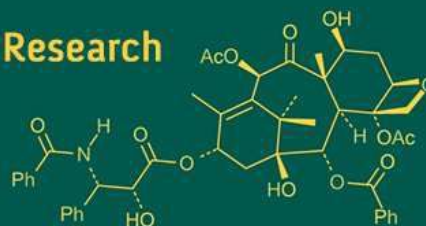


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Response of soil applied paclobutrazol for enhancing vegetative and reproductive growth in Kesar mango (*Mangifera indica* L.)

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Abstract

Paclobutrazol (PBZ) is a growth regulator used to control vegetative growth, stimulating the reproductive capacity of plants. PBZ has been widely marketed throughout the tropics to stimulate mango flowering. A field experiment was conducted during 2023-24 on a well-established ten-year-old mango orchard at the Department of Horticulture, College of Agriculture, Latur, to Response of soil applied paclobutrazol for enhancing vegetative and reproductive growth in Kesar Mango (*Mangifera indica* L.). The experiment followed a factorial randomized block design with two factors: the First factor being the concentration of paclobutrazol (C1: 1 ml a.i./m², C2: 1.5 ml a.i./m² and C3: 2 ml a.i./m²) and the Second factor being the time of application (M1: 15th July, M2: 1st August and M3: 15th August), with three replications. The treatments were applied as per the plan and observations on flowering, fruiting, yield and quality parameters were recorded.

The results revealed that the application of paclobutrazol at 2 ml a.i./m² resulted in significantly reduced shoot length (10.28 cm), internodal length (2.17 cm), minimum days to panicle emergence (46.89), maximum number of panicles per tree (621.68) and the longest panicles (31.33 cm). In terms of timing, application on 15th July showed the shortest shoot length (19.77 cm), internodal length (2.29 cm), minimum days to panicle emergence (46.33), the maximum number of panicles per tree (618.68) and the longest panicle length (34.69 cm).

These results suggest that the application of paclobutrazol at 2 ml a.i./m² on 15th July optimizes vegetative growth and flowering in mango cv. Kesar. However, the interaction effect of paclobutrazol concentration and time of application showed no significant effect on vegetative and flowering parameters. The interaction effect of paclobutrazol applied at 2 ml per meter of canopy diameter on July 15th was the most effective in achieving early emergence of panicles.

This study suggests that the multiple soil application of PBZ was effective in promoting vegetative and flowering parameters in Kesar mango, can help early flowering and more number of flowering shoots.

Keywords: Flowering, growth, mango, Kesar, paclobutrazol

Introduction

Mango (*Mangifera indica* L.) belongs to the family anacardiaceae and originated in Indo-Burma region. It is one of the important major fruit of India. It is cross pollinated amphidiploid crop with 2n=2x=40. It is the national fruit of India. It is called as the "King of Fruits" due to its delicious taste, captivating flavour and enticing aroma, excellent flavour attractive appearance and richness in phytochemicals and nutrients (Purseglove, 1972) [12].

Kesar is famous for its excellent fruit quality and delicious flavour. Flowering is an most important step in fruit production. The price of fruit is depends on market demand, so therefore, induction in flowering at certain times is necessary. Biennial bearing or irregular cropping is a major problem in commercial mango cultivation. Mango flowering is an important physiological event that sets the start of fruit production. Mango trees flower in response to the age of the last vegetative flush in the tropical conditions (Davenport 2007) [3]. Synchronization of the vegetative of tree canopies is a necessary first step in the flowering management program. Synchronization of growth is best accomplished by tip pruning all of the stems on the tree. The next step is to decide whether to use PBZ or not. PBZ has been used with considerable success to induce flowering in several fruit crops such as apple, Mango, citrus, pumelo.

it reduces vegetative growth and induces water-stress tolerance as well as increases total non-structural carbohydrates (TNC). PBZ has been widely marketed throughout the tropics to stimulate mango flowering. Soil application of PBZ has been found to be more responsive in regard to suppressing the vegetative growth and enhancing the reproductive growth in mango (Nartvaranant *et al.*, 2000) [9]. The first report about the use of paclobutrazol (PBZ) on mango in India was given by Kulkarni (1988) [8] tested concentration of 1.25 to 10 g a.i./tree on the cultivars Dashehari and Banganapalli. The induction of flowering in mango through chemical substances such as paclobutrazol, block the biosynthesis of gibberellins and reduced the growth of plants there by leading to blossoming (Rademacher, 1992) [13].

