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Response of foliar spray of seaweed extract at different pH levels on fruiting and yield of mango (*Mangifera indica* L.) cv. Kesar

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Abstract
An experiment was conducted to study the response of foliar spray of seaweed extract at different pH levels on fruiting and yield of mango (*Mangifera indica* L.) cv. Kesar at RHRS, ACHF, NAU, Navsari during the year 2018-19 and 2019-20. Mango trees treated at induction of flowering and marble stage with 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%. All the twelve treatment combinations were repeated thrice. The individual effects of foliar applications of different pH levels of spray solution and seaweed extract treatments as well as their interactions on fruiting and yield of mango cv. Kesar were recorded. Results revealed that the foliar spray solution at pH 4.5 level and 1% seaweed extract were gave maximum fruiting characters of mango *i.e.* number of fruits at pea stage, fruit set (%) at marble stage, fruit set (%) at harvest stage and fruit retention individually. The same treatments were also gave maximum yield characters *viz.*, number of fruits/panicle, numbers of fruits/tree, fruit yield (kg/tree and t/ha) and marketable fruit (kg/ha). Interaction of different pH levels with seaweed extract was found significant in case of fruit set (%) at marble stage, fruit set (%) at harvest stage, fruit retention (%) at harvest stage, number of fruits per tree, fruit yield (kg/tree and (t/ha) and marketable fruit (kg/ha) of mango during investigation, which were the maximum when mango cv. Kesar trees treated with 4.5 pH level of 1% seaweed extract at induction of flowering and marble stage.

Keywords: Mango, seaweed extract, pH levels

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 tropics. The most efficient or economical use of fertilizer is essential because of their high cost as well as concern about pollution. Foliar feeding is one of the ways to achieve the goal because in this method nutrients can be applied directly to the site of their metabolism and are therefore not subjected to various losses as occur in soil application. Foliar application of 2% KNO_3, 1% Novel Organic Liquid Nutrients, 1 to 1.5% micronutrient Grade - IV and 0.2% Boric acid at flower bud differentiation to marble stage has been reported or recommended to farmers by different scientists. Hence, there is need to application of bio-stimulants has also become an alternative approach to minimize the use of chemical fertilizers, introducing a material substitute to container nutrients (macro and micro) and the plant hormones natural (auxins, cytokinins and gibberellins), as well as being healthy and the absence harmful effects of side - impact use and cheap, economic, easy to prepare and use and these materials are extracts of seaweed (Suhail, 2013) [8]. Seaweed extract is act as bio-stimulant, being organic and biodegradable in nature is considered as an important source of nutrition for sustainable agriculture (Cassan *et al.*, 1992) [2]. 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. At present, there is little information available regarding the effect of seaweed extract at different pH level of foliar solution on mango fruit yield and quality under South Gujarat conditions. Therefore, it was deemed necessary to investigate the effect of seaweed extract at different pH level of foliar solution on 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 year 2018-19 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 namely, S1: 1%, S2: 2%, S3: 3%, S4: 4%. The treatment combinations were spray at induction of flowering stage and marble stage and repeated thrice. After completion of treatment recorded fruiting characters and yield characters as well as their interaction in mango fruits. The significance levels of generated data were decided using method of Panse and Sukathme.

Results and Discussions

Effect of pH levels of spray solution

A perusal of data presented in Table 1 clearly revealed that, the fruiting characters *viz.*, number of fruits at pea stage, fruit set (%) at marble stage, fruit set (%) at harvest stage and fruit retention (%) at harvest stage were observed maximum in A1 treatment (pH 4.5). It might be due to pH affects the ionic status of some nutrients and also that of the cuticle because it contains some free (unesterified) carboxylic acids (Holloway, 1982) [4] and incorporates embedded waxes which are principally fatty acids (Baker, 1982) [1]. Similar result was found by Patel *et al.* (2018) [7] in mango. The yield data presented in Table 2 revealed that there were significantly maximum number of fruits tree-1, fruit yield (kg ha-1), fruit yield (t ha-1) and marketable fruit (kg ha-1) found in A1 treatment (pH 4.5). The most outstanding effect of pH 4.5 was 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) [7].

Effect of seaweed extract

A perusal of data presented in Table 1 related to fruiting characters *viz.*, number of fruit set (%) at pea stage, fruit set (%) at marble stage, fruit set (%) at harvest stage, fruit retention (%) at harvest stage were observed maximum in S1 treatment (1% seaweed extract). This might be due to seaweed extract contain plant hormones which are leads to an increased in the power of attaching fruit tails to the plant and maximize the fruit set (Fakhrabad and Abedi, 2019) [3]. It is evident from the data (Table 2) that there were significantly maximum number of fruits tree-1, fruit yield (kg ha-1), fruit yield (t ha-1) and marketable fruit (kg ha-1) were observed in S1 treatment (1% seaweed extract). It might be attributed to its higher content of organic matter, proteins, N, P, K, Mg, Ca, S, Fe, Mn, Zn, Cu, B, cytokinins and IAA presence in seaweed extract (Khan *et al.*, 2009) [5]. These are responsible for enhancing cell division, building of plant pigments, enhance photosynthesis via increasing plants chlorophyll levels. By increasing the level of chlorophyll, would be able to efficiently harness the sunlight increasing yield (Pappachan *et al.*, 2017) [6]. In addition, seaweed extracts enhance the tolerance of plants to drought, salinity, pests and other unfavorable environmental conditions (Tung *et al.*, 2003) [9], ultimately they increased the marketable fruits.

