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Taifun Soy Info

Specialist information for soybean producers and processors

Soybean leaf analysis

Fertilization recommendations are usually based on soil analysis in order to maintain long-term soil fertility. Often an additional leaf analysis during the vegetation period is useful to be able to quickly remedy short-term deficiency symptoms by leaf fertilization. In addition, symptoms observed in the field can be correctly assigned. In combination with soil analyses, yield losses due to nutrient deficiency can thus be prevented in the long term. If the soil sample results do not indicate a deficiency, but the plant suffers from deficiency according to leaf analysis, the nutrient uptake from the soil is hindered. Reasons for this can be soil compaction, dryness, pH-value of the soil or waterlogging.

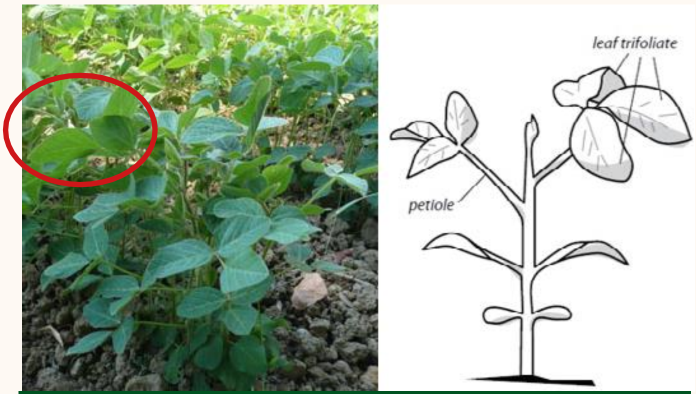

Figure 1: Uppermost fully developed trefoil for leaf analysis. Source: Taifun 2013 (left), Schwab et al. 2007 (right).

Sampling & Shipping

The sampling is decisive for the evaluation of the results. For soybeans, the uppermost fully developed "trefoil" is collected at the time of flowering (Fig. 1). At this time, the plants' growth rate is at its peak and the root system most widely branched, but the nutrient transfer from the leaves to the seeds has not yet begun. The leaves are collected in a paper bag or wrapped in newspaper without a leaf stem.

Leaves from at least 25 plants should be collected evenly distributed over the area to be sampled. If a part of the area stands out due to deficiency symptoms, it should be sampled separately and a sample of the healthy-looking plants should be taken for comparison. When taking the sample, it is essential to ensure that the plant material is clean (no soil or other dirt) and that no leaf fertilizer has been applied beforehand.

Before shipping a protocol must be completed and enclosed with the samples. The protocol must include the name of the area, the sampling date, the crop and the nutrients to be analyzed.

The collected sheets are immediately sent to the laboratory via express delivery – in Germany e.g. with DHL Express before 10:00 a.m. for approx. 30.00 €. This service is available at the local post office, you only have to ask for the latest possible delivery time so that the parcel will arrive the next day.

Analysis of the nutrient elements

In the laboratory the samples are washed and dried before analysis. The samples are then ground and digested by microwave digestion. Cations are analyzed with ICP-OES, nitrogen is taken directly from the ground sample using the DU-MAS method. The cost for an analysis is approx. 60,00 €.

Interpretation of the results

The information provided by three different authors on the optimal range of nutrient supply corresponds quite well (cf. Table 1).

If the values determined in the analysis are below the optimum range, it is important to determine whether there is really a nutrient deficiency in the soil or whether other factors (e.g. pH value of the soil, soil compaction, waterlogging, drought, diseases, pests, etc.) are responsible for the fact that the nutrient cannot be uptaken by the plant.

Nutrient in TM	After Bergmann (Institute for Agricultural and Environmental Analysis)	After Keith Reid, Horst Bohner (www.omafra.gov.on.ca)	After Nathan Mueller (https://igrow.org/)
Nitrogen [%]	4,5 – 5,5	4,0 – 6,0	4,0 – 6,0
Phosphorus [%]	0,35 – 0,6	0,35 – 0,5	0,35 – 0,55
Potassium [%]	2,5 – 3,7	2,0 – 3,0	2,0 – 3,0
Calcium [%]	0,6 – 1,5	n. s. -- 3,0	0,6 – 1,5
Magnesium [%]	0,3 – 0,7	0,1 – 1,0	0,3 – 0,7
Sulphur [%]	0,40 – 0,75	n. s.	0,25 – 0,50
Boron [ppm]	25 – 60	20 – 55	25 – 60
Copper [ppm]	10 – 20	4 – 30	6 – 20
Manganese [ppm]	30 – 100	14 – 100	30 – 100
Molybdenum [ppm]	0,5 – 1	0,5 – 5	1,0 – 5,0
Zinc [ppm]	25 – 60	12 – 80	25 – 60
Cobalt [ppm]	0,01 – 0,4	n. s.	n. s.

