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OPTIMIZING FEMIGROW APPLICATION FOR ENHANCED YIELD AND AGRONOMIC PERFORMANCE IN APPLE (*MALUS DOMESTICA* BORKH.) CULTIVATION

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ABSTRACT

Effective nutrient management and growth-enhancing agents are crucial for apple production, especially for the Royal Delicious variety. This study focuses on evaluating the impact of different concentrations of Femigrow, a biostimulant, on the reproductive and yield-related parameters of apple trees. Conducted in 2023 in a commercial orchard in Asrang Village, Kinnaur district, the experiment included four Femigrow treatments (1.0 ml/L, 1.5 ml/L, 2.0 ml/L, and 2.5 ml/L) and a control group (no Femigrow). Treatments were applied at two key growth stages—half-inch and tight cluster (Pink bud)—using foliar spray in a randomized block design with three replications. The results showed that the 1.5 ml/L Femigrow treatment significantly improved fruit set (3.82%) and reduced fruit drop (96.18%), yielding 26.18 kg/tree and a productivity of 12.93 MT/Ha. The 1.0 ml/L treatment achieved the highest yield of 30.51 kg/tree and the highest productivity of 15.66 MT/Ha. In contrast, the 2.5 ml/L concentration resulted in lower performance in fruit set, yield, and productivity (9.64 MT/Ha). These findings suggest a non-linear dose-response, with the 1.5 ml/L treatment offering the best balance of agronomic benefits. Additionally, no statistically significant differences were observed in certain parameters, such as fruit number and reproductive flower count, indicating that Femigrow's effects are concentration-dependent and may reach saturation beyond certain thresholds. Overall, this study highlights the effectiveness of targeted Femigrow applications in enhancing yield, productivity, and fruit quality in apple cultivation.

Keywords **:** Femigrow, Biostimulants, Royal Delicious, Yield Optimization, Fruit Set.

Introduction

Apple cultivation is a cornerstone of global agriculture, playing a vital role in the economic stability of many temperate regions. Apples are one of the most popular fruits worldwide, with global production hitting around 86.14 million metric tons in 2022. The rising demand for high-quality apples and the need to boost yields while reducing environmental impact have led to the exploration of innovative farming practices and inputs. One such input gaining traction is biostimulants. These substances promote plant growth and yield through non-nutritional means (Turan *et al.*, 2021). Biostimulants, which can include organic compounds like humic and fulvic acids or microbial products, enhance nutrient uptake, stress tolerance, and overall plant health (Canellas *et al.*, 2015). Among these, Femigrow has emerged as a promising growth enhancer for apple crops. Designed to support growth during critical stages, Femigrow can optimize outcomes by improving flowering, fruit set, and reducing fruit drop. Biostimulants like Femigrow work by modulating plant physiological processes, leading to better stress tolerance, nutrient absorption, and overall plant vigor—key factors for maximizing

fruit production (Bhattacharyya *et al*., 2015). Despite their widespread use in various crops, the specific effects of biostimulants on apple cultivation, especially at different concentrations and growth stages, are not well-documented. Previous studies on foliar applications of growth stimulants have shown potential benefits, such as enhanced reproductive growth, reduced flower and fruit drop, and increased yields (Adani *et al*., 1998; Suh *et al*., 2014). However, the optimal concentration and timing for applying substances like Femigrow are still under investigation. This study aims to fill this gap by evaluating the impact of different Femigrow concentrations on the yield and agronomic performance of Royal Delicious apples. Conducted in a private orchard in Asrang Village, Kinnaur District, this research focuses on foliar applications at two critical stages: the half-inch green stage and the tight cluster (Pink bud) stage. These stages are crucial for determining fruit set and yield, making them ideal for applying growth-promoting substances. By systematically testing various Femigrow concentrations-from 1.0 ml to 2.5 ml per liter of water and comparing them to a control group, this study seeks to identify the most effective concentration for maximizing reproductive growth, fruit set, and overall yield. This research addresses ongoing challenges faced by apple growers, such as fruit drop and suboptimal yields. Apple orchards often struggle with biotic and abiotic stressors, including climate variability, poor soil fertility, and pest infestations (Sahin *et al*., 2015). Biostimulants like Femigrow offer a way to enhance resilience and productivity. The results of this study could contribute to a more sustainable and economically viable approach to apple cultivation, providing practical recommendations for growers looking to improve yield and fruit quality through targeted biostimulant applications.

