Current Horticulture 11(2): 60–63, May–August 2023 DOI: 10.48165/chr.2023.11.2.12

Response of mango (*Mangifera indica*) cultivars to agro-chemicals for growth and flowering

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Received: 12 September 2020; **Accepted:** 3 Feburary 2022

ABSTRACT

An experiment was conducted during 2015-16 and 2016-17 at Agricultural Research Station, Banswara district of Rajasthan to study the response of different agro-chemicals for growth and flowering of mango (*Mangifera indica*). The plants were planted in a square system of planting with a 10m × 10m spacing. Agro-chemicals, calcium chloride, potassium nitrate, paclobutrazol and sorbitol were used. The treatment combinations were applied as the control (water spray), calcium chloride (0.3, 0.6 and 0.9%), potassium nitrate (1, 2 and 3%), paclobutrazol (500, 1000 and 1500 ppm) and sorbitol (1.5, 2.0 and 2.5%). Application of different agro-chemicals were applied at different stages and times. Effect of agro-chemicals was found significant for growth and flowering parameters. Paclobutrazol (1500 ppm) was found better for shoot length and diameter, tree spread, canopy volume and days of fruit setting from flower initiation and flowering characters, *viz.* date of flower initiation, per cent fruit setting and retention, days to harvest from fruit setting and first flush after fruiting.

Key Words: Calcium chloride, Potassium nitrate, Paclobutrazol, Sorbitol, Agro-chemicals

Mango (*Mangifera indica* L.) is popular fruit in world. The KNO_3 is suggested to induce ethylene production and efficacy of KNO_3 is suppressed by ethylene biosynthesis inhibiters, the involvement of ethylene appear an important factor in mango flower process (Upreti *et al.*, 2014). Paclobutrazol help for regular bearing in biennial habits of mango cultivars. It helps in getting more number of reproductive shoots (Muhammad *et al.*, 2010) and also increase the perfect flowers panicle^{-s} in mango. Hence, an experiment was conducted to see the response of mango to agro-chemicals for growth and flowering.

MATERIALS AND METHODS

The experiment was conducted in Banswara district of Rajasthan (Maharana Pratap University of Agriculture and Technology). The region falls under agro- climatic zone IVb "Humid Southern Plain Zones of Rajasthan'' at an altitude of 302m above mean sea-level and lies between 23°11′ N to 23°56′ N latitude and 73°58′ E to 74°49′ E longitude. Soils are predominantly reddish medium, well drained calcareous, shallow on hills and deep in valleys. The experiment consisted of 13 treatments along with the control and replicated thrice in a randomized block design. The 15-year-old mango orchard consisting of Dashehari, Langra and Kesar was selected.

Plants were planted in square system of planting at 10m × 10m spacing. Calcium chloride, potassium nitrate, paclobutrazol and sorbitol were applied. The treatment combinations, control (water spray), calcium chloride (0.3, 0.6 and 0.9%), potassium nitrate (1, 2 and 3%), paclobutrazol (500, 1000 and 1500 ppm) and sorbitol (1.5, 2.0 and 2.5%) were applied. The calcium chloride was applied one month prior to harvesting (7-8 May during both the years), potassium nitrate at marble-sized stage (27 February and 1-March during both the years), paclobutrazol at fruit-bud differentiation stage (11 October) and sorbitol at pea nut size (19 January).

The observations were recorded on shoot length, shoot diameter, tree spread (E-W) and (N-S), canopy volume, date of flower initiation, days of fruit setting

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from flower initiation, per cent fruit set, per cent fruit retention, days of harvest from fruit set and first flush after fruiting.

RESULT AND DISCUSSION

The minimum shoot length (24.63 cm) was observed in Kesar, followed by Langra (26.71 cm) and maximum (29.34 cm) in Dashehari. The shoot diameter showed decreasing trend, 0.77, 0.70 and 0.62 cm in Dashehari, Langra and Kesar, respectively. Maximum shoot diameter was observed under treatment V_1 (Dashehari) and minimum in V_3 (Kesar). It might be attributed to genetic make-up of cultivars. These results are in line with these of (Sarolia *et al.*, 2013-14). The minimum shoot length (24.72 cm) was observed in T_9 (PBZ 1500 ppm), followed by (25.09 cm) T_{12} (sorbitol 2.5%) and maximum (29.28 cm) by T_4 (KNO_3 1%), followed by T_0 (29.20 cm) (Table 1). When paclobutrazol @ 1500 ppm (V_3T_9) was applied in conjunction on Kesar, there was significant reduction in shoot length (22.76 cm) and canopy volume (138.13 m^3). Kesar showed strong biennial behaviour over Dashehari and Langra (Upreti *et al.*, 2013).

