H4BEES Boosting Bees Resilience & Performance

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H4BEES is an Israeli agri-technology company developing a nano-science-based nutritional supplement designed to strengthen honeybee colonies, improve resilience to stress, and increase both pollination efficiency and honey yield.

H4BEES produces a nano-micronutrient bee feed complex, Nano-B-Feed™, formulated to enhance bees' natural immune defenses and overall colony strength. The product is designed to be attractive to bees, easy to apply (spoon-full product at the entrance to the hive), and adaptable to different stressors and bee species. The product combines mineral, organic, and pheromonal components delivered via a sugar-based carrier to improve bioavailability and distribution through trophallaxis.

Key Features of the H4BEES Products Include:

- **Natural ingredients**, including minerals, organic nano-elements and pheromones
- Patent-pending intellectual property
- Licensing by the Israeli Ministry of Agriculture and Food Security
- **Registered by FDA**
- **HACCP-compliant manufacturing**
- **Ingredients classified as Generally Regarded As Safe (GRAS)**

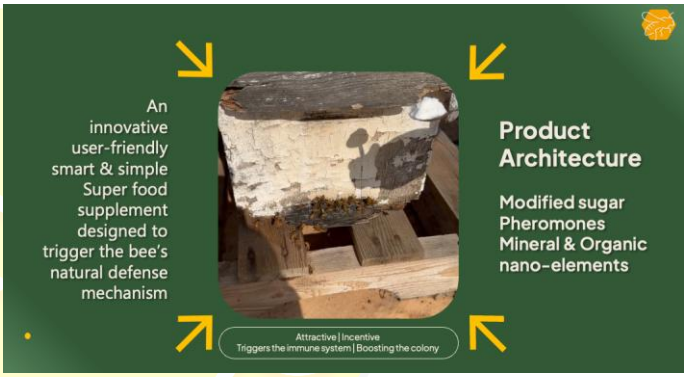
By strengthening colonies at a biological level, Nano-B-Feed™ enables improved survival under stress, stronger pollination activity, and higher honey yield, aligning beekeeper profitability with agricultural productivity.

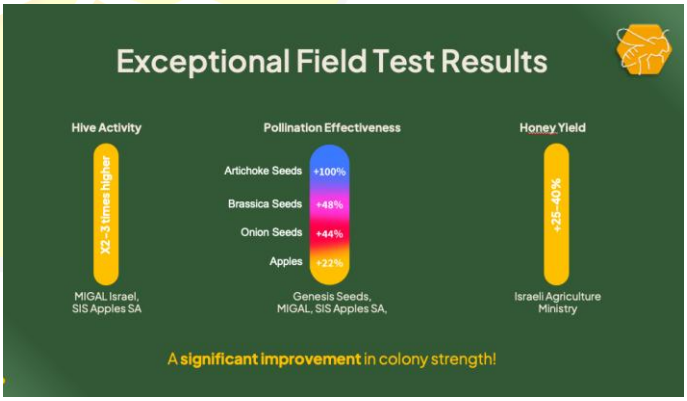
Field Validation and Performance

H4BEES products have been evaluated in multiple field trials across different crops and geographies, demonstrating consistent improvements in colony strength and pollination effectiveness. The evaluation was carried out with leading academic institutes and commercial beekeepers and farmers.

These Field Tests are Described in the Following Report:

1. Almonds
2. Apples
3. Avocado
4. Cashew & Honey
5. Coffee
6. Artichoke seed Production
7. Cotton Seed production
8. Honey Production
9. Colony Resistance to Cold
10. Colony Resistance to Neonicotinoids





1. *H4BEES in Almonds*

Evaluation of Nano-B-Feed™, on Honeybee Activity, Fruit Set, and Total Fruit Yield in Almond Orchards

Abstract

Honeybee pollination is essential for almond (Prunus dulcis) production, yet colony performance during bloom is often compromised by environmental stressors and pesticide exposure. This study was done in collaboration with Dr. Michal Ackerman-Lavert who is a Senior Researcher at Northern Agriculture R&D of Israel. The aim of the study was to evaluate the effects of Nano-B-feed™ on honeybee activity, fruit set, yield, and colony resilience in a commercial almond orchard in the Yavniel Valley, Israel. Treated colonies exhibited enhanced foraging activity, a 28% increase in fruit set, and a 34% increase in total yield compared with untreated controls. Treated hives also demonstrated improved resilience to pesticide exposure events. These results indicate that Nano-B-Feed™ is an effective intervention to improve pollination efficiency, orchard productivity, and colony health under commercial growing conditions.

Introduction

Almond orchards rely heavily on managed honeybee (Apis mellifera) pollination to achieve optimal fruit set and yield. Almond bloom occurs early in the season, when colonies may be weakened by winter stress, limited nutrition, low temperatures, and exposure to agrochemicals. These stressors can reduce foraging activity and compromise pollination efficiency.

Nano-B-Feed™ is a hive-applied formulation that developed to enhance colony vigor during pollination might contribute to the pollination efficiency of almond by honeybees. This study was designed to evaluate the impact of Nano-B-Feed™ on honeybee activity, fruit set, yield, and colony resilience under real-world commercial almond production conditions.

Materials and Methods

The field trial was conducted in 2025 in a commercial almond orchard (~50 dunam; 12.4 acres) in the Yavniel Valley, Israel. The orchard included the main cultivar Umm al-Fahem, with additional cultivars Gilad and 53. The orchard was divided into two

treatment groups: hives receiving Nano-B-Feed™ and untreated control hives. Colonies of comparable initial strength were distributed uniformly across the orchard at approximately 300 m intervals.

Nano-B-Feed™ was applied at the hive entrance according to H4bees' protocol (5 g per application, once every three days, for a total of five applications during bloom). Bee activity was assessed through flower visitation rates and hive-entrance activity monitoring. Fruit set was quantified by counting flowers and fruitlets on selected branches four weeks after bloom. Yield was determined by harvesting, weighing total green fruit, and calculating dry kernel yield. Statistical analyses were performed using one-way ANOVA ($p < 0.05$).