Applying paclobutrazol to mango plants in July-August promotes inflorescence emergence from October to November leading to fruit maturation from mid-March to April. This timing is highly profitable for farmers due to the high market demand during February-May resulting in higher prices for the produce. Soil application of paclobutrazol enhances yield by curbing vegetative growth and boosting flowering, fruit set, fruit mass, fruit size and overall quality (Burondkar and Gunjate, 1993) [1].

Paclobutrazol plays a critical role in modern mango cultivation, especially for managing tree growth and improving fruiting consistency. Its use has revolutionized mango farming by making production more predictable and efficient. However, proper application timing and dosage are key to achieving the desired results without compromising tree health.

Materials and Methods

The present experiment entitled, "Response of Soil Applied Paclobutrazol for Enhancing Vegetative and Reproductive Growth in Kesar Mango (*Mangifera indica* L.) was conducted in experimental cum research mango orchard, Department of Horticulture, College of Agriculture, Latur during the year 2023-24. The experiment was carried out on factorial randomized block design with two factors: First factor was concentration of paclobutrazol (C₁:1 ml a.i./ m², C₂:1.5 ml a.i./m² and C₃:2 ml a.i./m²) and Second factor is time of application of paclobutrazol on (M₁:15th July, M₂:1st August and M₃: 15th August) experiment having a three replications. The treatment combinations were soil application of paclobutrazol at T1: 15th July + PBZ 1ml a.i./m² (C₁M₁), T2: 1 August + PBZ 1ml a.i./m² (C₁M₂), T3: 15th August + PBZ 1ml a.i./m (C₁M₃), T4: 15th July + PBZ 1.5ml a.i./m² (C₂M₁), T5: 1 August + PBZ 1.5ml a.i./m² (C₂M₂), T6:15th August + PBZ 1.5ml a.i./m² (C₂M₃), T7: 15th July + PBZ 2ml a.i./m² (C₃M₁), T8: 1 August + PBZ 2ml a.i./m² (C₃M₂) and T9: 15th August + PBZ 2ml a.i./m² (C₃M₃). The treatments were applied as per the plan and observation on vegetative, flowering, yield and quality parameters were recorded.

Paclobutrazol (PBZ) was applied as a single soil application. The required quantity of paclobutrazol 23% active ingredients was dissolved in 5 liter of water and prepared solution was poured in the ring 1 m from tree trunk as per recommendation. Observations were recorded in respect to shoot length, internodal length, length of panicle and number of panicle per tree manually counted and recorded. For the calculation of days taken to flowering bud initiation, it was counted from cut off date 1st October to date of

appearance of two or three newly emerging flowering bud and average value was worked out.

Results and Discussion

Table 1: Effect of dose and time of application of paclobutrazol on shoot length and internodal length of mango Cv. Kesar

Treatments	Shoot Length (cm)	Internodal Length (cm)
Concentration of paclobutrazol (C)		
C ₁	11.92	2.69
C ₂	11.14	2.24
C ₃	10.28	2.17
S.E ±	0.313	0.156
C. D. at 5%	0.938	0.50
Time of Application (M)		
M ₁	9.77	2.42
M ₂	11.22	2.39
M ₃	12.35	2.29
S.E ±	0.313	0.156
C. D. at 5%	0.938	0.50
Interaction (C×M)		
C ₁ M ₁	10.39	2.86
C ₁ M ₂	12.20	2.81
C ₁ M ₃	13.16	2.40
C ₂ M ₁	9.11	2.21
C ₂ M ₂	11.19	2.30
C ₂ M ₃	13.12	2.20
C ₃ M ₁	9.81	2.19
C ₃ M ₂	10.26	2.07
C ₃ M ₃	10.77	2.26
S.E ±	0.54	0.27
C. D. at 5%	NS	NS
General Mean	11.11	2.37
Treatment details		
C ₁ -1 ml a.i./m ² PBZ	M ₁ -15 th July	
C ₂ -1.5 ml a.i./m ² PBZ	M ₂ -1 st August	
C ₃ -2 ml a.i./m ² PBZ	M ₃ -15 th August	