Table 1: Optimum range of nutrients in soy leaves (DM) at flowering according to different authors

Values above the optimum do not necessarily mean a toxic effect. They often occur when an antagonist nutrient is deficient. At low soil pH values, manganese toxicity may occur in soy (Yang et al., 2009). In this case the soil pH value must be raised.

Detailed descriptions of deficiency symptoms with photos can be found here:

University of Nebraska-Lincoln: Symptom Identification Key for Nutrient Deficiencies in Soybeans: **Link**

Mississippi State University: Diagnosing Nutrient Deficiencies in Mississippi Soybeans: **Link**

If nutrient tables other than those of the charged laboratory are used as a reference, it is important to pay attention to the time of sampling and the analysis methods. Sometimes the optimum ranges can vary slightly, but there should be no fundamental differences for the same sampling date.

Practical experience

Leaf samples were taken from 12 areas of four organic farms in summer 2014. An overview of the areas is given in Table 2. The results are presented in Table 3. On average, most of the nutrients were supplied in the optimum range. For single nutrients the observed range has been very large. E.g. in one area the boron value has already been in the toxic range. For all areas the potassium values were in the deficiency range. Here, further investigations will be necessary to find the cause. The areas with the most extreme shortage were still being fertilized with potash in spring, as the shortage on these areas results from the soil properties. Sulphur and molybdenum were applied as leaf fertilizer in initial trials on a field (Taifun Soy Info Nr. 6). Copper has also been deficient in three areas of the farm in Halle/Saale and was accompanied by boron surplus. For this area, the values can possibly be explained by earlier forms of land use.

In some cases, the soybeans showed weaker growth or lighter leaf coloring, so that a nutrient deficiency was suspected. However, a connection between symptoms and alleged deficiency was rarely found. Surprisingly, on some plots with dark green leaves, the leaf analysis nevertheless indicated a nitrogen deficiency. Often potassium was also in the deficiency range without any visible symptoms. Molybdenum deficiency occurred on some plots, partly together with nitrogen deficiency. This could be explained by the role of molybdenum in nitrogen fixation. An example of this is shown in Fig. 2, where severe molybdenum deficiency was found with slight N deficiency. The plants also showed a lighter leaf coloration (Fig. 3). Another area, whose test report (Fig. 4) shows a distinct nitrogen deficiency without being visible on the area, is shown in Fig. 5.

Nutrient in DM	**min. - max.**	**Ø over all 12 surfaces**	**Optimum range according to Bergmann**
Nitrogen [%]	3,7 – 5,24	4,53	4,50 – 5,50
Phosphorus [%]	0,27 – 0,36	0,31	0,35 – 0,60
Potassium [%]	1,04 – 2,82	**1,94**	2,50 – 3,70
Calcium [%]	0,97 – 1,47	1,37	0,60 – 1,50
Magnesium [%]	0,23 – 1,69	0,47	0,30 – 0,70
Sulphur [%]	0,22 – 0,3	**0,26**	0,40 – 0,75
Boron [ppm]	23 – **150**	61	25 – 60
Copper [ppm]	**3** – 26	10	10 – 20
Manganese [ppm]	31 – 78	53	30 – 100
Molybdenum [ppm]	**0,03** – 3,8	0,84	0,50 – 1,00
Zinc [ppm]	22 – 65	42	25 – 60
Cobalt [ppm]	0,01 – 0,15	0,06	0,01 – 0,40

Table 3: Overview of the leaf analysis results of all 12 sampled areas.

Area	**Location**	**Type of soil**	**pH in soil**	**Soil points**
a+b	Eichstetten/Kaiserstuhl	Clay	6,5 – 7,1	51 / 65
2a+b	Buggingen/Upper Rhine	Loess loam /sand loam	6,8 – 7,3	81 / 65
3a+b	Heitersheim/Upper Rhine	Clay	??	28 / 45
4a,b,c	Halle/Saale	Loamy sand /sand loam	6,4 – 6,9	30 / 40 / 60