Results

Treated colonies exhibited consistently higher flower visitation rates and elevated hive-entrance activity throughout the bloom period, reflecting enhanced colony vitality and a 53% increase in bee visitation to trees at peak flowering. Although some differences in activity were not statistically significant, the overall trend favored Nano-B-Feed™ –treated hives.

Trees pollinated by treated colonies exhibited a 28% increase in fruit set and a 34% increase in total yield per dunam compared with control trees. While average kernel weight was reduced by 13%, this reduction was not statistically significant and was consistent with the higher crop load observed in treated plots. Overall yield gains translated into a substantial improvement in orchard productivity.

Two pesticide-related mortality events occurred during the study. Chemical analyses indicated that treated colonies exhibited greater survival and recovery, suggesting enhanced resilience to agrochemical exposure.

Conclusions

This field study demonstrates that Nano-B-Feed™ significantly enhances honeybee activity, fruit set, and yield in almond orchards under commercial conditions. Treated colonies also showed increased resilience to pesticide exposure, an important advantage in early-season almond production. The results support Nano-B-Feed™ as a practical and scalable approach to improving pollination efficiency, orchard productivity, and pollinator health. Further multi-site and multi-season studies are warranted to confirm these findings and to further elucidate the underlying biological mechanisms.

Table 1 - Number of bees per tree per minute

Date	Number of Bees on Trees		No. Hive Entries		Temp	Time
	Control	Treatment	Control	Treatment	C°	
Feb 4	-	-	14	14	13	09:00
Feb 9	8	9 (+13%)	-	-	13	
Feb 11	24	30 (+25%)	37	35 (-5%)	23	13:00
Feb 14	7.5	11.5 (+53%)	28	37 (+32%)	14	08:00
Feb 14	8.9	13.2 (+48%)	-	-	15	11:00
Feb 19	9	11 (+22%)	59	65 (+10%)	16	09:00

Table 2 – Fruit set and total calculated yield

	Fruit set rate (%)	Total calculated yield per dunam (Kg Kernel)	Kernel Weight (gr)
Untreated hives	44	168	1.34
Treated hives	57	226	1.16
Increment (%)	+28%	+34%	-13%
Statistical significance (p<0.05)	S	S	NS

2. *H4BEES in Apples*

Evaluation of Managed Honeybee Pollination Supported by Nano-B-Feed™ on Apple Yield and Fruit Quality (Granny Smith and Pink Lady)

Abstract

Effective pollination is critical for apple (Malus domestica) production, directly influencing fruit set, seed number, fruit size, and commercial yield. This study evaluated the impact of Nano-B-feed™ on pollination efficiency, yield, and fruit quality in Granny Smith and Pink Lady apple orchards under commercial conditions in northern Israel. The study was done in collaboration with Prof. Raffi Stern who is a Senior Researcher at Northern Agriculture R&D of Israel. Across multiple complementary assessments, treated hives exhibited substantially higher bee activity, leading to increased initial and final fruit set, improved

seed number per fruit, larger fruit size, and significantly higher commercial yields compared with untreated controls. These results demonstrate that strengthening hive health through targeted supplementation represents a practical and scalable strategy to enhance apple productivity and fruit quality.

Introduction

Apple orchards rely on insect-mediated cross-pollination, with honeybees serving as the primary pollination vector. In recent years, declining apple yields have been reported globally, partly attributed to reduced bee activity and suboptimal pollination despite increased hive density and the introduction of alternative pollinators. Weak colony health, environmental stress, and limited foraging efficiency during bloom are considered major contributors to insufficient pollen transfer.
The objective of the present studies was to assess whether improving hive health through Nano-B-Feed™ supplementation enhances bee activity in apple orchards and translates into improved fruit set, yield, and fruit quality parameters in Granny Smith and Pink Lady cultivars.

Materials and Methods

Field trials were conducted in commercial apple orchards in Moshav Yonatan, Golan Heights, Israel, under the coordination of the Northern Agriculture R&D of Israel. Mature Granny Smith and Pink Lady apple trees planted in alternating blocks were included in the study. For each cultivar, one plot was supplied with hives treated with Nano-B-Feed™, while an adjacent plot served as an untreated control. Nano-B-Feed™ was applied at the hive entrance at a dose of 5 g per hive on a weekly basis throughout the pollination period (April 5–May 25, 2024). The supplement is based on modified powdered sugar containing trace minerals and pheromonal components and is approved for use by the Israeli Ministry of Agriculture (license #F151/2024) and manufactured under HACCP standards.
For each cultivar and treatment, ten trees were selected for detailed monitoring. Bee activity was quantified during peak bloom by counting the number of bees per tree per minute. Fruit set was assessed three weeks after full bloom and again later in the season to determine final fruit set. Additional measurements included fruit number per branch, seed count per fruit, fruit diameter, individual fruit weight, and commercial yield per dunam. Statistical analyses were conducted using one-way ANOVA with a significance threshold of $p < 0.05$.

Results

Bee activity on treated trees was markedly higher than on control trees, with increases of approximately 70–90% observed across both cultivars. This elevated activity was consistent across multiple observation dates and strongly correlated

with fruitlet formation.

Initial fruit set measured three weeks after bloom was significantly higher in treated plots for both cultivars. In Granny Smith, the treated trees exhibited a two-fold increase in early fruitlet rate compared with controls ($p = 0.015$). Pink Lady trees showed a 21% increase in early fruit set relative to controls. Although natural fruit drop and thinning reduced statistical significance later in the season, final fruit set remained higher in treated plots, with increases of 35% in Granny Smith and 22% in Pink Lady.