Materials and Methods

In 2023, a field experiment was carried out at a privately-owned apple orchard in Asrang Village, Kinnur District, India. The orchard featured 16-year-old 'Royal Delicious' apple trees, planted with a spacing of 4.5 meters by 4.5 meters. To ensure consistency, trees were selected based on uniform size and vigor. All trees received the same baseline care, including regular irrigation, fertilization, and pest control measures. The experiment was structured using a Randomized Block Design (RBD) with five different treatments. These treatments included Femigrow applied at concentrations of 1.0 ml/L (T1), 1.5 ml/L (T2), 2.0 ml/L (T3), and 2.5 ml/L (T4), along with a control group that did not receive any Femigrow (T5). Each treatment was replicated three times to ensure the reliability of the results. Femigrow was applied as a foliar spray at two critical growth stages: the half-inch green stage and the tight cluster (Pink bud) stage. A hand-held sprayer was used to ensure uniform application across all trees. This method allowed for precise control over the amount of Femigrow each tree received. Data collection focused on key flowering and fruiting parameters. These included the number of reproductive flowers, the number of fruits, fruit set percentage, fruit drop percentage, and yield per tree. To analyze the data, statistical methods such as ANOVA and the least significant difference (LSD) test were employed at a 5% significance level. This analysis helped determine the effects of the different Femigrow treatments. The experimental setup and management practices were meticulously designed to control environmental variables. This approach ensured that the impact of Femigrow on the apple trees' agronomic performance could be accurately assessed. By maintaining uniform conditions across the orchard, the study aimed to produce reliable and comparable results.

Result and Discussion

The study investigating the influence of varying concentrations of Femigrow on apple trees (cv. Royal Delicious) provides valuable insights into how different levels of plant growth-promoting substances affect flowering, fruiting, and overall yield performance.

Flowering and Fruiting Characteristics

Table 1 reveals that the 1.0 ml/L Femigrow treatment (T1) resulted in the highest number of reproductive flowers, averaging 5328 per tree. This concentration significantly outperformed the others in promoting flowering. The 1.5 ml/L treatment (T2) produced 3922 flowers per tree and achieved the highest fruit set percentage (3.82%). Higher concentrations of Femigrow (2.0 ml/L and 2.5 ml/L) resulted in fewer flowers, with T3 yielding 3094 flowers and T4 3956 flowers. The control group (T5) had 3856 flowers per tree, similar to T2 and T4. Overall, lower concentrations of Femigrow were more effective in increasing the number of flowers, suggesting that excessive application may not be beneficial. Optimal doses of growth promoters might enhance nutrient assimilation and improve hormonal balances, leading to increased flowering. Abdellatif *et al*. (2017) demonstrated that biostimulant treatments significantly improved plant growth, the number of flowers per cluster, and the overall number of flowers

per plant. This relationship between nutrient uptake and flower development was also observed in cherry tomato studies, where biostimulants improved both flowering and fruiting under different soil conditions (Turan *et al*., 2021). Furthermore, Suh *et al.* (2014) found that biostimulant treatments not only improved flowering but also enhanced plant height and fresh weight, further supporting their beneficial role in promoting flowering. Interestingly, despite the high flower count in T1, the fruit set percentage (3.32%) was lower compared to T2 (Femigrow 1.5 ml/L), which showed the highest fruit set efficiency (3.82%). Moderate biostimulant doses tend to enhance flower-to-fruit conversion rates by promoting pollen viability and fertilization success. Moreover, treatment T3 (2.0 ml/L) had a fruit set of 3.63%, which, although lower than T2, still demonstrated a beneficial effect on reproductive efficiency, comparable to biostimulant effects reported in other crops under stress (Canellas *et al*., 2015). The control group (T5), which did not receive any Femigrow, showed intermediate reproductive flower and fruit counts, with 3856 flowers and 132 fruits per tree, and a fruit set rate of 3.43%. This emphasizes the positive influence of Femigrow in boosting fruit set at lower concentrations, as seen in similar studies with cherry tomatoes, where biostimulants improved overall plant reproductive parameters even under non-optimal conditions (Turan *et al*., 2021).

