Journal of Applied and Natural Science 9 (1): 582 - 586 (2017)

JANS

Growth of mango (*Mangifera indica* L.) rootstocks as influenced by pre-sowing treatments

R. J. Patel, T. R. Ahlawat* A. I. Patel, J. J. Amarcholi, B. B. Patel and Kapil Sharma

Department of Fruit Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari – 396450 (Gujarat), INDIA

*Corresponding author. E-mail: tahlawat4@gmail.com

Received: June 23, 2016; Revised received: December 18, 2016; Accepted: February 23, 2017

Abstract: An experiment was carried out at Navsari Agricultural University, Navsari during 2014 to evaluate the effect of pre-sowing treatments on survival percentage and growth of mango rootstocks. Mango stones were soaked in aqueous solutions of GA_3 (100 and 200 ppm), Beejamruth (2 % and 3 %) and Thiourea (1 % and 2 %) for 12 and 24 hours. The trial was evaluated in Completely Randomized Design based on factorial concept and the treatments were replicated thrice. Imposition of treatments led to significant differences at 5 % level of significance for all parameters chosen in this study. Mango stones when treated with Thiourea at 1 % had the maximum shoot length (49.93 cm), root length (34.38 cm), shoot dry weight (21.08 g) and total dry weight (26.36 g). The highest number of lateral roots (10.90) and survival percentage (64.17) was observed in mango stones dipped in 100 ppm GA_3. Between the two soaking duration, soaking mango stones for 24 hours recorded higher values for shoot length (45.03 cm), root length (32.79 cm), number of lateral roots (9.83), survival percentage (62.72), shoot root fresh weight ratio (4.30), shoot dry weight (21.33 g), total dry weight (26.28 g) and shoot root dry weight ratio (4.32). Thus, survival percentage and growth of mango rootstocks can be substantially improved by soaking mango stones in aqueous solutions of 100 ppm GA_3 or Thiourea at 1 % for 24 hours before sowing.

Keywords: GA_3, Mango, Shoot length, Survival percentage, Thiourea

INTRODUCTION

Mango (*Mangifera indica* L.) regarded as the "King of Tropical Fruits" is closely linked with the culture and history of India. Mango is grown in India for the past four thousand years and there are more than a thousand varieties grown throughout the country. India is the largest producer (45.1 %) of mango in the world and caters to countries like United Arab Emirates, United Kingdom and Kuwait. The estimated area under mango in Gujarat is about 1.42 lakh hectares with a production of 11.25 lakh MT and a productivity of 7.9 t/ha (NHB, 2014. In Gujarat, Valsad, Junagadh and Navsari are the leading districts in mango production.

In the past two decades, India has witnessed an increase in the area under mango on account of demand for fresh fruits in the domestic as well as international market. However, limited availability of genuine planting material is a major bottleneck in the expansion of area under mango. As mango is a highly cross pollinated crop, there is an enormous variation in the seedlings raised even from the fruits of the same tree. When raised by seeds, mango plants are not true to type and lose many of their unique characteristics. Vegetative propagation thus became a necessity in mango to preserve and perpetuate the characteristics of each cultivar.

Mango is commercially propagated by grafting in different parts of the country. For successful graft union, rootstocks should be healthy, strong and vigorous. Owing to recalcitrant nature, mango stones are characterized by low viability. In Gujarat, mango stones are usually available between April to June when water is scarce and temperatures are high. As a result of which, seedling vigour and survival percentage is very low.

Evidence available in the public domain seems to indicate that soaking mango stones in water and chemical treatments can make a perceptible difference in enhancing germination, boosting growth and reducing mortality (Rao and Reddy, 2005; Kumar *et al.,* 2008; Shaban, 2010). It has also been reported that organic formulations like *amritpani*, *panchgavya* and *beejamruth* can enhance growth and germination in mango stones (Naguri and Tank, 2015). However, there is a wide variation in the duration of soaking reported and therefore, it was felt prudent to investigate the effect of pre-sowing treatments on the survival and growth of mango (*Mangifera indica* L.) rootstocks under South Gujarat conditions.