Yield and fruit quality assessments demonstrated substantial advantages for treated trees. In Granny Smith, treated branches showed a 60% increase in fruit number per branch, a 75% increase in seed number per fruit, an average increase of approximately 10 mm in fruit diameter, and a 40% increase in average fruit weight (113 g vs. 81 g). Pink Lady exhibited comparable improvements in fruit number, size, and quality. Commercial harvest data from entire plots indicated significant yield increases, corresponding to approximately 1,100 kg/dunam additional yield in Granny Smith and 600 kg/dunam in Pink Lady orchards.

Conclusions

The combined results of these apple field studies demonstrate that hive-level supplementation with Nano-B-Feed™ significantly enhances honeybee activity during bloom, leading to improved pollination, fertilization, and fruit development. Increased seed number per fruit was associated with larger fruit size and higher fruit survival, ultimately resulting in substantial gains in commercial yield for both Granny Smith and Pink Lady cultivars.

These findings indicate that strengthening colony health through Nano-B-Feed™ is an effective and practical strategy to improve apple yield and fruit quality under commercial orchard conditions. Further multi-season and multi-site studies, including full harvest data, are warranted to confirm the robustness and general applicability of this approach.

Figure 1 – Three weeks after pollination, apple fruitlets are visible.

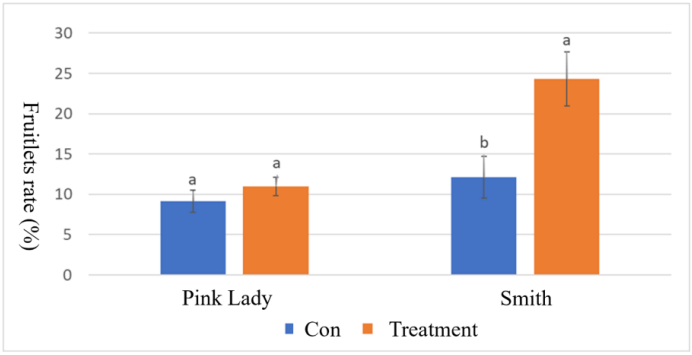


Fig. 2 Fruitlets rate in Smith and Pink Lady on May 8, 2024, three weeks after the full bloom that occurs on April 16, 2024. Statistical analysis was performed using one-way ANOVA P=0.05.

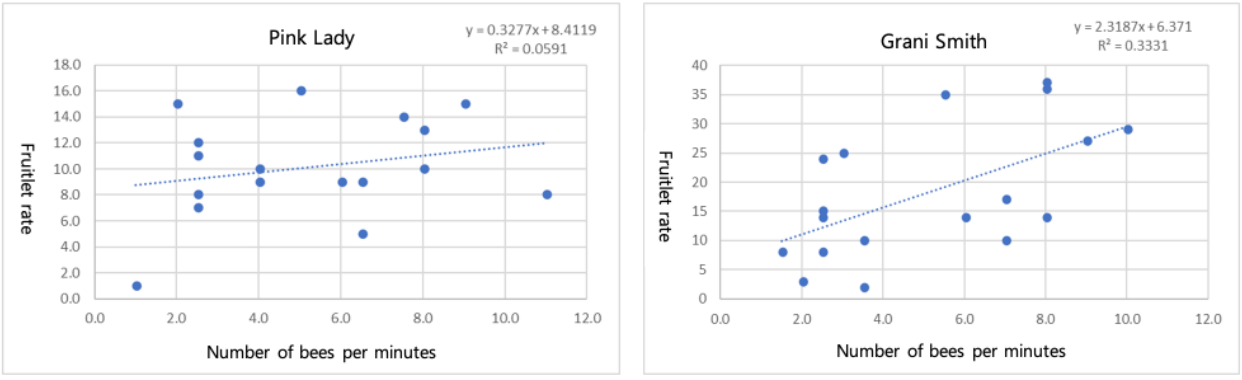


Figure 3 - A correlation between bee activity and fruitlet percentage

3. *H4BEES in Avocado*

Evaluation of Nano-B-Feed™ on Fruit Set, and Total Fruit Yield in Avocado Orchard

Abstract

Honeybee pollination is essential for Avocado production; The fact is that only a few flowers among the millions found on an avocado tree will be pollinated and will mature. This study was done in collaboration with 'Shiqma plantations' and Agro-Negev Avocado experts in the southern region of Israel. The aim of the study was to evaluate the effects of Nano-B-feed™ on pollination efficiency, fruit set and yield in Avocado (cultivar Has). Treated colonies exhibited enhanced foraging activity, reflected by a significant increase in bee visitation rate (bees per minute per tree) in the area where treated hives were deployed compared to the control area (mean difference = +8.25 bees·min^{-1}·tree^{-1}, $p = 0.014$). Trees located in areas where treated hives were deployed showed markedly higher productivity than those in areas with untreated hives. Total yield increased 7.6-fold and total fruit number 8.9-fold, with mean yield per tree rising from 9.3 to 70.9 kg and mean fruit number from 45.6 to 403.9. These differences were highly significant for both yield and fruit number ($p < 0.001$), indicating a strong and consistent treatment-associated effect at the orchard scale. Considering the generally lower yields observed during the study year, these results highlight the advantage of using Nano-B-feed™, particularly under suboptimal production conditions.

These results indicate that Nano-B-Feed™ is an effective intervention to improve pollination efficiency, orchard productivity, and colony health under commercial growing conditions un avocado orchard.

Introduction

Avocado pollination relies heavily on insect activity because the species exhibits a unique protogynous flowering system that limits effective self-pollination. Honeybees (*Apis mellifera*) are the dominant managed pollinators in commercial orchards, responsible for most inter-flower pollen transfer during the brief overlap of male and female flower phases, yet only a few flowers among the millions produced by an avocado tree will ultimately be pollinated and mature. However, avocado flowers are relatively unattractive to bees due to low nectar rewards and strong competition from surrounding flora, often resulting in suboptimal visitation rates. Nano-B-Feed™ is a hive-applied formulation developed to enhance colony vigor during pollination and may contribute to improved pollination efficiency by honeybees; accordingly, this

study evaluated its impact on honeybee activity, fruit set, yield, and colony resilience under real-world commercial avocado production conditions.