Table 2: Description of the sampling areas

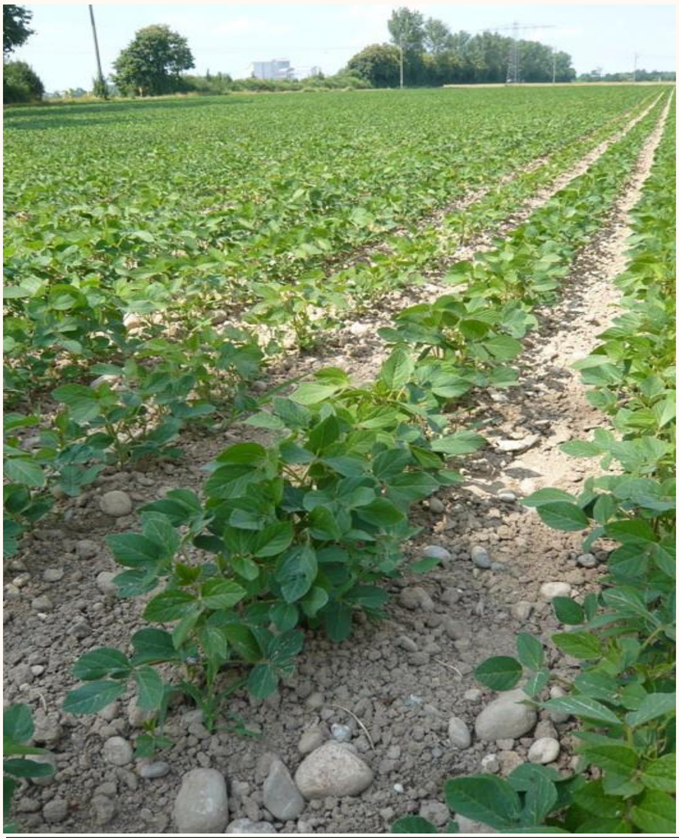

Figure 3: Area 1 with moloybdenum deficiency. Photo: Taifun, 2014.

Test report

A: malnourished range B: target range C: oversupplied

Element	Unit	min*	max*	Actual value	Assessment of the nutritional status: A	B	C
Nitrogen	% TS	4,50	5,50	**4,38**			
Calcium	% TS	0,60	1,50	**0,98**			
Phosphorus	% TS	0,35	0,60	**0,29**			
Potassium	% TS	2,50	3,70	**2,34**			
Magnesium	% TS	0,30	0,70	**0,28**			
Sodium	% TS	n.d.	n.d.	**0,03**			
Sulphur	% TS	0,40	0,75	**0,22**			
Boron	ppm	25,0	60,0	**35,1**			
Manganese	ppm	30,0	100	**70,4**			
Copper	ppm	10,00	20,0	**7,61**			
Zinc	ppm	25,0	60,0	**25,7**			
Iron	ppm	n.d.	n.d.	**101,4**			
Molybdenum	ppm	0,50	1,00	**0,03**			
Cobalt	ppm	0,01	0,40	**0,13**			

Water content	%			**missing**
Dry substance	%			**missing**

*min. Limit value according to Bergmann, TLL 1999 and own limit values
*max. limit value according to Bergmann, TLL 1999 and own limit values
***For the application you should follow the recommendation of the manufacturer.
Analysis methods: Total N according to VDLUFA Methods Book II, 3.5.2.7
Micro- and macronutrients according to VDLUFA Methods Book II. 2.2.2.6, 2nd part

Figure 2: Results of the leaf analysis of area 1 with severe molybdenum deficiency (Institute for Agricultural and Environmental Analysis, 2014).

Test report

A: malnourished range B: target range C: oversupplied

Element	Unit	min*	max*	Actual value	Assessment of the nutritional status: A	B	C
Nitrogen	% TS	4,50	5,50	**3,97**			
Calcium	% TS	0,60	1,50	**0,97**			
Phosphorus	% TS	0,35	0,60	**0,28**			
Potassium	% TS	2,50	3,70	**1,92**			
Magnesium	% TS	0,30	0,70	**0,23**			
Sodium	% TS	n.d.	n.d.	**0,03**			
Sulphur	% TS	0,40	0,75	**0,23**			
Boron	ppm	25,0	60,0	**25,3**			
Manganese	ppm	30,0	100	**52,9**			
Copper	ppm	10,00	20,0	**7,47**			
Zinc	ppm	25,0	60,0	**22,0**			
Iron	ppm	n.d.	n.d.	**102,5**			
Molybdenum	ppm	0,50	1,00	**0,10**			
Cobalt	ppm	0,01	0,40	**0,14**			

Water content	%			**missing**
Dry substance	%			**missing**

*min. Limit value according to Bergmann, TLL 1999 and own limit values
*max. limit value according to Bergmann, TLL 1999 and own limit values
***For the application you should follow the recommendation of the manufacturer.
Analysis methods: Total N according to VDLUFA Methods Book II, 3.5.2.7
Micro- and macronutrients according to VDLUFA Methods Book II. 2.2.2.6, 2nd part

Figure 4: Results of leaf analysis of area 2 with non-visible N and Mo deficiency (Institute for Agricultural and Environmental Analysis, 2014).

In the case of visible defects, a leaf analysis is a simple and reliable tool for assigning the symptoms to a nutrient element. In case of severe deficiencies, leaf fertilization can be applied to avoid yield deficits. Quotation Prof. Antonio Malla-Rino, Iowa State University: Leaf fertilization "can be used to correct problems. (...) I recommend foliar fertilization only as a rescue treatment."

Figure 5: Area 2, which appears to be sufficiently supplied, but whose analysis results indicate N and Mo deficiency (Figure4). Photo: Taifun, 2014.

Sources

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