MATERIALS AND METHODS

Study area: The experiment was carried out at Regional Horticultural Research Station (RHRS), ASPEE College of Horticulture and Forestry, Navsari

ISSN : 0974-9411 (Print), 2231-5209 (Online)

Agricultural University, Navsari during the year 2014. RHRS is situated on the coast of Arabian Sea at 20^0-57'N latitude and 72^0-54'E longitude at an altitude of about 10 meters above the mean sea level.

Climate and weather: Navsari campus is located in South Gujarat Heavy Rainfall Zone-I agroclimatic zone. It is typically characterized by fairly hot summer, moderate cold winter, more humid and warm monsoon with heavy rains. Annual rainfall is about 1500 to 1800 mm. Monsoon generally starts from the second week of June and lasts up to the second week of September. Most of the rainfall is received from South West monsoon in the months of July and August. During the experimental period (June to October) average maximum temperature ranged from 30.3 ^oC to 35.9 ^oC and minimum temperature from 22.4 ^oC to 27.9 ^oC and relative humidity was in between 43.0 to 92.9 %.

Treatment details: Mango stones were procured from Petson Food Industries, Sisodra, district Navsari and washed thoroughly to remove extraneous material adhering to it. Stones were dipped in water and allowed to settle at the bottom of the container. Stones floating on the surface of water were discarded and those which settled at the bottom were used for experimentation. Mango stones thus selected were dipped in aqueous solutions of gibberellic acid (100 and 200 ppm), thiourea (1 % and 2 %) and beejamrut (2 % and 3 %) for 12 and 24 hours. The resultant twelve treatment combinations were replicated thrice. Treated mango stones were sown in polythene bags which were properly filled, labelled with tags and placed in a naturally ventilated polyhouse. Stones were irrigated immediately after sowing in polythene bags. Subsequently, bags were watered as and when required. To protect mango stones and saplings from root rot disease, they were drenched with Copper oxychloride @ 0.02 % at monthly intervals. Dimethoate @ 0.03 % and Carbendazim @ 0.02 % was applied as foliar spray at monthly intervals to control sucking pest and fungal diseases. Five mango seedlings were selected at random from each repetition for recording observations after 120 days after sowing. Shoot length (cm) was measured from the soil surface to the growing tip. Root length was computed using a measuring tape after uprooting mango seedlings. The number of lateral roots was manually counted and averaged for five seedlings. The shoot root fresh weight ratio was calculated by the following formula:

$$\text{Shoot:root fresh weight ratio} = \frac{\text{Fresh shoot weight (g)}}{\text{Fresh root weight (g)}}$$

The shoot fresh weight and total fresh weight of five tagged seedlings was sun dried for 20 days and after stabilization in weight, the values were recorded on an electronic weighing balance. This accounted for the shoot dry weight (g) and total dry weight (g) of mango seedlings. The shoot root dry weight ratio was computed based on the following equation:

$$\text{Shoot:root dry weight ratio} = \frac{\text{Dry shoot weight (g)}}{\text{Dry root weight (g)}}$$

The survival percentage was calculated after 4 months of sowing based on the below mentioned formula:

$$\text{Survival (\%)} = \frac{\text{Number of survived seedlings}}{\text{Number of germinated stones}} \times 100$$

Statistical analysis: The experiment was evaluated in Completely Randomized Design based on factorial concept. Data recorded was subjected to statistical analysis as per the method suggested by Panse and Sukhatme (1967) under the direct supervision of Department of Agricultural Statistics, N. M. College of Agriculture, NAU, Navsari. Treatment means were tested using F test values at 5 % level of significance.

RESULTS AND DISCUSSION

Effect of pre-sowing treatments: Imposition of pre-sowing treatments led to significant differences at 5 % level of significance in survival percentage, growth parameters and biomass production among mango seedlings (Table 1). The highest shoot length (49.93 cm) was noted when mango stones were treated with thiourea 1 % and it was at par with GA_3 100 ppm. Thiourea is believed to be associated with enhanced metabolite translocation from source to sink (Srivastava *et al.,* 2008) and co-ordinated regulation of plant source to sink relationship (Pandey *et al.,* 2013). Thiourea may have stimulated cell division and cell elongation in seedlings thereby contributing to increased shoot length. Increased seedling height under Thiourea @1.0 % was earlier reported by Rashmi Kumari *et al.,* (2007) in aonla. Whereas, increment in seedlings height with GA_3 treatment may be due to the fact that GA_3 increased osmotic uptake of nutrients, causing cell elongation and thus increasing the shoot length (Shanmugavelu, 1966). These findings are in conformity with the results of Vasantha *et al*. (2014) in tamarind. They observed higher seedling height in tamarind when dipped in GA_3 @ 200 ppm before sowing seeds.