Materials and Methods

The field trial was conducted in 2025 in a commercial avocado orchard (~30 dunam; 7.5 acres) near Kibbutz Erez (southern Israel). The orchard included the main cultivar Has in their mature phase (4-6 years old) . The orchard was divided into two treatment groups: hives receiving Nano-B-Feed™ and untreated control hives. Colonies of comparable initial strength were distributed uniformly across the orchard at approximately 270 m intervals. In each plot, 10 comparable trees were marked at the onset of flowering in order to minimize experimental variability.

Nano-B-Feed™ was applied at the hive entrance according to H4bees' protocol; 5 g per application, once every week, for a total of five applications during bloom (April-May). Bee activity was assessed through flower visitation rates and hive-entrance activity monitoring. Fruit set was estimated by counting flowers and fruitlets on the selected trees four weeks after Yield was determined by harvesting, weighing total fruits number, average fruit weight per tree and total fruits weight per plot. Statistical analyses were performed using t-test and Mann-Whitney U test ($p < 0.05$).

Results

Treated colonies exhibited enhanced foraging activity, a paired t-test revealed a statistically significant increase in bee visitation rate (bees per minute per tree) in the area where treated hives were deployed compared to the control area (mean difference = 8.25 bees·min^{-1}·tree^{-1}, $t = 5.2$, $p = 0.014$).

Mann–Whitney U tests revealed a highly significant increase in both yield per tree and fruit number per tree in the area where treated hives were deployed compared to the control area (yield: $U = 98$, $p < 0.001$; fruit number: $U = 97$, $p < 0.001$), indicating a robust and consistent treatment effect across the orchard. Trees located in areas where treated hives were deployed exhibited a pronounced and consistent improvement in productivity compared to trees in areas with untreated hives. Total yield (per ten trees) reached 70.9 kg in areas with treated hives versus 93 kg in areas with untreated hives, corresponding to a 7.6-fold increase, while total fruit number increased from 45.6 to 403.9 fruits (8.9-fold). On a per-tree basis, mean yield rose from 9.3 kg to 70.9 kg and mean fruit number rose from 45.6 to 403.9 fruits. Importantly, this effect was not driven by isolated high-performing trees but reflected a systematic shift of the entire distribution, with trees in treated-hive areas consistently outperforming those in untreated-hive areas. Mann–Whitney U tests confirmed these differences to be highly significant for both yield per tree ($U = 98$, $p < 0.001$) and fruit number per tree ($U = 97$, $p < 0.001$), indicating near-complete

separation between the two distributions and demonstrating a robust treatment effect at the orchard scale.

The total yield across the plots (untreated, transition, and treated) exhibited a clear and significant gradient that was consistent with the results obtained from the ten sampled trees. As shown in Figure 1, total yield increased from 187 kg in the untreated plot to 850 kg in the transition plot and reached 1,280 kg in the treated plot.

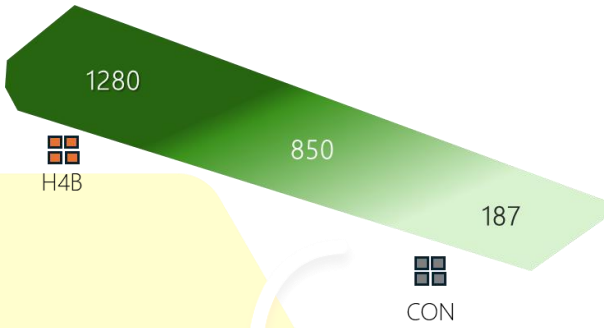


Figure 1 - The total yield across the plots untreated, transition, and treated.
CON =control hives placement
H4B = Treated hives placement

Conclusions

This field study demonstrates that Nano-B-Feed™ significantly enhances honeybee activity, fruit set, and yield in avocado orchards under commercial conditions. The results support Nano-B-Feed™ as a practical and scalable approach to improving pollination efficiency, orchard productivity, and pollinator health. Further multi-site and multi-season studies are warranted to confirm these findings and to further elucidate the underlying biological mechanisms.

4. H4BEES in Cashew

Enhancing Ghana's Honey and Cashew Production with Nano-B-Feed™

Introduction

Bees play a critical role in global food security. Approximately 75% of food crops depend on insect pollination, and nearly 35% of global food production relies on animal pollinators, with honeybees being the most important contributors. In Ghana, favorable climatic conditions and year-round nectar availability create a strong foundation for beekeeping and pollination-dependent agriculture. At the same time, the sector faces challenges including colony stress, parasite pressure, limited technical capacity, and under-utilized pollination services.

The following summary highlights the core solution, field validation data, and the specific relevance of Nano-B-Feed™ to Ghana.

The Challenge and Opportunity in Ghana

Ghana's beekeeping and honey sector faces several structural challenges. These include insufficient nationwide data on colony losses, high parasite loads, and gaps in beekeeper training and infrastructure. As a result, pollination services are often under-utilized, limiting crop productivity and farmer income.

At the same time, Ghana presents strong opportunities. Nectar flow is available throughout most of the year, demand for premium and organic Ghanaian honey is rising, and there is significant untapped value in managed pollination for cash crops such as cashew and coffee. These conditions make Ghana an attractive environment for scalable, impact-driven bee health solutions.

Ghana Case Study (December 2024 – April 2025)

A focused pilot study was conducted in the Bono East and Oti Regions of Ghana, key hubs for cashew production and beekeeping. The trials were carried out in collaboration with the Ghana National Beekeepers Association (NATBA) using traditional top-bar hives placed in commercial cashew orchards.

Results from the Ghana pilot demonstrated clear and measurable benefits:

- Honey yield increased by approximately 67%, from about 12 kg to 20 kg per hive
- Cashew nut yield increased by approximately 22%, from about 1,800 kg to 2,200 kg per 10 acres.

