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Effect of Humic acid on growth of Mango (*Mangifera indica* L.) nursery grafts Cv. Alphonso

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Abstract
A field experiment was conducted to study the effect of humic acid on growth of mango nursery grafts Cv. Alphonso during 2011-2012. Randomly 50 Alphonso mango nursery grafts per treatment were selected and kept in nursery. Thus in all 3000 number of Alphonso mango nursery grafts were selected for further investigation. Series of humic acid concentration were prepared and drenching was done as per treatment details. Among different growth parameters studied, number of drenching had significant effect on most of the characters *viz*; plant height, leaf area, plant spread, girth at collar, root length, number of secondary and tertiary roots, dry matter. Similar to the effect of number of drenching, significant variations due to humic acid concentration treatments were also observed among different characters studied. The values for different growth parameters were increased with increasing levels of number of drenching different concentration of humic acid and their interactions. The better effects of number of drenching were obtained when drenching of humic acid was done four and five times. Further, increased concentration of humic acid was related with better results of most of the growth parameters. The concentration @ 7.5 ml and 10 ml humic acid/liter of water had better results on most of the parameters studied during the present investigation.

Keywords: Humic acid, growth of Mango, Alphonso mango nursery grafts

Introduction
In recent years, many advances have been achieved towards improvement on the quality and quantity of agriculture. The advances and development in agriculture depend not only on mechanization and new hybrid seeds but also on the improvement on the soil properties which also help to increase the crop productivity. Unsuitable soil conditions for the plant development generally arise from the lack of organic contents in the soil. To solve this problem, humic substances have started to be given to the soil in Egypt and in other parts of the world as well to improve the crop yield. For example, Humic and fulvic acid preparation have been commonly used in many green houses. Majority of them are produced domestically although some of them are imported.

Humic acid is a principal component of humic substances, which are the major organic constituents of soil (humus), peat, and coal, many upland streams, dystrophic lakes, and ocean water. Humic acids (HA) are high molecular weight aromatic organic acids that have a polyphenolic backbone with numerous carbohydrate and peptide side chains that give rise to complex array of structures (Hayes, 1989) [7].

Tan and Nopamornbodi (1979) [12] noted the effect of humic acid on growth of corn plants at different concentrations 0, 320, 640 1600 and 3200 ppm and found that 640 ppm humic acid was beneficial for the root growth of corn. Mylonas and McCants (1980) [9] reported that tobacco (*Nicotiana tobacum L.*) plants grown on filter paper saturated with HA solutions had higher root numbers and total root length than those grown on filter paper saturated with nutrient solutions or demonized water. Demir *et al*. (1997) [4] reported that effect of humic acid on the yield and mineral nutrition of cucumber grown with different salinity levels. Humic acid was applied @ 0, 1, 2 g/kg soil. Iron and Zinc content of leaves and stem tissues where increased by salinity and humic acid treatments, humic acid increased zinc content of the plants. Mackowiak *et al.* (2001) [8] noted the beneficial effects of humic acid on micro nutrients availability to wheat. There was no statistically significant difference in total biomass or seed yield among treatments, but humic acid was effective at ameliorating the leaf interveinal chlorosis that occurred during early growth of the non-chelated treatments. Atiyeh *et al.* (2002) [1] stated that the incorporation of humic acid into soilless plant growth media @ 150, 200, 250 and 500mg/kg showed increased plant height and leaf area in tomato seedlings.

Paksoy *et al*. (2010) [10] noticed that the application of 1500 mg humic acid / kg treatment showed more number of leaves, increased stem girth and shoot and root dry weight in okra when applied to growing media before sowing of seeds under saline soil conditions. The objective of this study was to determine the effect of humic acid concentrations and its number of drenching on growth of Alphonso mango nursery grafts.

Materials and Methods

The field experiment was conducted at the fruit crop nursery, Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, and Dapoli. Randomly 50 Alphonso mango nursery grafts per treatment were selected and kept in nursery. Thus in all 3000 number of Alphonso mango nursery grafts were selected for further investigation. Series of humic acid concentration were prepared and drenching was done as per treatment details. Observations on growth of five randomly selected Alphonso mango nursery grafts in each treatment were recorded at 3 month age as initial observation and thereafter at 6 and 9 month age.

