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Paclobutrazol – A mileage for mango production

Paclobutrazol is considered as one of the most potential plant growth retardant which restricts vegetative growth, inhibits gibberellin biosynthesis, induce flowering and control biennial bearing in mango. It has been characterized as an environmentally stable compound in soil with half-life of more than one year under different conditions. However, when it is applied at an optimized rate, the residual level detected will not be above the quantifiable level in soil and fruits. The main objective of the article is to provide contemporary information about paclobutrazol in mango production and its risk assessment.

BIENNIAL bearing is one of the most serious issues with mango and one of the most significant barriers to increasing production. In the biennial years, the yield varies greatly, with the year of optimum or heavy fruiting (on year) being followed by a year of little or no fruiting (off year). There are numerous mango varieties, but only a few are commercially important. Since a specific variety of mango is not expected to perform equally well under different sets of climatic factors, each region of the country has its own commercial varieties. The majority of commercial varieties in the country, such as Alphonso, Dashehari, Langra, Chausa, Bombay Green, and Lucknow Safeda, are biennial bearers; however, their cultivation is critical to the economies of the respective regions.

Some of the causes of biennial bearing in mango are excessive vegetative growth, high gibberellin synthesis, an imbalance of C/N ratio at the time of flower bud genesis, and heavy fruiting in one year causing nutritional deficiency in the following fruiting year. Slowing vegetative growth, reducing gibberellin biosynthesis, providing adequate nutrition, and bringing the C/N ratio to the level at which flower bud differentiaties are all necessary steps in increasing the tree's reproductive performance. The majority of these properties are shared by paclobutrazol, a growth retardant and this issue has been addressed through soil application of this chemical.

Paclobutrazol is effective not only for flower induction but also for early and off-season flower induction in mango, as well as for canopy volume reduction. Paclobutrazol's action is heavily influenced by the rate of administration as well as the surrounding environment. However, the slow mobility and hazardous nature of the vehicle raise legitimate concerns about its long-term use.

Paclobutrazol application

Flowering in 'off' year by paclobutrazol

Fruiting in paclobutrazol treated tree

Mode of application

When applied to the soil at a rate of 4g a.i. per tree, this chemical is effective in controlling biennial bearing. The dose is calculated based on the tree canopy, and soil drenching at 3.2 ml per metre canopy diameter is very effective in controlling biennial bearing and increasing yield. Apply paclobutrazol to the tree basin soil during the last week of September to the first week of October by digging a 15 cm deep and 30 cm wide furrow at a radial diameter of 1.0-1.5 m from the tree trunk. The required dose of paclobutrazol is mixed with 10 liters of water and applied in furrow by line pouring method to maintain uniformity during application. Apply paclobutrazol in two rings around the trunk at the same distance in radial diameter and with the same concentration when the tree is old and has a large canopy area. Although foliar application is possible, soil application is more effective. Where mango performance is heavily influenced by climatic fluctuations such as frequent and untimely rain, staggered flowering and fruiting, especially in the Konkan region, foliar application is generally effective.

Paclobutrazol has been shown to be effective in regulating physiological and agronomical traits in mango, and it can be used to effectively regulate flowering, yield, and quality.

Vegetative and reproductive growth

Vegetative growth in mango is through cyclic flushing. The flushing is more frequent as temperature increases. Episodic or recurrent flushing is common in subtropical and tropical regions. The timing of flush development is important for successful flowering and fruiting because bud release, for vegetative or reproductive growth, can only occur from mature flush. However, the paclobutrazol treatments which reduce vegetative vigour manipulate the timing of flush development may help in bud release around the time of inductive temperatures. The production of vegetative shoots in place of reproductive shoots is due to the elevated level of gibberellin which is considered as a vegetative promoter. Paclobutrazol, a gibberellin inhibitor, reduces level of vegetative promoter and stimulates flowering in inductive shoots. Moreover, fruit load may nullify the inductive effects of paclobutrazol. There are different fruit load value in different cultivars, above which paclobutrazol is ineffective.

Hormonal relationship of paclobutrazol associated with floral induction

There are some evidences that the indigenous hormonal level, GA in particular, regulates floral initiation in mango. The concentration of GA in terminal bud decreased prior to panicle emergence in trees that flowered and increased during the same period in trees that remained vegetative. This suggests that GA plays a direct inhibitory role in mango floral initiation. Our recent study clearly demonstrated that paclobutrazol treatment reduces the concentration of various forms of GA (GA4, GA3, GA7, and GA1) content in both leaves and buds, with buds being more sensitive to paclobutrazol treatment. Paclobutrazol, in addition to affecting gibberellins, increases ABA and cytokinin contents in mango buds, as well as the C: N ratio and leaf water potential, in order to elicit flowering responses.