Beekeepers reported higher bee activity, improved survival under stress, and visibly stronger colonies following application of Nano-B-Feed™ .

Scaling Strategy and Partnerships

H4BEES is preparing to scale its operations and impact in Ghana during 2026. The company seeks to collaborate with rural-livelihood NGOs, agri-investors, honey aggregators and exporters, and commercial beekeepers and processors. H4BEES provides not only the product itself, but also application protocols, training, and ongoing monitoring to ensure consistent performance and measurable outcomes. Strategic partnerships will be key to expanding adoption and maximizing economic and social impact.

Conclusion

H4BEES offers a validated, science-driven solution to strengthen bee health while simultaneously increasing honey production and crop yields. Field results from Ghana and international trials demonstrate meaningful benefits for beekeepers, farmers, and the broader agricultural ecosystem. With strong local partnerships, H4BEES is well positioned to support sustainable agriculture, rural income growth, and food security in Ghana.

5. *H4BEES in Coffee*

Impact of Managed Honeybee (Apis mellifera L.) Pollination Supported by BioSynergy Beenovation on Robusta Coffee Yield and Quality in Dak Lak Province, Vietnam

Background and Objective

Coffee is the most traded agricultural product in the world. It is grown in over 70 nations between the Tropics of Cancer and Capricorn, but more than 50% of the world's coffee is produced by just four countries: Brazil, Vietnam, Indonesia and Colombia (FAO 2021). These four countries produce 31, 19, 8 and 6% of the coffee, respectively (ICO 2021). With an annual production of about 1.8 million tons of coffee green beans, Vietnam is the second biggest coffee producer but is the largest Robusta coffee producer in the world. The crop is mainly grown in the Central Highlands region, which is the home of Lam Dong, Dak Nong, Dak Lak, Gia Lai, and Kon Tum provinces. Both commercial coffees (Robusta and Arabica) are produced nationally by approximately 600,000 growers from an estimated 700,000 hectares. Robusta accounts for 95% of national Vietnamese coffee production (International Coffee Council 2021).

Robusta coffee (Coffea canephora) is a self-incompatible crop that depends on cross-pollination to achieve optimal fruit set and yield. In Vietnam, limitations in pollination efficiency and declining honeybee populations pose challenges to sustainable productivity. This study aimed to evaluate the effect of managed honeybee pollination supported by BioSynergy Beenovation (Vietnam trade name of Nano-B-Feed™) on coffee yield and bean quality under field conditions in the Central Highlands of Vietnam.

Materials and Methods

A comparative field study was conducted at the Western Highlands Agro-Forestry Science Institute (WASI) research station in Dak Lak Province. Two 1-hectare Robusta coffee farms (TR9 variety, planted in 2010) were selected: one control farm without beehives and one pilot farm with beehive deployment. Agronomic practices, including fertilization, irrigation, pruning, and pest control, were identical between the two sites.

The pilot farm was equipped with five honeybee (Apis mellifera) hives per hectare, installed two weeks prior to flowering. Beehives were supported with BioSynergy Beenovation (Vietnam trade name of Nano-B-Feed™) at a total application rate of 50 g/ha over one month. On each farm, five trees were selected, four branches per tree

were marked, and five nodes per branch were monitored for flower number, fruit set, fruit development, yield, and bean quality. Statistical comparisons were performed using paired t-tests in IBM SPSS Statistics (version 22).

Results

The number of flowers per node did not differ significantly between the pilot and control farms, indicating comparable flowering potential. However, the proportion of fruit set per node was significantly higher in the beehive-supported farm (42.91%) compared with the control farm (17.79%). The percentage of fully developed coffee cherries was also substantially higher in the pilot farm (28.90%) than in the control farm (11.31%).

These improvements translated into a marked increase in yield, with the pilot farm producing 2.37 t/ha compared with 1.59 t/ha in the control, representing an approximately 1.5-fold increase. Post-harvest quality assessments showed that beans from the beehive-supported farm required fewer cherries per kilogram, exhibited a lower proportion of single-bean cherries, and showed a higher percentage of beans meeting the standard 16-gauge sieve size for Robusta coffee grading.

Conclusions

Managed honeybee pollination supported by Nano-B-Feed™ significantly improved fruit set, yield, and bean quality of Robusta coffee under field conditions in the Central Highlands of Vietnam. These benefits were observed despite adverse environmental conditions, including drought and pest pressure. The findings support the deployment of five beehives per hectare in combination with 50 g/ha of Nano-B-Feed™ as an effective and practical strategy to enhance Robusta coffee productivity and quality in Vietnam and other Robusta-growing regions.

6. H4BEES in Artichoke Seed Production

Effect of Managed Honeybee Pollination Supported by Nano-B-Feed™ on Artichoke Seed Production under Arid Conditions

Abstract

Efficient pollination is critical for artichoke (Cynara cardunculus var. scolymus) seed production, particularly under arid conditions where floral resources are limited. This study evaluated the effect of hive-level supplementation with Nano-B-Feed™ on honeybee (Apis mellifera) activity, colony condition, and seed yield in commercial artichoke seed fields. Field trials conducted in collaboration with Genesis Seed Company demonstrated enhanced colony recovery, increased bee visitation to inflorescences, reduced bee mortality, and a two-fold increase in seed yield compared with untreated controls. The results indicate that targeted hive supplementation represents an effective strategy to improve pollination efficiency and seed productivity in artichoke seed production systems.

Introduction

Artichoke seed production depends on intensive insect-mediated pollination, with honeybees serving as the primary pollination vector. Pollination efficiency is often challenged in arid and desert environments due to high temperatures and the absence of alternative pollen and nectar sources during bloom. Under such conditions, colonies frequently weaken following hive placement in seed fields, leading to reduced foraging activity and suboptimal seed set.