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

Treatments	Number of fruits at pea stage	Fruit set (%) at marble stage	Fruit set (%) at harvest stage	Fruit retention (%) at harvest
pH levels of spray solution (A)				
A1: pH 4.5	38.92	22.74	8.14	30.31
A2: pH 5.5	33.07	19.44	6.83	27.13
A3: Best available water	27.23	16.01	5.52	23.94
S.Em. ±	0.52	0.23	0.07	0.27
C.D. at 5%	1.49	0.64	0.22	0.78
Seaweed extract (S)				
S1: 1% Seaweed Extract	35.27	20.83	7.32	28.32
S2: 2% Seaweed Extract	33.81	19.78	6.99	27.52
S3: 3% Seaweed Extract	32.35	18.90	6.67	26.73
S4: 4% Seaweed Extract	30.88	18.07	6.34	25.93
S.Em. ±	0.60	0.26	0.09	0.31
C.D. at 5%	1.72	0.74	0.25	0.90
Interaction (A × S)				
S.Em. ±	1.05	0.45	0.15	0.55
C.D. at 5%	NS	1.28	0.44	1.56
C.V.%	7.74	5.69	5.64	4.98

Interaction effect

Data presented in Table 3 clearly indicated that the significantly maximum fruiting characters *i.e.*, fruit set (%) at marble stage, fruit set (%) harvest stage, fruit retention (%) at harvest stage and yield characters *viz.*, number of fruits tree-1, fruit yield (kg ha-1), fruit yield (t ha-1) and marketable fruit (kg ha-1) were noted in treatment combination A1S1 (4.5 pH levels with 1

% seaweed extract) in mango cv. Kesar.

Table 2: Effect of different pH levels of foliar solution and seaweed extract on yield characters of mango cv. Kesar (Mean of two years)

Treatments	Number of fruits trees-1	Fruit yield (kg tree-1)	Fruit yield (t ha-1)	Marketable fruit (kg ha-1)
pH levels of spray solution (A)				
A1: pH 4.5	406.23	120.76	12.08	11832
A2: pH 5.5	368.06	104.56	10.46	10139
A3: Best available water	329.92	90.36	9.04	8701
S.Em. ±	4.045	1.51	0.15	152
C.D. at 5%	11.50	4.28	0.43	432
Seaweed extract (S)				
S1: 1% Seaweed Extract	387.08	112.26	11.23	10906
S2: 2% Seaweed Extract	374.74	107.45	10.74	10442
S3: 3% Seaweed Extract	361.22	102.83	10.28	9989
S4: 4% Seaweed Extract	349.25	98.36	9.84	9559
S.Em. ±	4.67	1.74	0.17	175
C.D. at 5%	13.28	4.95	0.49	499
Interaction (A × S)				
S.Em. ±	8.09	3.01	0.30	304
C.D. at 5%	23.00	8.57	0.86	864
C.V.%	5.38	7.01	7.01	7.28

Table 3: Interaction between different pH levels of foliar solution and seaweed extract on fruiting and yield characters of mango cv. Kesar (Mean of two year)

Treatment combinations	Fruit set (%) at marble stage	Fruit set (%) at harvest stage	Fruit retention (%) at harvest	Number of fruit trees-1	Fruit yield (kg tree-1)	Fruit yield (t ha-1)	Marketable fruit (kg ha-1)
A1S1	24.79	8.54	33.06	447.43	136.12	13.61	13348
A1S2	22.39	8.42	29.40	424.19	125.24	12.52	12271
A1S3	22.87	7.89	28.99	386.88	115.39	11.53	11301
A1S4	20.84	7.68	29.65	366.44	106.28	10.63	10409
A2S1	20.77	7.32	28.19	382.97	111.28	11.13	10793
A2S2	20.98	6.58	27.84	374.12	107.13	10.71	10395
A2S3	17.77	6.67	27.43	363.21	102.07	10.21	9895
A2S4	18.16	6.71	24.92	351.95	97.76	9.78	9475
A3S1	16.87	6.07	24.21	330.84	89.37	8.94	8578
A3S2	15.92	5.95	25.44	325.93	89.99	9.00	8661
A3S3	16.01	5.42	23.46	333.56	91.02	9.10	8771
A3S4	15.16	4.59	22.53	329.35	91.05	9.11	8795
S.Em. ±	0.45	0.15	0.55	8.09	3.01	0.30	304
C.D. at 5%	1.28	0.44	1.56	23.00	8.57	0.86	864
C.V.%	5.69	5.64	4.98	5.38	7.01	7.01	7.28

Conclusion

Based on the findings of this study, it can be concluded that the foliar application of 4.5 pH level of 1% seaweed extract at induction of flowering and marble stage were increased the fruiting characters and yield in mango cv. Kesar.

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