Root activity and nutrient dynamics

In paclobutrazol-treated mango, there is a significant increase in root activity towards the trunk and close to the soil surface, but less root activity in the subsoil zone. Paclobutrazol has an inhibitory effect on soil nutrient status and microbial population at higher concentrations. The effect of paclobutrazol on leaf nutrient content is inconsistent, as it varies with crop geometry and soil conditions.

Off-season flowering and fruiting

Paclobutrazol is the most widely used chemical for commercial off-season flower induction and fruit production in many mango growing areas, whereas early flower induction in the subtropics is possible but has no commercial value due to flower initiation when temperature regimes are not suitable for fruit development. Where paclobutrazol can successfully induce early crop, precise cultural operations are required to support advanced fruit harvesting and warrant induction of vegetative shoots for their sustainable conversion to flowering shoots to bear regularly.

Compaction of panicle by higher dose of paclobutrazol

Flowering in paclobutrazol treated tree

Residual effect and risk assessment of paclobutrazol

Long term effect on plant growth

Paclobutrazol is a persistent plant growth regulator with a long history of prolonged persistence in soil and primarily translocated in the xylem through the stems and accumulated in the leaves. However no basipetal movement is reported. PBZ exhibits differential genotypic effect in mango as residue persist in soil of Dashehari orchard could regulates the fruiting with its half dose in the second year. Increasing dose of PBZ application in mango caused reduction in length of new shoots produced. Reduction of root hydraulic conductivity, alteration in nutrient uptake and morphological alteration in young roots and shoots are observed after PBZ treatment.

Residual effect on fruits

Higher persistence in soil does not match with its residue level in mango fruits which might be due to the biodegradation of PBZ or decreased hydraulic conductivity of leaves and thereby reducing its translocation to fruits. Its residue was detected in unripe mango fruits (cv. Dashehari) below its MRL value of 0.5 mg/kg, the same was not found in fully mature fruit and its pulp. Use of paclobutrazol in mango continuously at recommended doses may not result in its residues in mango fruits at harvest at levels which may pose any risk to human health. However, in areas where paclobutrazol is applied regularly, there may be risk of environmental contamination due to its residues persisting in soil for a very long time.

Degradation and persistence in orchard soil

In India, PBZ has been reported persistent from 210 to 300 days in mango orchard soil of different locations. In Southern India, PBZ has been found persistent up to 210 days in 0-15 cm soil layer after its application at 5 and 10g a.i./tree. Prolonged persistence of PBZ in mango orchard soil up to 3 years was also observed from the highest dose (1.0 mg/kg at 8 g a.i./tree), which was found sufficient for inducing flowering in Dashehari and discontinuation of its application or lowering the dose in subsequent year was suggested. Paclobutrazol has a history of prolonged persistence in soil which makes it susceptible for microbial degradation. A microbial consortium having *Pseudomonas* sp. was found effective in degrading PBZ.

Precautions

1. Wear gloves and a mask over your mouth when using paclobutrazol. Smoking and eating should be avoided while using paclobutrazol.
2. Paclobutrazol has the potential to cause minor skin and eye irritation. After use, thoroughly rinse the skin and eyes with water.
3. Because treated soil is likely to be washed away by rainfall or irrigation runoff, extreme caution should be exercised when applying soil, particularly in orchards located in sloppy areas. Extreme caution should be exercised in such areas to prevent contaminated soil from eroding into bodies of water. Furthermore, in such cases, terracing and bunds may be an effective approach.
4. Do not pollute water sources with empty cans of paclobutrazol that have been left out after use.
5. Excessive paclobutrazol use can harm mango orchard soil health, particularly the fauna and flora found in this ecosystem, resulting in low quality fruit production.
6. Paclobutrazol has a remote chance of contaminating the environment due to its low mobility and high persistence, but the risk cannot be completely eliminated. To significantly reduce residue threats, it is recommended that the optimal dose be used at the appropriate time, and that the amount of paclobutrazol applied the following year be based on the residue available in orchard soil.
7. Increased paclobutrazol concentrations cause panicle compaction, which creates ideal conditions for disease and pests while also complicating phytosanitary control.

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