The experiment consisted of 5 main plot treatments, *viz*, D_1-(Drenching once, i.e. immediately after planting grafts in nursery polybag), D_2-(Drenching twice, i.e. immediately after planting grafts and 1month after), D_3-(Drenching thrice, i.e. immediately after planting grafts and 1 and 2 months after), D_4-(Drenching four times i.e. immediately after planting grafts and 1, 2 and 3 month after, D_5-(Drenching five times, i.e. immediately after planting grafts and 1, 2, 3 and 4 month after), and 4 sub plot treatments, C_0-control (without humic acid), C_1- 5ml humic acid / litre of water, C_2-7.ml humic acid / litre of water, C_3-10 ml humic acid / litre of water. The treatments were arranged in split plot design with 3 replication. The experiment was started on July 7th 2011 and ended on 14th April 2012. 50 ml prepared humic acid solution was drenched 5 times at monthly interval to the Alphonso mango nursery grafts.

The graft height was measured from the graft joint to the tip of Alphonso mango nursery grafts at 3, 6 and 9 month age. Similarly, number of shoots, plant spread (cm), number of leaves, girth at collar region (cm), number of primary, secondary and tertiary roots, root length, root to shoot ratio were also measured at 3, 6 and 9 month age. Leaf area (cm^2) at initial 3 month age and final 9 month age was estimated with leaf area meter. Dry matter of plants was estimated at initial 3 month age and final 9 month age. Plants were filled in separate brown paper bags and kept in hot air oven. Weighing was done regularly until constant weight and recorded as dry matter of plants. Absolute growth rate (cm/day) and Relative growth rate (cm/cm/day) were also calculated. The statistical analysis was done by the method suggested by Panse and Sukhatme (1985) [11].

Results and Discussion

Humic acids are technically not a fertilizer, although in some walks people do consider it. Humic acids are an effective agent to use as a complement to synthetic or organic fertilizers. In many instances, regular humic acids use will reduce the need for fertilization due to the soil and plant ability to make better use of it. In some instances, fertilization can be eliminated entirely if sufficient organic material is present and the soil can become self-sustaining through microbial processes and humus production.

Effect of number of drenching of humic acid on growth of Alphonso mango nursery grafts

Among different parameters studied, number of drenching had significant effect on most of the characters *viz*, plant height, leaf area, plant spread, girth at the collar region, root length, number of secondary and tertiary roots, dry matter production. At the end of 9 month age.

The highest AGR (0.13076 cm/day) was observed at D_5. The non-significantly varied relative growth rate (RGR) was the highest (0.05678 cm/cm/day) at the treatment in D_5. In descending order, RGR was D_1>D_1>D_1> D_1> D_1> D_1> D_1>D_4.

Table 1: Effect of number of drenching of humic acid on growth of Alphonso mango nursery grafts

	D_1	D_2	D_3	D_4	D_5
Plant height (cm)	39.82	41.50	43.20	44.33	46.38
Plant spread (cm)	34.80	35.72	37.25	37.67	38.57
No. of leaves	15.94	16.87	16.98	17.03	17.33
Leaf area (cm2)	637.880	651.111	685.197	712.926	772.468
Girth (cm)	3.11	3.31	3.47	3.51	3.86
Secondary roots	21.88	23.67	29.94	30.48	34.51
Tertiary roots	108.08	111.68	140.93	156.03	183.53
Root length (cm)	29.61	32.43	33.77	35.42	39.07
Dry matter (g)	19.75	25.12	26.37	29.01	33.06
AGR (cm/day)	0.1088	0.1119	0.1204	0.1069	0.1307
RGR (cm/cm/day)	0.0472	0.0486	0.0523	0.0464	0.0567

D_1- drenching once, D_2-drenching twice, D_3-drenching thrice, D_4-drenching four times, D_5-drenching five times.

Effect of humic acid concentration on growth of Alphonso mango nursery grafts

Similar to the effect of number of drenching, significant variation due to humic acid concentration treatments were also observed among different characters studied. Significantly the highest plant height (45.75 cm) was observed in C_3 and was superior to all. The plant height as affected by humic acid concentrations in descending order was C_3> C_2> C_1> C_0. Significantly the highest plant spread (38.369 cm) was observed in C_3. Descending order of plants spread was C_3> C_2> C_1> C_0. The treatment C_3 was significantly superior showing the highest number of leaves (18.31). The number of leaves as affected by humic acid concentrations in descending order was as follows C_3> C_2> C_1> C_0. Leaf area, significantly the highest value (748.702 cm^2) was observed in C_3 and was superior to C_0 only i.e. control. Descending order of leaf area was C_3> C_2> C_1> C_0. Girth at collar region observed in C_3 (3.66 cm) was superior to all except C_2 and in descending order was C_3> C_2> C_1> C_0. Significantly the highest number of secondary roots was noticed in treatment C_3 (33.15). Further, the number of secondary roots as affected by humic acid concentration in descending order was C_3> C_2> C_1> C_0. Significantly the highest number of tertiary roots was noticed in treatment C_3 (170.14). Further, the number of tertiary roots as affected by humic acid concentration in descending order was C_3> C_2> C_1> C_0. The treatment C_3 showed significantly the highest root length (39.07 cm) and was superior to all except C_2. The root length of Alphonso mango nursery grafts as affected by humic acid concentration in descending order was C_3> C_2> C_1> C_0.