Shoot length (cm)

Effect of dose (C)

The shoot length of mango was significantly reduced by paclobutrazol application. The shoot length (10.28 cm) was recorded minimum with the dose of paclobutrazol @ 2 ml a.i. (C₃) which was at par (11.14 cm) with the dose of paclobutrazol @ 1.5 ml a.i. (C₂) and maximum shoot length (11.92 cm) was obtained with the dose of paclobutrazol @ 1 ml a.i. (C₁) respectively. Paclobutrazol can enhance the total phenolic content in terminal buds and alter the phloem to xylem ratio in the stem which is crucial for restricting vegetative growth and promoting flowering by modifying assimilate partitioning and nutrient supply patterns for new growth. PBZ could also induce flowering in mango trees because it reduced vegetative growth. The involvement of the GA in mango was also demonstrated by Yamashita *et al.* 1997, who reported that GA acts as a flowering inhibitor. Similar results were observed by Kulkarni (1988) [8] in the Banganapalli, Dashehari and Peddarasam cultivars, Reddy and Kurian and (2008) [15].

Effect of time (M)

The data revealed that the variation in shoot length was found significant. The shoot length of mango was significantly reduced by different time of paclobutrazol application. Minimum shoot length (9.77 cm) was noted at application of paclobutrazol on 15th July (M₁) which was at par (11.22 cm) noted with the application of paclobutrazol

on 1st August (M₂) and maximum shoot length (12.35 cm) was recorded at the application of paclobutrazol on 15th August (M₃) respectively. Paclobutrazol is a plant growth regulator that inhibits gibberellin biosynthesis, when paclobutrazol is applied it interferes with the normal production of gibberellins leading to reduced cell elongation and consequently shorter shoot length. Same result found by with the earlier findings of paclobutrazol influence on shoot growth of mango by Ram & Tripathi (1993) ^[14], Chavan (2023) ^[2] and Gohel *et al.* (2021) ^[5] in kesar mango.

Interaction Effect (M x C)

The interaction effect of time and dose of paclobutrazol application on shoot length were found non-significant.

Internodal Length (cm)

Effect of dose (C)

The internodal length significantly reduced by the paclobutrazol application. The internode length (2.17 cm) was recorded minimum with the dose of paclobutrazol application @ 2 ml a.i. (C₃) and maximum length of internode (2.69 cm) was obtained with the dose of paclobutrazol application @ 1 ml a.i. (C₁). Paclobutrazol act as a plant growth regulator that primarily functions by inhibiting gibberellin biosynthesis hormone responsible for promoting cell elongation and plant growth. When

paclobutrazol is applied to plants it slows down vegetative growth leading to shorter more compact plants with smaller leaves and reduced internode lengths. This observation is in agreement with the earlier findings of Khader (1991) ^[7] in dashaheri mango, Salazar-garcia and Vazquez-valdivia (1997) ^[16] in Tommy Atkins mango.

Effect of time (M)

Minimum internodal length (2.29 cm) was noted at application of paclobutrazol on 15th August (M₃) which was at par (2.39 cm) noted at the application on 1st August (M₂) and maximum internodal length (2.42 cm) was recorded at application of paclobutrazol on 15th July (M₁). Paclobutrazol is a plant growth regulator that inhibits gibberellin biosynthesis leading to reduced stem elongation and shorter internodal lengths. Paclobutrazol works by inhibiting the synthesis of gibberellins. A group of plant hormones responsible for promoting cell elongation and division. This results in reduced cell elongation. This observation are in agreement with the earlier findings of paclobutrazol influence on shoot growth of mango Ram and Tripathi (1993) ^[14] and Reddy and Kurian (2008) ^[15].

Interaction Effect (M x C)

The interaction effect of time and dose of paclobutrazol application on internodal length were found non-significant.

