Boron for Boosting Makhana(*Euryale ferox*)Yield and Quality

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Makhana (*Euryale ferox* Salisb.), also known as Fox nut, Gorgon nut, and Euryale seed, is fast emerging as a superfood globally owing to its richness in medicinal values and mineral contents (Jha et al 2018, Kumar et al 2020a). It is an aquatic crop, grown mostly in India, China, Japan, South Korea, Bangladesh, Russia and a few other countries of the world.

A view of Makhana crop grown at ICAR-NRC for Makhana, Darbhanga

Conventionally, Makhana has been growing in wild form in ponds and natural water bodies with not much management interventions, but owing to the recent rise in its global demand, led by growing awareness about its medicinal and nutritive values, Makhana has received unparalleled focus in recent times. And, to exploit its economic potential, this crop is being increasingly cultivated in field conditions as well with relatively lesser water requirements (Singh et al 2020; Kumar et al 2021). Observations suggest that field cultivation of Makhana is several folds more remunerative than rice and wheat, the two most commonly grown crops in south Asia including India (Kumar et al 2020b).

As the field cultivation of Makhana has just begun, it's essential to develop nutrient management strategies to exploit its yield potential (Fig. 1). As compared to its productivity in pond system of cultivation (1.4–2.2 t ha-1), the productivity is reported to be much higher (more than 2.5 t ha-1) in field conditions (Kumar et al. 2011) due to better feasibility of nutrient management and plant protection interventions in field system of cultivation. As regards nutrient management strategies in Makhana, primary nutrients' (NPK) recommendation is of general farmers' knowledge, with little known about the impact of micronutrients on the yield and quality of Makhana. In a recent study on nutrient management in Makhana, Singh et al. (2020) reported 19% yield enhancement with NPK application @100:60:40 kg ha-1 as compared to control (no nutrients' application), with no further yield improvement being observed at higher NPK doses. In line with the concept of Liebig's law of the minimum, they explained that micronutrients' could be the most yield limiting factors that might have denied any possibility of yield enhancement at higher doses of NPK application. Critical importance of micronutrients in improving the effectiveness of primary nutrients has also been stressed by Kumar et al (2016).

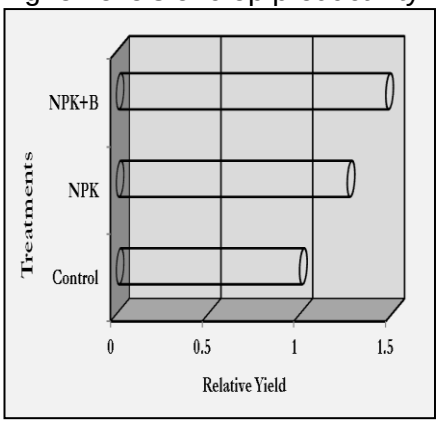
Boron for boosting Makhana

Boron is the most deficient micronutrient in Indian soils after zinc with more than 33% of the soils being deficient in B availability (Rattan et al 2009). Its deficiency is particularly prevalent in eastern and northeastern regions with relatively more rainfall. The fact that Makhana is grown mostly in eastern India makes B an unavoidably important micronutrient for growth and yield of this miraculous crop. Since nearly 90% of the national Makhana production is contributed by this B-deficient area, it's critically important to know how B fertilization could affect the yield and quality of Makhana in this region.

In the latest study, and only study available on effect of B fertilization on Makhana yield and quality, Kumar et al 2022 reported significantly improved Makhana yield and seed quality consequent to soil application of B in a sandy loam soil of subtropical climate. In a three-year field experiment, the impact of B fertilization vis-à-vis NPK applications on yield and quality of Makhana was evaluated at ICAR-NRC for Makhana, Darbhanga.

Boron fertilization @1.0 kg ha-1 along with NPK@100, 60 & 40 kg ha-1 increased the relative yield of Makhana up to 1.47, compared to 1.0 at control (no fertilization) and 1.26 with NPK application without B fertilization (Fig. 2). Interestingly, the magnitude of B application effect was very close to that of NPK application, which was mediated mostly through their positive effect on seed weight and size. Share of seeds with more than 10 mm diameter was 79 % in NPK+B fertilized crop compared to 76% in crop receiving only NPK and 69% in crop receiving no external fertilization at all (control). B application also helped in improving or at least

sustaining the seed protein and other nutrient content even at higher levels of crop productivity.



Effect of NPK and B fertilization on relative yield of Makhana

The encouraging effect of B on seed yield was attributed to its widely accepted role in chlorophyll synthesis, photosynthesis, carbohydrate translocation, flowering, seed formation and filling, and plants generative growth (Szulc & Rutkowska, 2013; Kumar, 2022). The fact that experimental soil was deficient in B availability (hot water extractable B - 0.4 ppm) also contributed to the yield boosting effect of B fertilization in the study. It's also to be noted that the critical limit of hot water extractable B in Indian soils is 0.5 ppm. Since more than one-third of Indian soils are B deficient, with the B deficiency further aggravating with time particularly in north-eastern and eastern India, B fertilization is logically expected to yield similar positive effects on Makhana yield and quality in the region.

Conclusion

As the awareness about nutritive and medicinal value of Makhana is growing globally, the demand for this super food is skyrocketing which presents a unique opportunity for Makhana farmers to improve their income and livelihood. To exploits the yield potential of this miraculous aquatic crop, B fertilization has been found to boost the yield as well as seed quality of Makhana. It is therefore recommended to practice boron fertilization @1.0 kg ha-1along with usual doses of primary nutrients to improve yield, seed quality and net income from Makhana cultivation in eastern India and beyond. .

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