Genesis Seed Company specializes in the production of organic vegetable seeds and has collaborated with H4Bees Ltd over the past two years to evaluate hive-level interventions aimed at strengthening colonies during pollination. The present study summarizes a flagship 2022 field experiment designed to assess the impact of H4Bees™ supplementation on honeybee performance and artichoke seed yield under desert conditions.

Materials and Methods

The experiment was conducted in 2022 in the Ashalim region of southern Israel, characterized by desert and dry climatic conditions. Two identical artichoke seed production plots (20 dunams each) were selected and separated by approximately 3 km to prevent overlap of foraging bees. Honeybee hives were introduced into both plots approximately seven days prior to peak flower vitality.

Number of treated bees on Artichoke inflorescences

No alternative pollen or nectar sources were available during the flowering period.
Hives were managed by Genesis Seed Company under standard breeder practices, including supplemental sugar syrup feeding. H4Bees' supplementation protocols were adapted based on colony condition: strong colonies received 5 g of Nano-B-Feed™ powder at the hive entrance every two weeks for one month, while medium-strength colonies received 5 g of Nano-B-Feed™ weekly. Control hives received no H4Bees™ supplementation. Hive condition, bee activity, and mortality were assessed through field observations conducted independently by the Genesis' farm agronomist. Seed yield was determined by harvesting inflorescences, extracting seeds, and calculating yield per dunam.

Results

Within days of hive placement, several colonies in both plots exhibited initial deterioration, a phenomenon commonly observed in artichoke seed fields due to limited forage availability. Treated hives, however, recovered rapidly following Nano-B-Feed™ supplementation and were reported to have fully restored colony condition within approximately ten days, while control hives showed little or no recovery.
During the pollination period, bee visitation rates to artichoke inflorescences were markedly higher in the treated plot. Field observations recorded an average of four to five bees per inflorescence, exceeding both historical benchmarks and levels observed in the control plot. Notably, no dead bees were observed on inflorescences in the treated plot, whereas bee mortality was present in the control plot and consistent with previous years' observations, attributed to bees becoming trapped in sticky, pollen-heavy inflorescences.
At the end of the pollination season, treated colonies appeared stronger and more populous than control colonies. Seed yield analysis revealed a two-fold increase in the treated plot, reaching approximately 70 kg per dunam compared with 35 kg per dunam in the control plot.

Conclusions

The results of this field study demonstrate that hive-level supplementation with Nano-B-Feed™ significantly enhances honeybee colony resilience, pollination activity, and seed yield in artichoke seed production under arid conditions. Rapid colony recovery, increased bee visitation, reduced bee mortality, and a doubling of seed yield highlight the effectiveness of this approach. These findings support the use of Nano-B-Feed™ as a practical and scalable intervention for improving pollination efficiency and seed productivity in challenging agricultural environments. Further

multi-season and multi-location studies are recommended to confirm the robustness of these results.

7. H4Bees in Cotton Seed Production

Effect of Managed Honeybee Pollination Supported by Nano-B-Feed™ on Hybrid Cotton Seed Production

Abstract

Efficient pollination is critical for hybrid cotton seed production, as pollination quality directly affects seed yield and commercial value. This study evaluated the impact of hive-level supplementation with Nano-B-Feed™ on honeybee (Apis mellifera) pollination efficiency and seed yield in hybrid cotton fields operated by HaZera 1939 Seed Company. Under commercial field conditions, hives receiving Nano-B-Feed™ treatment demonstrated superior pollination performance, resulting in improved boll development and approximately two-fold higher seed yield compared with untreated controls. These findings support the use of targeted hive supplementation as a practical tool to enhance hybrid cotton seed production under high-temperature field conditions.

Introduction

Hybrid cotton seed production relies on precise and effective insect-mediated pollination to ensure high-quality seed set and optimal yield. Honeybees play a central role in pollen transfer, and insufficient pollination can negatively impact boll development, seed weight, and overall profitability. High temperatures, large field sizes, and intensive pollination demands can further challenge pollination efficiency. HaZera 1939 Seed Company, develops hybrid cotton varieties using proprietary technologies. The present study was designed to assess whether strengthening honeybee colonies through hive-level supplementation with Nano-B-Feed™ improves pollination quality and seed yield in large-scale hybrid cotton seed production.

Materials and Methods

The field experiment was conducted during the 2023 growing season in a commercial hybrid cotton seed field located at Azrikam in the southern coastal plain of Israel. The field measured approximately 1,000 × 200 meters (200 dunams) and was virtually divided into two equal plots (500 × 200 meters): a treatment plot and an untreated control plot. Plot assignment was determined arbitrarily by the experiment manager

of HaZera 1939 Seed Company.

A total of 144 honeybee hives were placed at 18 points around the field on June 18, 2023, with eight hives per point. Hives assigned to the treatment plot received Nano-B-Feed™ supplementation once weekly for approximately 52 days (until August 15, 2023), totaling eight applications. This intensive protocol was selected due to high ambient temperatures and the absence of prior pre-pollination treatment. Pollination monitoring and sampling were conducted by the company's agronomist, including assessment of boll (lobe) condition and seed yield per plant.

Results

Visual and quantitative assessments demonstrated improved pollination outcomes in the treatment plot compared with the control plot. Boll condition at sampling points adjacent to treated hives was markedly superior at the end of the pollination period. The final results indicated 59 gr seeds per plant which were recorded in the treatment sampling point compared with 29 gr in the control sampling point, with average seed counts of 37 seeds per plant in the treatment plot versus 13 seeds per plant in the control plot.

In transition zones located between treated and control areas, intermediate improvements in pollination quality were observed, consistent with proximity to treated hives.

Conclusions

This commercial-scale field study demonstrates that hive-level supplementation with Nano-B-Feed™ significantly enhances pollination quality and seed yield in hybrid cotton seed production. Improved boll condition, increased seed number per plant, and approximately two-fold higher seed yield were observed in treated plots compared with untreated controls, even under challenging high-temperature conditions.