The maximum root length (34.38 cm) was recorded when mango stones were treated with thiourea 1 % which was at par with GA_3 100 ppm (32.47 cm), GA_3 200 ppm (32.17 cm) and thiourea 2 %. GA_3 treatment might have resulted into increased production of photosynthates and their translocation through phloem to the root zone might be responsible for increasing the root length (Vachhani *et al*., 2014). These results are in close agreement with Shaban (2010) in mango and Brijwal and Kumar (2013) in guava.

The maximum number of lateral roots (10.90) was recorded when mango stones were soaked in GA_3 100 ppm. Higher production of photosynthates under GA_3 treatment and their increase translocation to the root

Table 1. Effect of pre-sowing treatments on survival percentage and growth of mango seedlings.

Treatments	Shoot length (cm)	Root length (cm)	Number of lateral roots	Shoot root fresh weight ratio	Survival percentage	Shoot dry weight (g)	Total dry weight (g)	Shoot root dry weight ratio
Pre-sowing treatments								
S_1 : GA_3 100 ppm	45.29	32.47	10.90	4.17	64.17	19.96	24.34	4.59
S_2 : GA_3 200 ppm	43.62	32.17	9.92	3.81	61.50	18.85	23.91	3.75
S_3 : Beejamruth 2%	37.36	25.85	6.92	3.25	50.33	16.66	21.21	3.66
S_4 : Beejamruth 3%	38.54	28.40	8.67	3.46	52.83	17.27	22.33	3.41
S_5 : Thiourea 1%	49.93	34.38	9.50	4.38	60.17	21.08	26.36	3.99
S_6 : Thiourea 2%	40.34	30.95	9.08	3.55	56.50	18.29	23.70	3.40
S. Em. ±	1.91	1.51	0.26	0.24	1.40	0.99	1.08	0.20
CD 5%	5.61	4.43	0.76	0.71	4.11	2.90	3.17	0.57
Duration of soaking								
D_1 : 12 hrs	39.99	28.61	8.50	3.24	52.44	16.04	21.00	3.28
D_2 : 24 hrs	45.03	32.79	9.83	4.30	62.72	21.33	26.28	4.32
S. Em. ±	1.10	0.87	0.15	0.14	0.81	0.57	0.62	0.11
CD 5%	3.24	2.56	0.44	0.41	2.37	1.67	1.83	0.33
S x D								
S. Em. ±	2.71	2.14	0.37	0.34	1.98	1.40	1.53	0.28
CD 5%	NS	NS	1.08	NS	5.81	NS	NS	NS
CV%	11.03	12.04	6.93	15.64	5.96	12.95	11.18	12.63

zone may have led to an increase number of lateral roots. In a previous study on papaya, Kumawat *et al*. (2014) had reported higher number of lateral roots in a treatment involving GA_3 @ 150 ppm. The minimum shoot root fresh weight ratio (3.25) was recorded when mango stones were treated with Beejamruth 2 %. It was at par with Beejamruth 3 % (3.46), thiourea 2 % (3.55) and GA_3 200 ppm (3.81). The shoot root ratio refers to the proportion of above ground biomass to the root biomass. It is a measure of balance between the transpiring area (shoot) and the water absorbing area (roots) of the plants. It was reported that seedlings with a lower shoot-root ratio within the same class of height exhibit better survival rate (Hermann, 1964; Lopushinsky and Beebe, 1976). Shoot root ratio has also been shown to influence the stability of seedlings to withstand wind (Cannel and Willett, 1976). In the present trial, shoot root fresh weight ratio for GA_3 treatments ranged between 3.81 to 4.17 and for thiourea treatments between 3.55 to 4.38, respectively. Although these values are on the higher side, they can probably be explained based on the higher shoot length under these treatments.