Table 2: Effect of dose and time of application of paclobutrazol on Days of panicle emergence, Number of panicle per tree and Length of panicle (cm)

Treatments	Days of panicle emergence	Number of panicle per tree	Length of panicle (cm)
Concentration of paclobutrazol			
C ₁	51.12	516.13	27.99
C ₂	52.73	564.90	29.47
C ₃	46.89	621.68	31.63
S.E ±	1.06	18.49	0.81
C. D. at 5%	3.203	55.4	2.45
Time of Application			
M ₁	46.63	618.68	34.69
M ₂	49.33	552.85	27.88
M ₃	54.77	531.18	26.52
S.E ±	1.06	18.49	0.81
C. D. at 5%	3.203	55.4	2.45
Interaction (C×M)			
C ₁ M ₁	48.13	541.65	29.73
C ₁ M ₂	48.77	522.71	27.66
C ₁ M ₃	56.45	484.02	26.59
C ₂ M ₁	46.70	634.83	36.01
C ₂ M ₂	52.53	536.92	26.92
C ₂ M ₃	58.95	522.96	25.46
C ₃ M ₁	45.04	679.56	38.32
C ₃ M ₂	46.70	598.93	29.05
C ₃ M ₃	48.91	586.56	27.51
S.E ±	1.85	32.04	1.42
C. D. at 5%	5.55	NS	NS
General Mean	50.24	567.57	29.60
Treatment details			
C ₁ -1 ml a.i/m ² PBZ		M ₁ -15 th July	
C ₂ -1.5 ml a.i/m ² PBZ		M ₂ -1 st August	
C ₃ -2 ml a.i/m ² PBZ		M ₃ -15 th August	

Days of panicle emergence

Effect of dose (C)

The days of panicle emergence of mango was significantly reduced by paclobutrazol application however, the effect was more pronounced in the higher concentrations than the lower concentration. Days of panicle emergence (46.89) was

recorded minimum with the dose of paclobutrazol @ 2 ml a.i. (C₃) which was at par (51.12) recorded with the dose of paclobutrazol @ 1 ml a.i. (C₁) and maximum days of panicle emergence (52.73) was obtained with the dose of paclobutrazol @ 1.5 ml a.i. (C₂). All the available evidence opined that carbohydrate reserves played an important role

in flower bud differentiation and they provide conditions favorable for the synthesis of substances which are required for flower bud differentiation. The high C:N ratio during flower bud differentiation was ascribed to the increased carbohydrate availability and considered as an important factor in regulation of flowering in fruit crops. This finding is similar to Gohel *et al.*, (2021) [5] in kesar mango and Sarker and Rahim (2012) [17], where paclobutrazol induced flowering 85 days after treatment application. The total activity of auxin-like substances increased the higher starch reserve, total carbohydrates and higher C: N ratio in the shoots favour flower bud initiation in mango (Jogdande and Choudhari (2001) [6].

Effect of time (M)

Minimum days required for the panicle emergence (46.33) was noted at application of paclobutrazol on 15th July (M₁) however maximum days required for the panicle emergence (54.77) was recorded at application of paclobutrazol on 15th August (M₃). The application of paclobutrazol in mid-July suppressed vegetative growth and induced early and profuse flowering during the investigation. In other words the flower inductive cycle which is part of the phenological and physiological cycle of the Mango tree may commence earlier in the season but flowering is delayed by the inhibitor until sufficient promoter builds up to counteract the inhibitor. Paclobutrazol appears to help achieve this stage much earlier due to its inhibitory activity. This hypothesis is particularly compelling when considering the flower-inhibitory role of gibberellins in trees and the anti-gibberellin activity of paclobutrazol as observed by Kulkarni (1988) [8] and Padhiar (1999) [10] in mango. The results of the present investigation showed that paclobutrazol induced early flowering, advanced fruit maturity and provided opportunities for the commercial advantages of early-season marketing. These findings are consistent with the results obtained by Kulkarni (1988) [8] in mango, Sarker and Rahim (2018) [18] in Amrapali, Chavan (2023) [2] and Gohel *et al.* (2021) [5] in Kesar mango.