These findings indicate that strengthening honeybee colonies through targeted supplementation is an effective and scalable strategy to improve pollination efficiency and seed productivity in hybrid cotton systems.

Over the past two years (2024-2025), HaZera 1939 Seed Company implemented the commercial use of Nano-B-Feed™ in more than 1,000 hives each year. The results indicated an average increase of over 30% in seed yield in plots serviced by treated hives compared with plots in which the hives were not treated.

Map 1: Azrikam cotton field

Table 2: Average number of open lobes, total weight of lobes, average number and weight of seeds per plant. The lobes were harvested, dried for three days at room temperature, and then weighed. Those numbers in parenthesis represent the ratio of the control (1) to the treatment.

Zone	Average number of open lobes per plant	Total weight of the open lobes per plant (gr)	Average seed number per plant	Average seed weight per plant (gr)	Germination rate (proper>85 %)
Untreated hives (control)	22 (1)	41 (1)	13 (1)	29 (1)	95%
Twilight zone	24 (1.09)	59 (1.43)	26 (2.0)	35 (1.20)	91%
Treated hives	29 (1.31)	85 (2.07)	37 (2.84)	59 (2.03)	90%

8. H4BEES in Honey Production

Effect of Nano-B-FeedTM Supplementation on Honey Production and Colony Performance under Commercial Beekeeping Conditions

Abstract

Honey production is a central economic outcome of commercial beekeeping and a key indicator of colony health. This study evaluated the effect of Nano-B-Feed™ hive supplementation on honey yield and colony strength under field conditions in Israel. In a controlled experiment conducted at two sites in central Israel, beehives treated with Nano-B-Feed™ exhibited significantly higher honey production and improved colony status compared with untreated controls. Average honey yield per hive increased by approximately 30%, and total honey production per site increased by 40%. The treatment demonstrated a favorable cost–benefit ratio, supporting its application as a practical intervention to enhance honey production and colony performance.

Introduction

Honey production represents the primary economic output of both amateur and commercial beekeeping operations worldwide. Global demand for honey and pollination services has intensified the need for management strategies that sustain colony health and maximize productivity. Colony weakening due to nutritional stress, environmental pressures, and disease can significantly reduce honey yield. Nano-B-Feed™ developed to support colony strength, brood continuity, and foraging activity. The present study was designed to assess the impact of Nano-B-Feed™ supplementation on honey yield and colony performance under commercial beekeeping conditions, with independent data collection and analysis conducted by the Israeli Ministry of Agriculture Extension Service.

Materials and Methods

A field experiment was conducted in Nahalim, central Israel, in collaboration with Dr. Ohad Afik Head of Bees and Pollination of the Israeli Ministry of Agriculture and Rural Development Extension Service. Two geographically separated apiary locations were selected. At each location, approximately 40 beehives were deployed and divided equally into two groups: an untreated control group and a treatment group.

Hives in the treatment group received 5 g of H4Bees™ supplement applied at the hive entrance once every 20 days over a five-month period. Control hives received no supplementation. Beekeeping management practices were identical between groups and provided by the same commercial beekeeper. Hive condition assessments, honey harvest measurements, and statistical analyses were conducted independently by the Extension Service to ensure objectivity.

Results

After five months, hives treated with Nano-B-Feed™ produced significantly more honey than control hives. Total honey production per site increased from 466 kg in the control group to 655 kg in the treated group. Average honey yield per hive was 25.2 ± 3.6 kg in the control group and 32.8 ± 2.5 kg in the treated group, representing an approximate 30% increase (P = 0.034).

The number of hives producing no honey was reduced from three in the control group to one in the treated group. Overall, honey yield increased by 189 kg per site, corresponding to an estimated additional revenue of approximately 4,000 NIS based on a conservative market price of 20 NIS per kg of honey. Treatment costs were estimated at approximately 400 NIS per site, yielding a cost–benefit ratio of approximately 1:10.

Additional qualitative assessments indicated that treated hives exhibited greater colony strength, including improved brood continuity and general colony condition, compared with control hives.

Conclusions

The test results were described by Dr. Ohad Afik as positive and encouraging, due to a notable increase in both the strength of the bee population in both the beehive and in the honey crop under commercial beekeeping conditions. The treatment resulted in higher average and total honey yields, fewer non-producing hives, and improved colony strength, while maintaining a highly favorable economic return. These findings support the use of Nano-B-Feed™ as a practical, scalable intervention to enhance honey production and colony resilience.

Since this primary trial, additional multi-site and multi-season studies have been undertaken to validate long-term benefits for beekeepers and to refine treatment protocols under diverse regional and climatic conditions.

9. *H4BEES And Colony Resistance to Cold*

Effect of Hive-Level Supplementation on Honeybee Cold Resistance and Productivity during Early-Season Pollination

Abstract

Low post-dormancy temperatures limit honeybee activity and challenge early-season pollination. Accordingly, this study was conducted in an avocado orchard where cold conditions during the pollination period negatively affect bee activity.

This study evaluated updated Nano-B-Feed™ formulations designed to increase colony resistance to cold and maintain productivity during pollination period of avocado orchard. Field trials conducted in an avocado orchard at Kibbutz Saad, Israel, demonstrated that treated hives produced significantly more honey than untreated controls, with yield increases ranging from 36% to 70% depending on formulation. These results indicate that targeted hive supplementation improves colony performance under cold conditions and supports earlier, more effective pollination readiness.

Introduction

H4Bees has developed updated product formulations intended to enhance colony resistance to cold and sustain foraging activity during winter and early spring. The present study evaluated these formulations under commercial conditions in an avocado orchard located in a region where temperatures during the pollination period frequently fall below 18 °C, thereby limiting hive activity, with honey production used as an integrated indicator of colony strength and pollination potential.

Developing cold-adapted formulations is particularly important for deciduous trees such as almond, which initiate flowering immediately after winter when bee colonies are relatively weak.

