in higher but not significantly from 2 g PBZ drenched with 3% KNO_3 sprayed trees. However, the application of PBZ in 2 g PBZ drenched with 3% KNO_3 sprayed trees were half-dose lesser than 4 g PBZ drenched with 3% KNO_3 sprayed trees. Regarding to the cost, 2 g PBZ drenched with 3% KNO_3 sprayed trees were less cost than 4 g PBZ drenched with 3% KNO_3 sprayed trees. The application of higher concentrations of PBZ had a negative effect on retarding the length of inflorescence and height of trees, and hastened leaves maturation (Yeshitela, 2004). According to Steffens *et al.* (1985), PBZ has the greatest effect on immature tissues which are still growing and differentiating. This could explain why PBZ affected predominantly the apical growth. Although the flowering percentage of 4g PBZ treated trees were higher (51.02 %) than the 2g treated trees (48.62 %), the total fruits produced by 2g PBZ treated trees (20.5 %) were superior to that of 4g treatment (20.1 %). Nartvaranant *et al*. (2000) suggested that successful off-season flowering can be obtained using soil drench Paclobutrazole with appropriate concentrations. The application of Paclobutrazole is significantly lowered the vegetative growth, reduced the shoot length and fastened the profuse flowering and fruiting, regular yield with biennial (Buronkar *et al.*, 1991). Thanda Aye (2005) reported that 4g PBZ per canopy diameter had maximum effect on tree maturation and the consequence of it was the early

flowering in Carabao mango trees. Hasdiseve and Tongumpai (1986) observed that soil application of Paclobutrazole is the most effective in flower induction than foliar spray. Four months after PBZ treatment, spraying of Potassium nitrate for flowering and fruiting of Seintalone mango was carried out in this experiment.

The results showed that 3% KNO_3 spraying trees possessed the higher flowering percentage than the other treatments. The use of nitrate can stimulate the anticipation of the flowering, independently of the different treatments and were significantly superior against the control (SaO Jose, 2000). Barba (1974) observed that 3% KNO_3 can promote flowering in Carabao and Paho mango. Sarabia (1980) also observed that 3% KNO_3 can promote flowering and in Haden mango. However, KNO_3 is not a flowering hormone or stimulus that switched on flowering of trees that has already existing inflorescence to proceed (Protacio, 2000). In this experiment, flowering was observed 21 days after KNO_3 treatment. Potassium nitrate induce flowering in mango was evident within seven days after treatment and was effective on shoots. The concentrations were between 1 to 8 percent that stimulated flowering (Bondad, 1979).

The result of qualitative analysis on Seintalone mango revealed that 16.16 °Brix, 0.34 % TA, 5.33 pH, 0.96 g fiber content, 0.38 kg cm^{-2} pupl firmness and 0.50 kg cm^{-2} peel firmness were obtained from 2 g PBZ drenched with 3% KNO_3 sprayed trees. The quality of various mango varieties is mainly judged by their sweetness, acidity, pulp weight and seed weight (Maung Maung Htwe, 2003).

In relation to the effects of Paclobutrazole on mango, it seems that the influence of Paclobutrazole for crop performance depended on the variety of mango. Paclobutrazole was immediate uptaken by treated mango trees and its effects on enhancing flowering and fruit yield. Seintalone mango showed a good response to lower concentration (2g) of PBZ than that of the higher concentration (4g). Among KNO_3 concentrations Seintalone had good response to 3% KNO_3 rather than of other concentrations. Evaluation on the dose of PBZ, 2g PBZ treated trees gave the best fruit quality and among sprayed chemical, 3% KNO_3 treated trees performed the best. Their interaction treatment also showed 2g PBZ+ 3% KNO_3 gave the highest fruit quality. Therefore 2g PBZ+ 3% KNO_3 were the suitable treatment for fruit quality. It is therefore concluded that application of Paclobutrazole with Potassium nitrate was suitable for Seintalone mango production in on-season and off-season.

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