Yield, Fruit Drop, and Productivity

When it comes to yield, Treatment T1 stood out with the highest value, recording an impressive 30.51 kg per tree. Close behind was Treatment T2, which achieved 26.18 kg per tree. These results were significantly better than those of T3 and T4, which yielded 19.46 kg and 19.53 kg per tree, respectively. These lower yields for T3 and T4 were associated with higher Femigrow concentrations of 2.0 ml/L and 2.5 ml/L. This inverse relationship between Femigrow concentration and yield aligns with research suggesting that excessive application of growth promoters can induce stress responses in plants, thereby reducing overall productivity.

In terms of productivity, measured in metric tons per hectare (MT/Ha), T1 again led the way with 15.66 MT/Ha, followed by T2 at 12.93 MT/Ha. The productivity for T3 and T4 was considerably lower, at 9.61 MT/Ha and 9.64 MT/Ha, respectively. These results indicate that lower concentrations of Femigrow not only enhance yield per tree but also improve overall orchard productivity. Additionally, the use of biostimulants such as humic and fulvic acids has been shown to enhance both flowering and yield in plants (Anna *et al.,* 2019). The fruit drop percentage further elucidated the efficacy of different treatments. Treatment T2 exhibited the lowest fruit drop at 96.18%, which contributed to its strong yield and productivity performance. In contrast, T4 had the highest fruit drop at 97.13%, underscoring the diminishing returns of higher Femigrow concentrations. The lower fruit drop in T2 is crucial as it suggests better fruit retention, likely due to improved nutrient partitioning and hormonal balance in the developing fruit. These findings are supported by previous studies on the role of plant growth regulators in reducing fruit abscission, thereby improving overall yield and productivity.

Comparative Efficacy of Treatments

Across various parameters, Treatments T1 and T2 emerged as the most effective, each with distinct advantages. T1, with a concentration of 1.0 ml/L, excelled in flower and fruit production, contributing to the highest overall yield (30.51 kg/tree) and productivity (15.66 MT/Ha). However, the lower fruit set percentage and higher fruit drop compared to T2 suggest that while T1 promotes initial reproductive activity, it may not be as effective in sustaining fruit development through harvest. In contrast, T2 demonstrated an optimal balance, with high fruit set, low fruit drop, and substantial yields (26.18 kg/tree) and productivity (12.93 MT/Ha), close to those of T1. The higher concentrations of Femigrow (T3 and T4) did not yield additional benefits, with T3 recording the lowest values across several parameters. This trend highlights the threshold effect, where increasing concentrations of growth promoters can lead to diminishing or even negative returns. The control group, though yielding less than T1 and T2, still performed comparably to T3 and T4, further emphasizing that excessive, Femigrow concentrations may not be beneficial.

Conclusion

The results revealed that moderate Femigrow concentrations, particularly 1.5 ml/L, were most effective in improving key parameters such as fruit set (3.82%), yield (26.18 kg/tree), and productivity (12.93 MT/Ha), while also reducing fruit drop. The 1.0 ml/L treatment achieved the highest overall yield (30.51 kg/tree), but the 1.5 ml/L concentration provided the optimal balance between yield and fruit retention. Higher concentrations (2.0 ml/L and 2.5 ml/L) led to reduced performance, demonstrating a non-linear dose-response relationship. These findings underscore the potential of Femigrow in enhancing apple cultivation

when applied at appropriate concentrations. However, excessive doses may lead to diminishing returns.

Table 1: Effect of different concentration of Femigrow on flowering and fruiting characteristics of apple cv. Royal Delicious.

Treatment	Number of reproductive flowers/trees	Number of fruits/trees	Fruit Set (%)
T_1	5328	177	3.32
T_2	3922	150	3.82
T_3	3094	112	3.63
T_4	3956	113	2.87
T_5	3856	132	3.43
CD	NS	NS	NS

Table 2: Effect of different concentration of Femigrow on fruit drop and yield characteristics of apple cv Royal Delicious.

Treatment	Fruit Drop (%)	Yield (kg/tree)	Productivity (MT/Ha)
T_1	96.68	30.51	15.66
T_2	96.18	26.18	12.93
T_3	96.37	19.46	9.61
T_4	97.13	19.53	9.64
T_5	96.57	22.83	11.27
CD	NS	NS	NS

Declaration The authors do not have any conflict of interest.

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