

# Drone-based application of boron for higher sunflower yield

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*Efficient micronutrient management is crucial for enhancing sunflower productivity and profitability, particularly under intensive cropping systems. Boron plays a vital role in flowering, pollen viability, seed setting and oil formation, but its deficiency often limits yields. Drone-based foliar application of boron enables precise, timely and uniform nutrient delivery at the critical flowering stage, overcoming constraints of manual spraying in tall crops. Frontline demonstrations have shown that this technology significantly improves seed yield, oil content and economic returns with minimal additional cost. By reducing labour dependence, ensuring better nutrient use efficiency, and improving crop performance, drone-based boron application promotes sustainable sunflower cultivation and supports higher productivity and farm income.*

**Keywords:** Balanced micronutrient management, Drone, Farmer-friendly precision agriculture

SUNFLOWER (*Helianthus annuus* L.) is one of the most important oilseed crops grown in India due to its short duration, adaptability to diverse soils and climates, fitting into various cropping systems and high-quality edible oil. Sunflower crop matures within 90–105 days and grows well under both irrigated and rainfed conditions. Sunflower oil is preferred by consumers due to its light colour, high linoleic acid content, and health benefits.

Sunflower occupies an area of 0.19 million hectares, producing 0.24 million tonnes with a productivity of 1,397 kg/ha at national level. While in Telangana state, sunflower is cultivated in an area of 8.62 thousand hectares with a production of 14.07 thousand tonnes. The crop is grown during *rabi* season with an average productivity of 1,632 kg/ha, which is above the national average. There is further scope to improve the productivity of sunflower in the state

by adopting balanced nutrition, particularly foliar spray of boron as it plays a significant role, but often not applied by the farmers due to the height of the crop at ray floret opening stage. The advent of drone technology has provided an opportunity to the farmers for taking up boron spray which is precise, timely, and cost-effective solution.

In order to show the production potential and profitability of drone-based spray of boron in the farmers' fields, frontline demonstrations (FLDs) were conducted during 2022-2025 *rabi* season in Siddipet

district of Telangana. The FLDs conducted by ICAR-Indian Institute of Oilseeds Research (IIOR) have shown that foliar application of boron at ray floret opening stage significantly improved seed yield, oil content, and economic returns in sunflower. In Siddipet district, paddy is the predominant crop grown during *kharif* and off late season with farmers prefers to grow paddy even during *rabi* season. The efforts of ICAR-IIOR has resulted in crop diversification during *rabi* in Narayanaopet and Chinnakoduru mandals, Siddipet district. In rice-sunflower systems, boron becomes unavailable under prolonged flooding and is not adequately replenished for the succeeding sunflower crop. In many cases, crops appear healthy during the vegetative stage but fail to produce full heads due to boron deficiency at the time of flowering.



## Importance of boron and drone-based application

Boron is involved in several physiological and biochemical processes, including cell wall formation, membrane integrity, sugar transport, hormone regulation, pollen germination, and fertilisation. Adequate boron supply ensures proper development of reproductive organs, effective pollen tube growth, and successful seed set. Deficiency of boron disrupts these processes and results in poor fertilisation, malformed heads, chaffy seeds and ultimately lower yield and oil content. Boron is toxic at 1.0–1.5 mg/kg soil, which is rare in Indian soils and 1,130 mg/kg in plant tissue.

Among different methods of micronutrient application, foliar spray is the most effective and economical way that ensures quick absorption to the plant at the critical stage. With the advent of agricultural drones, foliar application has become even more effective. Drone-based spraying ensures micronutrient solutions applied uniformly across the field. For sunflower, drone-based boron application offers several advantages like uniform spray coverage, timely application, and reduced water requirement compared to conventional spraying and faster operation, especially in large fields.

**Table 1.** SOPs developed for drone-based application

| Particulars             | Standard operating procedure (SoP) |
|-------------------------|------------------------------------|
| Drone flying speed      | 4.5–5.0 m/sec                      |
| Height above the canopy | 1.5–2.5 m                          |
| Water volume            | 25 L                               |
| Nozzles type and no.    | Anti-drift Flat fan; 4–6 nozzles   |
| Suitable time of spray  | 6–10 am                            |
| Wind speed              | < 3 m/sec                          |
| Temperature             | < 35°C                             |
| Spray fluid (L)         | 40 L                               |
| Boron                   | 1,000 g/ha                         |