The minimum shoot diameter (0.56 cm) was observed in treatment T_7 (PBZ 500 ppm), followed by (0.58 cm) T_8 (PBZ 1000 ppm) and maximum (0.84 cm) under T_{12} (sorbitol 2.5%). It is clear that treatment combination V_3T_7 (Kesar + PBZ 500 ppm) resulted in lowest shoot diameter (0.50 cm), followed by V_3T_8 (0.52 cm) which were at par with each other. Further, highest shoot diameter (0.91 cm) was obtained from treatment combination V_1T_0 (Dashehari + water spray), V_1T_{12}, followed by V_1T_{11} (0.87 cm) which were statistically at par with treatment V_1T_0 (Dashehari + control). Tree spread (E-W) and (N-S) showed non-significant effect during both the years.

The stimulation on such growth characters were attributed to application of different agro-chemicals. The influence of applied agro-chemicals on these characters may be ascribed to its catalytic or stimulatory or suppression effect on most of the physiological and metabolic processes of plants. Paclobutrazol is a broad spectrum plant growth retardant that selectively controls tree vigor (Uperti *et al.*, 2013). Thus, application of paclobutrazol, suppress vegetative growth and development of plant and helps in getting more number of reproductive shoots (Muhamad *et al.*, 2010).

There was maximum canopy volume (253.50 m^3) in Dashehari than in Langra (184.07 m^3) and was recorded under cv. Kesar (148.47 m^3). The minimum canopy volume (181.08 m^3) was observed under T_9 (PBZ 1500 ppm). Interaction effect of cultivars and agro-chemicals showed significant influence (Table 1). The maximum canopy volume (292.27 m^3 and 285.22 m^3) was recorded in combination V_1T_0 (Dashehari + water spray) and minimum (139.19 m^3 and 138.13 m^3) in V_3T_9 (Kesar + PBZ 1500 ppm). Treatment combination V_3T_9 (Kesar + PBZ 1500 ppm) recorded 48% lower canopy over tree V_1T_0 (Dashehari + water spray).

Reduction in shoot growth by PBZ is primarily as a consequence of reduced internodal elongation associated with GA biosynthesis inhibition and increasing synthesis of inhibition like ABA. Abscisic acid also produced through the terpenoid pathway. Treatment with PBZ promotes the production of ABA much like phytol production. The PBZ also interferes with the normal breakdown of ABA. The combined effect on both production and breakdown of ABA resulted in enhanced concentration of ABA in leaves. The ABA caused stomata to close, reduced shoot growth and water loss through transpiration (Srilatha *et al.*, 2014).

Kesar recorded most early initiation of flower (8 December during 2015-16 and 3 December during 2016-17), followed by Dashehari (18 December during 2015-16 and 10 December during 2016-17) and cultivar Langra (26 December during 2015-16 and 15 December during 2016-17) in T_9 (PBZ 1500 ppm). T_9 (PBZ 1500 ppm) recorded early flower initiation, while late flower initiation recorded under the control. Treatment T_9 recorded about 20-32 days early flowering initiation over the control in different mango cultivars. Paclobutrazol increased flowering by reducing the effectiveness of gibberellic acid by preventing shoot elongation and also causes rapid development of reproductive buds by interfering with gibberellins metabolism which otherwise promotes vegetative growth. The PBZ blocks the terpenoid pathway at several steps inhibiting the gibberellins synthesis (Srilatha *et al.*, 2014). Soil application of paclobutrazol exhibited less number of vegetative flushes/shoot, checking vegetative growth with paclobutrazol by inhibiting the biosynthesis of gibberellins in plants by blocking the conversion of kaurene and kaurenoic acid is possible reason for restricting the more vegetative flush per shoots (Shankaraswamy *et al.*, 2015).

The highest fruit setting (1.15%) was recorded in V_2 (Langra), followed by (1.10%) V_1 (Dashehari), while minimum (1.08%) was noted in V_3. The fruit setting indicates that different agro-chemicals had

Table 1: Response of mango cultivars to agro-chemicals with respect to growth and flowering parameters

