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Effect of foliar spray of seaweed extract at different pH levels on quality and shelf life of mango (*Mangifera indica* L.) cv. Kesar

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Abstract
A field experiment was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari to study the effect of seaweed extract at different pH levels of foliar solution on quality and shelf life of mango cv. Kesar during the year 2018-19 and 2019-20. Mango trees treated with three pH levels of spray solution *viz.*, A1: 4.5 pH, A2: 5.5 pH and A3: Best available water and four concentrations of seaweed extract namely, S1: 1%, S2: 2%, S3: 3%, S4: 4%. All the twelve treatment combinations were repeated thrice. Results of two year experiments revealed that the foliar spray solution at pH 4.5 levels and 1% seaweed extract were improved quality parameters like, TSS, ascorbic acid content, total sugars, reducing sugars, non-reducing sugars, ß-carotene content and increased shelf life and lower the acidity. Sensory parameters recorded highest score for colour and flavor in A2S4 treatment. While, taste in A1S4 and odour were recorded in A1S3 treatment in mango cv. Kesar.

Keywords: Seaweed extract, pH levels, foliar solution

Introduction
Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae order Sapindales and originated in Indo-Burma region from where it has been distributed worldwide to become one of the most cultivated fruits in the tropics. Due to its high palatability, excellent taste, flavor and exemplary medicinal and nutritive values it is said to be the “King of Tropical Fruits”. Numerous cultivars of mango are cultivated in India with diversity of flavor and taste among them, Kesar is the most popular mango variety and has good export potential. Kesar, is a famous cultivar of Gujarat and it is selection from the Mangrol (Junagadh) region. It is the most popular and commercial cultivar of Saurashtra region and now a days of South Gujarat also. Kesar mangoes are more demanded in national as well as international markets. The area under Kesar variety is increasing not only in Gujarat but also in nearby states like Maharashtra, Madhya Pradesh and Rajasthan due to its It‟s high yield potential, almost regular bearer, mid-season variety, having good consumers‟ acceptance, attractive shape, size and saffron coloured pulp. It has very good keeping quality with most preferred taste and sugar/acid blend is excellent. It is also preferred variety for mango pulp processors. (Salveit, 1999) [7].
Foliar absorption is pH dependent. This is attributed to the effect on the cuticle of complex electrostatic repulsion and attraction phenomena, which are regulated by pH. The optimum pH probably varies somewhat with each nutrient and its carrier. Acidifying the water to a safe level is increase solubility of nutrients within the spray tank and making them more readily available plant uptake. Seaweed extract contains major and minor nutrients, amino acids, vitamins, cytokinins and auxin substances. Seaweed extract act as growth promoter by stimulating the root growth which increase uptake of nutrients from soil and crop protectant against pests and diseases (Khan *et al.*, 2009) [4]. At present, there is scanty information about effect of seaweed extract at different pH level of foliar solution especially under South Gujarat conditions. Hence, the present investigation was carried out to study the different pH level of foliar solution and seaweed extract on quality and shelf life of mango cv. Kesar.

Materials and Methods
The present experiment was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year2018-19 and 2019-20.

The field experiment was laid out following the completely randomized design with factorial concept which included twelve treatment combinations comprising three pH levels of spray solution namely, A1:4.5 pH, A2: 5.5 pH and A3: Best available water and four concentrations of seaweed extract *viz.*, S1: 1%, S2: 2%, S3: 3%, S4: 4%. Foliar sprays were done at induction of flowering stage and marble stage. The quality parameters *i.e.* TSS, acidity, ascorbic acid content, total sugars, reducing sugars, non- reducing sugars, ß-carotene content and shelf life as well as sensory parameters *i.e.* colour, taste flavor and odour were observed during experimentation. Scoring was done by a panel of ten judges by using 9 Hedonic Scale for each character.