Materials and Methods

The experiment was conducted in 2023 at an avocado plantation in Kibbutz Saad, southern Israel, selected for its relatively cold microclimate and stationary beehives that remain on-site throughout winter. During the non-bloom period, bees relied primarily on avocado pollen and nectar.

A total of 62 honeybee hives were allocated to four groups: one untreated control group and three treatment groups receiving different Nano-B-Feed™ formulations (v1.0, v1.1, and v1.2), with approximately 15 hives per group. Treated hives received 5 g of supplement every three weeks, for a total of six applications per hive. The trial ran

from January to May. Honey yield per hive was recorded and analyzed using one-way ANOVA.

Results

All H4Bees-treated groups produced significantly more honey than untreated controls. Average honey weight per hive increased from 11.36 kg in control hives to 15.39–19.28 kg in treated hives. Nano-B-Feed™ v1.1 produced the strongest effect, increasing expected honey production by approximately 70%, while v1.0 and v1.2 increased production by approximately 36%.

Economic analysis based on expected yield from all 62 hives demonstrated substantial profit gains, with the v1.1 formulation yielding the highest incremental income. Observations indicated that as temperatures increased, continued use of cold-adapted formulations led to excessive colony activity, emphasizing the need to revert to standard formulations as conditions normalize.

Conclusions

Hive-level supplementation with cold-adapted Nano-B-Feed™ formulations significantly enhance honeybee productivity and colony performance during winter and early spring. Increased honey yield reflects improved colony strength and readiness for early-season pollination of deciduous crops.

Among the tested formulations, Nano-B-Feed™ v1.1 demonstrated superior performance under cold conditions. These findings support Nano-B-Feed™ supplementation as a practical and scalable strategy to improve colony resilience to cold stress. Further multi-season studies are recommended to refine treatment protocols.

10. H4BEES And Colony Resistance to Neonicotinoids

Effect of Nano-B-Feed™ Supplementation on Honeybee Colony Resistance to Neonicotinoid Exposure

Abstract

Exposure to neonicotinoid pesticides is widely recognized as a major factor contributing to honeybee colony decline. This study evaluated the effect of Nano-B-Feed™ supplementation on colony survival and honey production following chronic exposure to a sublethal concentration of the neonicotinoid Confidor®350C. In a controlled experimental setting, colonies treated with Nano-B-Feed™ demonstrated significantly improved survival and partial recovery of honey production compared

with untreated, contaminated colonies. The findings indicate that hive-level supplementation enhances colony resilience to pesticide stress.

Introduction

Neonicotinoid insecticides have been implicated in widespread declines of honeybee populations worldwide, primarily through sublethal effects that impair immunity, behavior, and colony development. During crop pollination, beehives are frequently exposed to pesticide residues, increasing stress and mortality risk. Nano-B-Feed™ originally developed to strengthen colony vitality and immune function. This study, conducted in collaboration with the Behavioral Biology Laboratory at the Technion – Israel Institute of Technology, aimed to evaluate whether Nano-B-Feed™ supplementation improves colony survival and productivity under controlled neonicotinoid exposure.

Materials and Methods

The experiment was conducted between October 2015 and June 2016 in collaboration with Prof. Avi Avital's Behavioral Biology Laboratory at the Technion (currently a prof. in Haifa University). A total of 20 honeybee hives were divided into three groups: (1) eight control hives fed sugar solution (50% w/w) containing Confidor®350C at a concentration of 35 ppb (sublethal dose), (2) eight hives receiving the same contaminated sugar solution supplemented with Nano-B-Feed™ and (3) four uncontaminated hives fed non-contaminated sugar solution to represent normal colony development.

Colonies were monitored for survival and honey production. Honey was extracted in May 2016, approximately seven months after experiment initiation. Data were analyzed using one-way ANOVA, with statistical significance defined as $P < 0.05$.

Results

Colonies exposed to neonicotinoids without Nano-B-Feed™ supplementation exhibited substantial decline. Survival in the contaminated control group was reduced to 62.5%, and average honey yield was limited to 1.9 ± 0.68 kg per hive. In contrast, Nano-B-Feed™ -treated colonies exposed to the same neonicotinoid concentration showed significantly higher survival (87.5%) and greater honey production (7.6 ± 1.4 kg per hive).

Uncontaminated control hives exhibited 100% survival and produced 16.9 ± 2.2 kg of honey per hive. Due to near collapse of the contaminated control hives, the experiment was terminated early. Statistical analysis confirmed significant differences among treatment groups for both survival and honey yield ($P < 0.05$).

Conclusions

This study demonstrates that Nano-B-Feed™ supplementation significantly increases honeybee colony resistance to sublethal neonicotinoid exposure. Treated colonies exhibited improved survival and partial restoration of honey production compared with untreated contaminated colonies.

These findings suggest that strengthening colony health through targeted hive-level supplementation can mitigate the negative impacts of pesticide exposure encountered during agricultural pollination. In the year following this trial, beekeepers who used Nano-B-Feed™ reported improved resilience and survival of colonies that had been affected by drift of neonicotinoid-class pesticides. A representative example was previously reported in the almond trial that was conducted in collaboration with Northern Agriculture R&D. At the end of the pollination period, colonies were exposed to a spray-drift of neonicotinoid pesticide named Clutch (clothianidin 50%). The beekeeper reported a recovery rate of approximately 80% in treated colonies, whereas survival in untreated colonies was about 50%, with substantially weaker colony development compared to treated hives.

Table 2. Comparison of the survival rate and the honey yield between the treatments. Honey was extracted in May 2016, 7 months after the initiation day. Results are presented as means ± standard error of the means (SE). Differences in the honey yield between the treatments were found to be statistically significant ($P<0.05$).

	Control	Neonicotinoid treatment'	Nano-B-Feed™ Treatment
Beehive No.	4	8	8
Survival (%)	100 [a]	62.5 [b]	87.5 [a b]
Honey Yield (Kg±SE)	16.9±2.2[a]	1.9±0.68[c]	7.6±1.4[b]

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