## Frontline demonstrations (FLDs) on drone-based application of boron

The FLDs were conducted with drone based foliar spray of boron



Drone-based application of boron in sunflower

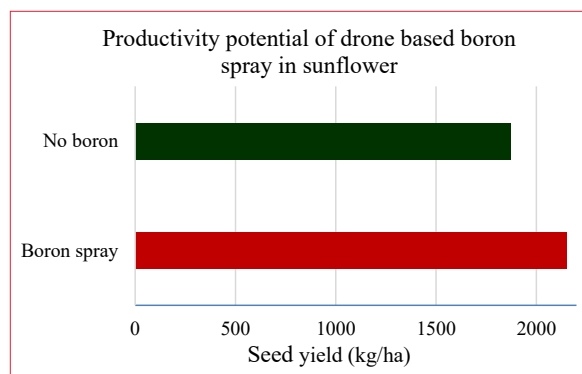
@ 0.2% at ray floret opening stage. The SOPs developed for drone-based application in safflower by PJTAU were followed for boron spray in sunflower. Focussed group discussions were organised with the farmers on the importance of micronutrient management with specific reference to drone-based application of boron in sunflower. Farmers were also apprised of the benefits of use of boron in sunflower. Each FLD was conducted in an area of 0.40 ha and the rest of the field acted as farmers practice (no application of boron). The idea was to provide an opportunity for the farmers to compare and evaluate the results based on the visual differences in the field. Field days were also organised each year at peak flowering and seed setting stage to show the results to other farmers in the village and nearby villages. Discussions were held with farmers with the involvement of extension functionaries to understand the benefits of drone-based spray of boron in sunflower.

## Yield enhancement and economic returns

Across all three years, sunflower under drone-based spray of boron consistently performed better than no boron spray. The mean seed yield was 2,150 kg/ha under boron spray as compared to 1,870 kg/ha in farmers practice

of no boron spray. This resulted in an average yield advantage of about 15% over no boron spray indicating stable and repeatable performance of drone-based boron spraying. The mean cost of cultivation was ₹27,850/ha with boron spray as compared to ₹26,900/ha without boron spray and mean gross monetary returns were ₹1,45,308/ha with boron spray as compared to ₹1,26,402/ha without boron spray. The additional net returns (ANR) clearly demonstrated the economic advantage of improved technology. The mean ANR of ₹18,906/ha indicated that adopting drone-based boron spraying generated extra income compared to no boron spray with an additional investment of ₹950/ha. The higher B:C ratio confirms the economic feasibility and better performance of drone-based boron application.

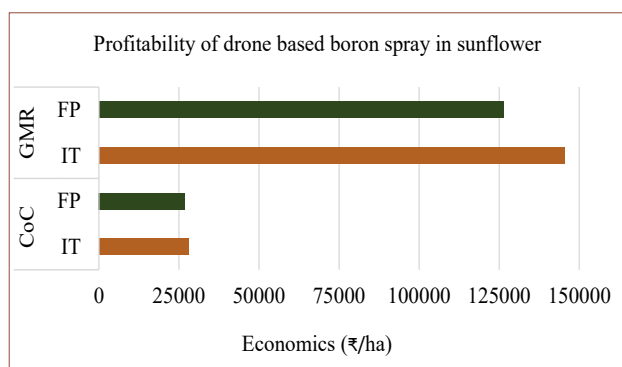
The results clearly indicated that boron spray at the ray floret opening stage played a major role in enhancing sunflower productivity by increasing the number of fertilised



Yield improvement with drone-based boron spray in sunflower



Boron sprayed field of sunflower



Comparison of profitability of drone-based boron spray in sunflower

GMR: Gross monetary returns, CoC: Cost of cultivation, FP: Farmer practice, IT: Improved technology.

florets, pollen viability and proper movement of sugars to developing seeds. Foliar boron spray ensures that these physiological processes occur smoothly, leading to bold, uniform, and well-filled sunflower heads.

Farmers' feedback indicated that drone-based sprays resulted in easy and timely application even when the crop height was above the waist level, uniform crop response across the field, reduced dependence on labourers and visible improvement in head size and seed filling. Many farmers observed that a single drone spray of boron made a noticeable difference in crop performance.

the starting home point of the drone for flying.

- ❖ Do not fly drone very close to the crop canopy, it may cause crop lodging.

#### Operational constraints

Major constraints in up scaling the drone-based sprays are lack of skilled manpower to handle the drones, SOPs for plant protection and nutrients sprays, licensing, approvals, safety standards and regulatory compliances. Further, the capacity of the drones in terms of battery time, frequent recharging at field level and quantity of spray fluid are the bottle necks being faced by the farmers at field level.

However, the custom hiring services on drone-based spraying being provided at most of the villages has a positive effect in overcoming these constraints.

#### SUMMARY

Balanced micronutrient management is essential for realising the yield potential of sunflower, particularly in intensive cropping systems where deficiencies often go unnoticed until the reproductive stage. Among micronutrients, boron plays a critical role in pollen viability, fertilisation, seed setting, and oil formation, yet its application is frequently neglected due to practical difficulties in manual spraying on sunflower crop. The emergence of drone technology as an efficient and precise solution for foliar application of boron, enabling uniform coverage, timely application at the critical ray floret opening/early flowering stage, with reduced labour and water use is a boon to farmers. Frontline demonstrations conducted by ICAR-IIOR in Telangana demonstrated that drone-based foliar application of boron @ 0.2% as recommended for manual spray significantly improved seed yield, head size, oil content, and economic returns compared to farmers' practice of no spray of boron. The technology resulted in 15% higher seed yield, increased gross and net monetary returns and a superior benefit-cost ratio, proving its economic feasibility. Beyond yield gains, drone spraying minimised crop damage, ensured uniform crop response and addressed labour scarcity issues. Overall, drone-based boron application represents a smart, sustainable and farmer-friendly precision agriculture technology that enhances sunflower productivity and profitability.

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