Results and Discussions

Effect of pH levels of spray solution

It is evident from the data presented in Table 1 showed that significantly maximum TSS (°Brix), ascorbic acid content (mg 100g-1), total sugars (%), reducing sugar (%), β-carotene content (µg 100g-1) and minimum acidity (%) as well as maximum shelf life were recorded in A1 treatment (4.5 pH level). It might be due to acidic pH increases the availability of Cations (H+) in the spray solution on the leaf surface. This creates a Cation diffusion gradient along which essential nutrients like Ca+, K+, Zn+, Mg+, Mn+, B+, Mo+ can move across and through plant cell walls (Patel *et al.*, 2018) [6]. The sensory parameters colour and flavor highest score were recorded in treatment combination A2S4. While, taste in A1S4 and odour were recorded in A1S3 treatment combination in mango cv. Kesar (Table 2).

Effect of seaweed extract

A perusal of data presented in Table 1 clearly indicated that there were significantly maximum TSS (°Brix), ascorbic acid content (mg 100g-1), total sugars (%), reducing sugar (%), β-carotene content (µg 100g-1), minimum acidity (%) and maximum shelf life were noted in in A1 treatment (4.5 pH level). It may also be related with enzymes which are present in seaweed extract that enhanced the synthesis of different proteins, acids and sugars (Khan *et al.*, 2012) [4]. Similar results were found by Abd El- Hamid *et al.* (2015) [1], Ibrahim *et al.* (2015) [3] and Ahmed *et al.* (2015) [2] in mango. Shelf life improved due to seaweed extracts can be an alternative to chemical fungicides for inhibiting the development of post-harvest decay, improving fruit quality and storability of fruits (Omar, 2014) [5].

Table 1: Effect of different pH levels of foliar solution and seaweed extract on quality and shelf life of mango cv. Kesar (Mean of two years)

Treatments	TSS (ºBrix)	Acidity (%)	Ascorbic acid content (mg 100 g^{-1})	Total sugars (%)	Reducing sugar (%)	Non reducing sugar (%)	β-carotene content (µg 100g-1)	Shelf life (days)
pH levels of spray solution (A)								
A1: pH 4.5	19.78	0.265	45.84	15.21	6.86	8.65	697.88	18.45
A2: pH 5.5	18.69	0.279	41.46	14.45	5.95	8.50	577.59	16.74
A3: Best available water	17.59	0.292	37.08	13.68	5.04	8.35	457.29	14.70
S.Em. ±	0.20	0.003	0.36	0.09	0.06	0.11	5.587	0.18
C.D. at 5%	0.57	0.007	1.04	0.28	0.18	NS	15.89	0.51
Seaweed extract (S)								
S1: 1% SWE	19.35	0.270	43.10	14.77	6.29	8.52	622.69	17.39
S2: 2% SWE	18.91	0.276	42.01	14.55	6.06	8.51	592.63	16.96
S3: 3% SWE	18.47	0.281	40.91	14.34	5.84	8.49	562.55	16.36
S4: 4% SWE	18.03	0.287	39.82	14.13	5.61	8.48	532.48	15.83
S.Em. ±	0.23	0.003	0.42	0.11	0.07	0.13	6.45	0.21
C.D. at 5%	0.66	0.008	1.20	0.32	0.20	NS	18.34	0.59
Interaction (A × S)								
S.Em. ±	0.40	0.005	0.73	0.19	0.12	0.22	11.17	0.37
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	5.27	4.38	4.32	3.30	5.11	6.43	4.74	5.25

Table 2: Effect of different pH levels of foliar solution and seaweed extract on Organoleptic test of mango fruits cv. Kesar

Organoleptic evaluation (Colour, Taste, Odour and Flavour)				
Treatments	**Colour**	**Taste**	**Odour**	**Flavour**
A1S1	6.15	7.10	7.73	7.07
A1S2	7.22	7.98	7.28	7.56
A1S3	5.62	8.27	8.40	6.82
A1S4	6.96	8.85	7.95	8.05
A2S1	7.50	7.69	6.62	6.34
A2S2	6.42	7.40	8.17	7.32
A2S3	8.04	6.81	7.06	7.81
A2S4	8.30	8.55	7.51	8.30
A3S1	7.72	5.94	6.84	6.58
A3S2	6.69	6.23	6.39	5.60
A3S3	5.88	6.53	5.95	5.85
A3S4	5.35	5.65	6.17	6.09

Conclusion

The results of present study foliar application of 4.5 pH level of 1% seaweed extract at induction of flowering and marble stage were improved fruit quality and shelf life of mango cv. Kesar.

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