Interaction Effect (M x C)

The data showed that minimum days of panicle emergence was recorded in the treatment combination of C₃M₁ (45.04) which was at par with treatment C₂M₁ and C₃M₂ (46.70) and maximum number of days required for panicle emergence recorded in the treatment combination of C₂M₃ (58.95). These findings are consistent with the results obtained by Sarker and Rahim (2018) [18] in Amrapali, Chavan (2023) [2] in Kesar mango and Gohel *et al.* (2021) [5] in Kesar mango.

Number of panicle per tree

Effect of dose (C)

The effect of different dose of paclobutrazol on number of panicle per tree was found significant. Number of panicle per tree (621.68) was recorded maximum with the dose of paclobutrazol @ 2 ml a.i. (C₃) which was at par (564.90) with the dose of paclobutrazol @1.5 ml a.i. (C₂) and minimum number of panicle per tree (516.13) was obtained with the dose of paclobutrazol @1 ml a.i. (C₁). Yeshitela *et al.* (2004) [20] reported that increased number of panicles for paclobutrazol treated plants is due to lower expenditure of tree reserves to the vegetative growth parameters and consequently no assimilates limitations, compared with an excessive vegetative growth in the control trees. This

observation are in agreement with the earlier findings of paclobutrazol influence on the days of panicle emergence Burondkar and Gunjate (1993) [1], Chavan (2023) [2] and Gohel *et al.*, (2021) [5] in Kesar mango.

Effect of time (M)

Maximum number of panicle per tree (618.68) was recorded at application of paclobutrazol on 15th July (M₁) which was at par (552.85) was noted at application of paclobutrazol on 1st August (M₂) and minimum number of panicle per tree (531.18) was noted at application of paclobutrazol on 15th August (M₃). Paclobutrazol known to decrease vegetative growth rate through early cessation of growth which results in the accumulation of carbohydrates in trees and slightly decreasing the total nitrogen in the terminal shoots which favours flowering by maintaining high C: N ratio in the shoots.

Interaction Effect (M x C)

The interaction effect of time and dose of paclobutrazol application on number of panicle per tree were also found non-significant.

Length of panicle (cm)

Effect of dose (C)

The effect of different dose of paclobutrazol on length of panicle was found significant. The length of panicle of mango was significantly increased by paclobutrazol application however, Maximum length of panicle (31.63 cm) was obtained with the dose of paclobutrazol @ 2 ml a.i. (C₃) which was at par (29.47 cm) was recorded with the dose of paclobutrazol @ 1.5 ml a.i. (C₂) and minimum length of panicle (27.99 cm) was obtained with the dose of paclobutrazol @ 1 ml a.i. (C₁). This observation are in agreement with the earlier findings of paclobutrazol influence on the length of panicle by Desai and Chundawat, (1994) and Sarker and Rahim (2018) [18] in Amrapali.

Effect of time (M)

The data revealed that the variation in length of panicle was found significant as influenced by different time of paclobutrazol application. Maximum length of panicle (34.69) was recorded at application of paclobutrazol on 15th July (M₁) which was at par (27.88) was noted at application of paclobutrazol on 1st August (M₂) and minimum length of panicle (26.52) was noted at application of paclobutrazol on 15th August (M₃) respectively. This observation is in agreement with the earlier findings of paclobutrazol influence on the length of panicle by Ram and Tripathi (1993) [14], Sarker and Rahim (2018) [18] in Amrapali Gohel *et al.* (2021) [5] and Chavan (2023) [2] in Kesar.

Interaction Effect (M X C)

Meanwhile, the interaction between different time and dose of paclobutrazol application on length of panicle was found non-significant.

Conclusion

The present investigation, based on Response of soil applied paclobutrazol for enhancing vegetative and reproductive growth in Kesar mango (*Mangifera indica* L.), led to the following conclusions: Treatment with a concentration of paclobutrazol at 2 ml a.i per meter of canopy diameter had a significant positive impact on vegetative parameters and

flower parameters of mango. The application of paclobutrazol on July 15th was found to have the most beneficial effects on vegetative parameters as well as flower parameters of mango. The interaction effect of paclobutrazol applied at 2 ml per meter of canopy diameter on July 15th was the most effective in achieving early emergence of panicles.

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