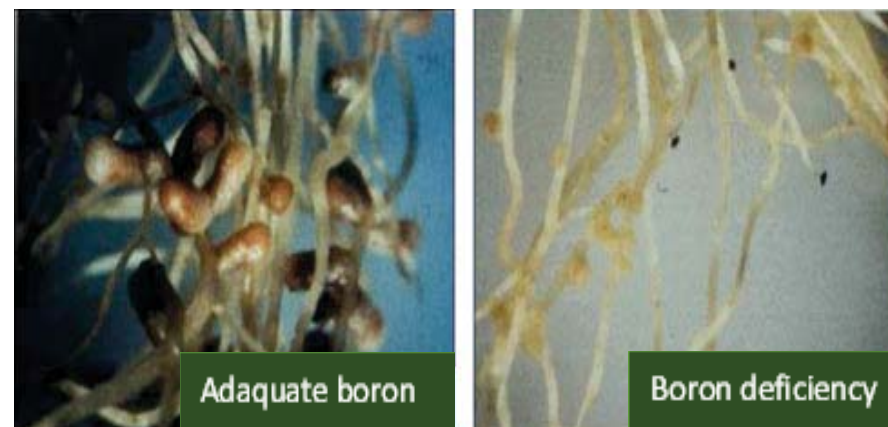


# SOYBEAN

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Soybean plant is the most produced oilseed plant. One of the problems frequently encountered in soybean plant in terms of mineral nutrition is the problem of boron deficiency. Boron deficiency causes negative effects on both the yield capacity and oil quality of the plant.

As it is known, boron has many different physiological and morphological functions in plants. In the case of legumes, boron also has important roles in nitrogen fixation, nodule formation and nodule function. It is known that the nodule forming capacity of legumes decreases significantly and nitrogen fixation decreases in case of severe boron deficiency (Figure 1). These results indicate that an adequate boron nutrition has positive effects on the nitrogen nutrition level and protein formation capacity of legumes.



**Figure 1.** The effect of sufficient and insufficient B nutrition on root nodule formation in pea plants [Bolanos et al. 1994] .

It is reported that there is an increase in protein concentration in the grain with the improvement of boron nutrition in soybean plant. This result is complied with the positive effects of boron on both nitrogen fixation and nodule forming capacity. The critical boron deficiency limit value in soybean is mostly reported as 20 mg/kg. If there is boron below 10 mg/kg in the seed, it is considered as a sign that there is a boron deficiency problem in the plant.

### Soil Application:

1-2 kg ha<sup>-1</sup> B can be applied before or during sowing.

### Foliar Application:

30 grams of B dissolved in 100 liters of water can be applied 10-15 days before blossoming.



**Figure 2.** Root growth of soybean fed with adequate and deficient levels of boron [Çakmak et al. 2022, unpublished results].

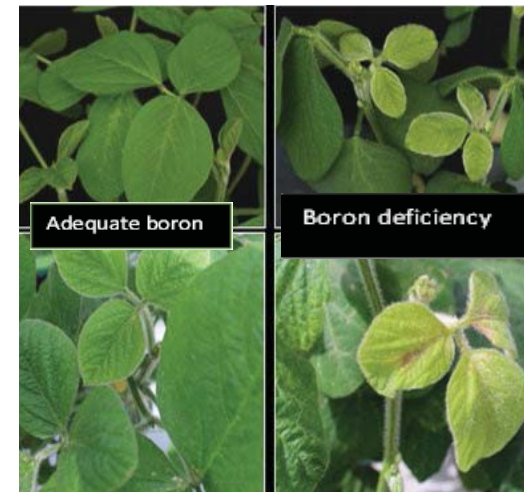
It is known that phloem transport of boron is very limited in soybean plant as in most other plant species. Due to the very limited transportability of boron in the plant, both above and below ground active growth points in soybean plants are hypersensitive to boron deficiency. [Figure 2] With the progression of boron deficiency, roots gradually become darker and turn brown, and sudden stops are observed in root elongation and development of lateral roots.

As the boron deficiency progresses, the actively growing parts of the green parts are also severely affected by the boron deficiency and the green part growth of the plant shows a significant decrease. [Figure 3] With the exacerbation of the deficiency in soybean, significant regressions occur in longitudinal elongation and green part biomass production decreases.



**Figure 3.** Effect of B applied at increasing rates on root and green part growth of soybean on the 13th and 22nd days after germination [Çakmak et al. 2022, unpublished results].

In boron deficiency, growth activity decreases and comes to a stopping point in the growth points of the green parts and the youngest leaves, as well as the growth at the root tips. Necrosis and yellowing are seen on the youngest leaves, the leaves remain small as a result of growth arrest and sometimes show shedding with tissue death. [Figure 4]



**Figure 4.** Youngest leaves of soybean fed with deficient and adequate B [Çakmak et al. 2022, unpublished results].

As stated above, there are many studies showing that grain boron concentration in soybean plant can be used as an indicator of boron deficiency. For example, it was emphasized that severe boron deficiency symptoms are observed in plants if the grain boron concentration is below 5 mg kg<sup>-1</sup>, and mild deficiency symptoms are observed between 6-10 mg kg<sup>-1</sup>. It was suggested that there should be around 20 mg kg<sup>-1</sup> boron in soybean seeds in order to avoid the aforementioned germination problems. Soil analysis must be done before boron fertilization to determine the boron needs of the soil.