Observation / Treatment	Shoot length (cm)	Shoot diameter (cm)	Tree spread		Canopy volume (m^3)	Days of fruit set from flower initiation	Per cent fruit set	Per cent fruit retention	Days to harvest from fruit set	First flush after fruiting (days)
			E-W(m)	N-S (m)						
Varieties										
V_1 (Dashehari)	29.34	0.77	9.06	8.73	253.50	21.17	1.10	1.52	87.09	87.81
V_2 (Langra)	26.71	0.70	9.14	8.86	184.07	22.80	1.15	1.56	93.52	80.97
V_3 (Kesar)	24.63	0.62	9.10	8.81	148.47	19.77	1.08	1.39	90.78	62.45
SEm±	0.127	0.003	0.045	0.046	1.159	0.34	0.01	0.01	0.44	0.238
CD (5%)	0.354	0.009	NS	NS	3.237	0.94	0.02	0.03	1.22	0.664
Agro-chemicals										
T_0 (Control) WS	29.20	0.83	9.34	9.08	213.59	22.41	0.69	0.86	103.33	68.00
T_1 ($CaCl_2$ 0.3%)	27.57	0.69	9.16	8.79	196.53	22.40	0.85	1.31	97.61	81.94
T_2 ($CaCl_2$ 0.6%)	26.88	0.71	9.11	8.72	192.07	22.26	0.85	1.32	97.22	81.39
T_3 ($CaCl_2$ 0.9%)	26.61	0.73	9.07	8.67	188.69	22.16	0.87	1.33	96.61	80.94
T_4 (KNO_3 1%)	29.28	0.61	9.22	8.84	200.22	20.85	0.92	1.42	84.78	80.10
T_5 (KNO_3 2%)	28.77	0.63	9.26	8.99	207.76	20.24	0.95	1.45	83.33	79.55
T_6 (KNO_3 3%)	28.46	0.66	9.34	9.05	212.88	20.08	0.99	1.50	82.05	78.92
T_7 (PBZ 500ppm)	26.12	0.56	8.99	8.79	190.82	20.85	1.48	1.70	85.16	74.53
T_8 (PBZ 1000ppm)	25.41	0.58	8.92	8.70	185.89	20.36	1.53	1.76	83.66	73.72
T_9 (PBZ 1500ppm)	24.72	0.62	8.86	8.61	181.08	19.89	1.59	1.84	82.66	72.66
T_{10} (Sorbitol 1.5%)	26.00	0.79	9.05	8.82	194.17	22.01	1.20	1.58	93.72	77.55
T_{11} (Sorbitol 2.0%)	25.52	0.81	9.02	8.82	193.18	21.48	1.25	1.64	93.11	76.89
T_{12} (Sorbitol 2.5%)	25.09	0.84	8.99	8.56	182.62	21.18	1.30	1.68	92.78	75.83
SEm±	0.264	0.007	0.094	0.097	2.412	0.700	0.015	0.019	0.910	0.495
CD (5%)	0.737	0.018	0.261	0.270	6.739	NS	0.043	0.053	2.541	1.383

significant effect on the basis of pooled analysis. The maximum per cent fruit setting (1.59%) was recorded in T_9. Whereas, T_0 resulted in lowest fruit setting (0.69%). Combined effect of cultivars and agro-chemicals had significant effect on per cent fruit setting. The treatment combination V_2T_9 (Langra + PBZ 1500 ppm) resulted in maximum per cent fruit setting (1.74%), whereas minimum (0.67%) was recorded with Dashehari + water spray.

The maximum per cent fruit retention (1.56%) was registered in V_2 (Langra), followed by (1.52%) treatment V_1 (Dashehari), while lowest (1.39%) obtained from treatment V_3. Further, in agro-chemical, maximum per cent fruit retention (1.84%) was reported in treatment T_9 and minimum (0.86%) was in the control. The maximum per cent fruit retention (2.06%) was recorded in V_2T_9 (Langra + PBZ 1500 ppm) and minimum (0.83%) in treatment V_1T_0 (Dashehari + water spray) which was statistically at par (0.86%) with V_2T_0 (Langra + water spray). The mean maximum (1.97%) per cent fruit retention was registered in V_2T_9 and minimum (0.84%) in V_1T_0 treatment combination. It might be due to PBZ initiates early flowering by mimic the effect of environmental factors on flowering and reduces the age dependency of shoots for early and profuse flowering (Srilatha *et al.,* 2014).

These results are in accordance with those of Sarkar *et al.* (2014). Srividhya *et al.* (2022) reported that Paclobutrazol could enhance the total phenolic content of terminal buds and altered the xylem to phloem ratio, which is important in restricting vegetative growth and enhancing flowering by altering assimilates partitioning and patterns of nutrient supply for new growth. KNO_3 used to stimulate off-season flowering of mango especially under tropical regions. Rapid decrease in potassium content in leaves at initial stage corresponded with the period of rapid growth of shoots. Decreasing or stability in potassium content after flowering, fruit setting and fruit growth might be due to utilization of potassium by fruits in their development (Bhalerao *et al.,* 2013).

The days to harvest from fruit setting was minimum (87.09 days) in. Dashehari and maximum (93.52 days) in Langra. Among chemical treatment, minimum days of harvest from fruit setting (82.05 days) was in T_6 (KNO_3 3%) which remained at par with T_9 and maximum (103.33 days) was reported under the control. By use of KNO_3 (3%), 21.28 days early crop (fruit setting to harvesting) obtained over the control. The first flush after fruiting was early (62.45 days) recorded in Kesar, followed by (80.97 days) and (87.81 days) in Langra and Dashehari, respectively. Srilatha *et al.* (2015) reported that the paclobutrazol accelerated the induction of flowering as indicated by increase in percentage of flowering plants, more flowers, faster rate of flower emergence, more petals and higher yield in 20 accessions of mango hybrids.

CONCLUSION

It was concluded that Langra and Dashehari are promising in the region. Paclobutrazol (1500 ppm) was found better for shoot length and diameter, tree spread, canopy volume and days of fruit setting from flower initiation and flowering.

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