Significantly the highest value for dry matter production (30.47 g) was observed in C_3 and desceding order was C_3> C_2> C_1> C_0. During the period of 180-270 days, significantly varied highest AGR (0.12170 cm/day) was observed in C_1. The AGR as affected by humic acid concentrations in

descending order was C_3> C_2> C_1> C_0 at 180-270 days. Similarly the significantly varied RGR was the highest in the treatment C_2 (0.05285 cm/cm/day). The RGR as affected by humic acid concentrations in descending order was C_3> C_2> C_1> C_0 at 180-270 days.

Table 2: Effect of humic acid concentration on growth of Alphonso mango nursery grafts

Plant height (cm)	C_0	C_1	C_2	C_3
Plant spread (cm)	40.15	42.33	43.93	45.75
No. of leaves	35.06	36.24	37.50	38.39
Leaf area (cm2)	15.49	16.19	17.31	18.31
Girth (cm)	624.016	675.193	719.755	748.702
Secondary roots	3.19	3.37	3.57	3.66
Tertiary roots	23.18	27.05	29.01	33.15
Root length (cm)	109.13	132.01	148.92	170.14
Dry matter (g)	30.06	32.13	34.98	39.07
AGR (cm/day)	22.68	25.63	27.87	30.47
RGR (cm/cm/day)	0.1050	0.1217	0.1212	0.1151
	0.0456	0.0528	0.0526	0.0500

C_0- Control, C_1- 5ml humic acid/L, C_2-7.5 ml humic acid /L, C_3 -10 ml humic acid/L

Interaction effect of number of drenching and concentration of humic acid

All the growth parameters, except growth rates were non-significantly varied due to the interaction effect of number of drenching and different concentrations of humic acid. Even though the interaction effect was non-significant, the highest plant height (49.92 cm) was observed in treatment combination D5C3. Similar in the case of plant spread also, highest plant spread (41.19cm) was observed in D5C3.Significantly the highest AGR (0.15326 cm/day) was observed in D3C1 and was significantly superior over all. Similarly the highest RGR (0.6671 cm/cm/day) was observed in D3C1.Thus, values for different growth parameters were increased with increasing levels of number of drenching, different concentrations of humic acid and their interactions. The better effects of number of drenching were obtained when drenching of humic acid was done four and five times. Further, increased concentration of humic acid was related with better results of most of the growth parameters. The concentration @ 7.5 ml and 10 ml humic acid/liter of water had better results on most of the parameters studied during the present investigation.

Addition of humic acid promoted growth and nutrient uptake of plants. The plants take more mineral elements due to the better-developed root systems and thereby promote growth. (Chen and Aviad, 1990.; Fagbenro and Agboola, 1993 and David *et al*.; 1991) [2, 5, 3].

Humic acid and Fulvic substances contain auxins; auxins are involved in the chelation of iron for the plant, improving growth, health, and nutrient intensity of the plant, especially the development of the root system of the plant. Humic matter has been shown to increase the uptake of nitrogen by plants, and to increase soil nitrogen utilization efficiency, thereby increasing the vegetative growth (plant height, number of shoots, plant spread, number of leaves and leaf area) which in turn increases the dry weight of plant. When dilute solution of humic acid is used as foliar spray, it causes the plant to experience a notable uptake of oxygen, and it also increase the chlorophyll content thus increasing the plant growth (William R. Jackson).

Many scientists have reported the beneficial effects of humic acid on various vegetative growth parameters like plant height, number of leaves, leaf area, plant spread and root length in different horticultural crops like Tomato (Atiyeh *et al*.,2002) [1], Teak (Fagbenro and Agboola,1993) [5], Okra (Paksoy *et al*., 2010) [10], Cucumber (Hartwigsen and Evans, 1996) [6]. Similar findings were also obtained by humic acid application in the present investigation entitled "Effect of humic acid on growth of mango nursery grafts cv. Alphonso".

Conclusion

It could be concluded that drenching of humic acid at concentration @ 7.5 to 10 ml /lit. To the mango nursery grafts cv. Alphonso at 4 to 5 times at monthly interval had shown better results in terms of growth behavior during 3-9 months period.

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