The highest survival percentage (64.17) was recorded when mango stones were subjected to GA_3 at 100 ppm. It was at par with 200 ppm GA_3 treatment (61.50 %) and thiourea at 1 % (60.17 %). Higher survival percentage under GA_3 treatment might be due to early germination of mango stones which helped in successful acclimatization and establishment. Better vegetative growth under GA_3 and thiourea treatments may also have played a part in increasing the survival percentage. This is in line with results earlier reported by Supe *et al*. (2012) and Manekar *et al.* (2011) in aonla. They found higher survival percentage in aonla when treated with GA_3 at the rate of 750 ppm and 200 ppm, respectively.

Mango stones when soaked in thiourea 1 % exhibited the maximum shoot dry weight (21.08 g). It was at par with GA_3 100 ppm (19.96 g), GA_3 200 ppm (18.85 g) and thiourea 2 % (18.29 g). Application of 1 % thiourea and GA_3 treatments recorded higher shoot length which may have contributed to an increase in shoot dry weight (Pampanna and Sulikeri, 1999). These results also corroborate the findings of Meena and Jain (2005) in papaya. They observed higher seedling length in four different cultivars of papaya when soaked in aqueous solution of 100 ppm GA_3.

The maximum total dry weight (26.36 g) was recorded when mango stones were treated with thiourea 1 %. It was at par with treatment GA_3 100 ppm (24.34 g), GA_3 200 ppm (23.91 g) and thiourea 2 % (23.70 g). The increased total dry weight may be due to higher shoot length, root length, number of leaves and number of lateral root under these treatments. All of these may have led to the overall assimilation and redistribution of photosynthates within the plant, thereby promoting growth and development (Brian and Hemming, 1955). Identical results were obtained by Padma Lay *et al.* (2013) in papaya and Gurung *et al.* (2014) in passion fruit (*Passiflora edulis* Sims.).

The shoot root dry weight ratio is an effective and safe index to evaluate seedling quality, as described by Parviainen (1981). It is an important measure for seedling survival but requires destructive sampling. Lower values of shoot root dry weight ratio indicate a healthy seedling with better chances of survival (Jaenicke, 1999). The minimum shoot root dry weight ratio (3.40) was recorded when mango stones were soaked in thiourea 2 %. It was at par with Beejamruth 3 % (3.41), Beejamruth 2 % (3.66), and GA_3 200 ppm (3.75). As mentioned earlier, higher shoot length may have contributed to greater shoot root dry weight ratio recorded in GA_3 100 ppm and thiourea treatments.

Effect of duration treatment: Duration of soaking had a significant influence at 5 % level of significance on all parameters included in the study (Table 1). Soaking for 24 hours resulted in higher shoot length (45.03 cm), root length (32.79 cm), number of lateral roots (9.83) and survival percentage (62.72). The 24 hour soaking treatment also recorded higher values of shoot root fresh weight ratio (4.30), shoot dry weight (21.33 g), total dry weight (26.28 g) and shoot root dry weight ratio (4.30) of mango seedlings.

Soaking mango stones for 24 hours may have accelerated the hydrolysis of complex sugar into simple sugars which are than utilized in the synthesis of auxins and proteins. It is a well known fact that proteins are utilized in the production of new tissues and that auxins promote growth. This probably explains the higher values recorded for various growth parameters under 24 hours soaking treatment. Harshavardhan and Rajasekhar (2012) recorded better vegetative growth in jackfruit seedlings when soaked in aqueous solution of GA_3 @ 200 ppm for 24 hours as compared to a soaking duration of 12 hours.

During the framing of this trial, authors had come across work done on different fruit crops in India and abroad pertaining to the effect of plant growth chemicals on germination in fruit crops. Nevertheless, there was not much clarity with regard to soaking duration in case of mango which varied from 12 hours to 40 hours. This study was therefore an attempt to identify the right chemical and the proper duration of soaking so as to maximize survival percentage and hasten seedling growth in mango.

Conclusion

It was concluded that for higher survival percentage and better growth, mango stones should be soaked in 100 ppm of GA_3 or 1 % thiourea for 24 hours before sowing them. The resultant seedlings had higher shoot and root length as well as number of lateral roots. The survival percentage after 120 days of sowing was above 60 per cent. This simple intervention can help nurserymen raise vigorous mango rootstocks with higher survival percentage.

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