Issue No 6, December 2014

Taifun Soy Info

Specialist information for soy producers and processors

Leaf fertilization of soybeans

Background

Nutrient uptake by plants mainly occurs via the roots. However, small amounts of nutrients can also be absorbed through the leaves. As in the case of uptake from the soil, there are many factors influencing uptake by the leaves (Marschner, 1995): thickness of the cuticle, hydrophobic leaf surface, washing off by rain, rapid drying in the sun, relocation of nutrients, limited amounts of nutrients that can be applied, leaf damage e.g. by burns. However, there are also some advantages of leaf fertilization. Micronutrients are quickly available, so that a deficiency during the vegetation period can be compensated. All in all, however, leaf fertilization should only be an additional tool and the actual nutrient supply should take place via the soil. If the soil is sufficiently supplied with nutrients and the plant still shows deficiency symptoms, the reasons for the blocked uptake have to be found (soil compaction, pH-value, dryness, waterlogging) instead of treating the symptoms with leaf fertilization.

History of leaf fertilization of soybeans

In the 1970s and 1980s, hundreds of experiments were carried out on leaf fertilization in late growth stages of soybeans. The idea behind the experiments was that at this growth stage the root activity decreases and the plant relocates nutrients from the leaf to the seeds. If additionally supplied with nutrients by the leaves, the plant would hence be able to produce higher yields.
The results of these experiments are extremely contradictory and range from an increased yield of about 3 dt/ha to a loss of 4 dt/ha (Mallarino, 2008).

Subsequently, the focus has been laid on tests carried out on soybeans in early growth stages (see Fig. 1). Rosolem et al (1982) found no influence of N-P-K leaf fertilization at 30, 45, 60 and 75 days after emergence. Mazhar and Mallarino (1998) showed in a trial with 48 sites that also in early stages leaf fertilization in soy does not allow clear statements on yields (V5). On 7 plots the yield increased significantly compared to the unfertilized control, on 2 plots it was significantly reduced. Otherwise no significant differences were found. Further, the different P and K contents of the soils did not provide sufficient explanation. Further experiments with different fertilizer mixtures (N, P, K, S, B, Zn, Fe) at stage V5 also showed no effects (Mallarino et al., 2001).

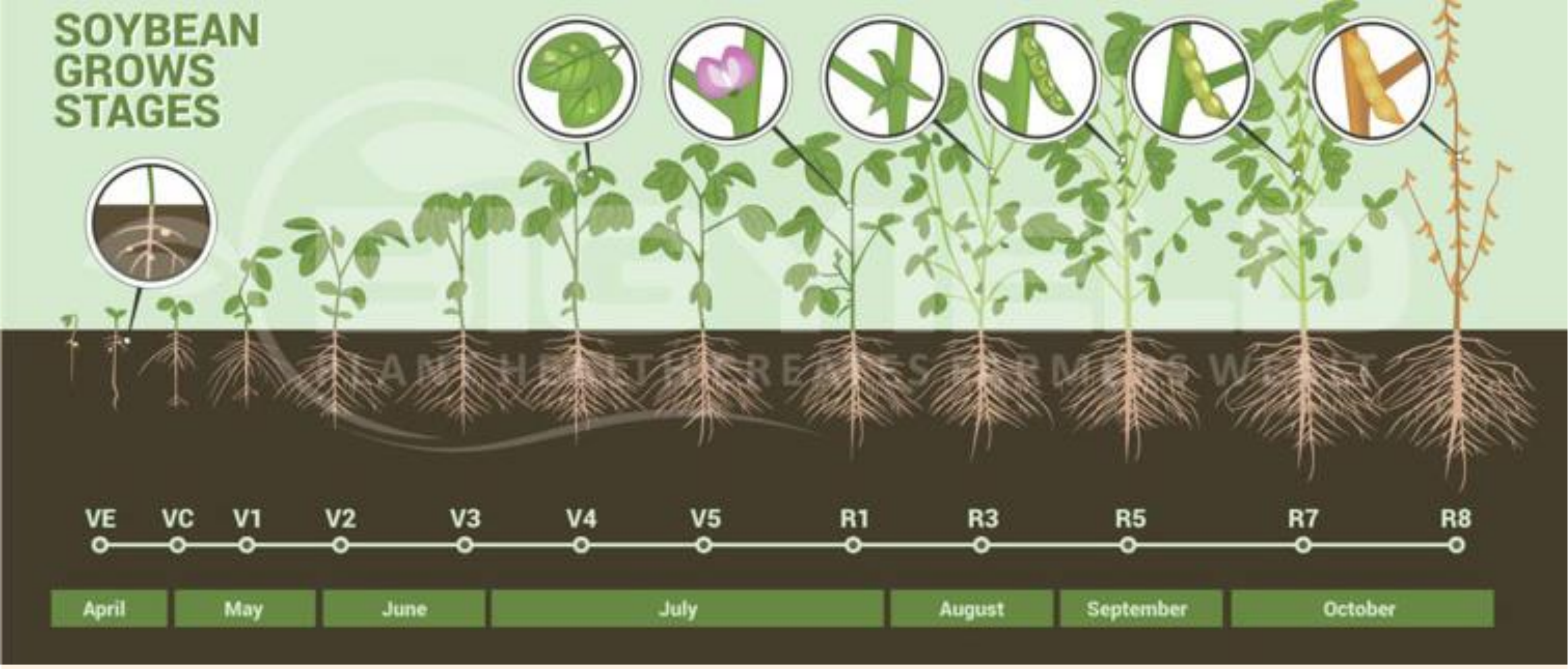

Figure 1: Soybean growth stages. Source : http://mashastudio.net/portfolio/soybean-grows-stages/.

Leaf fertilization in practice

The fluctuating results of the many experiments show that the costs and benefits of leaf fertilization must be weighed against each other. In conventional agriculture, the costs are rather negligible, since foliar fertilization can be applied in connection with herbicide spraying and thus only the costs for the fertilizer itself occur.

In a practical trial in 2014 on an organic farm, leaf fertilizer was applied to two plots. After analysis of the leaf samples, a strong molybdenum deficiency was found on one plot (sowing date: 17. 5. 2014, soil rating of 28 points, variety: Korus) and a Sulphur deficiency with a slight magnesium deficiency on the second plot (sowing date: 18. 5. 2014, 45 points, variety: Primus). For details see Fig. 2 and 3. Suitable leaf fertilizers were selected from the list of fertilizers approved for organic farming (www.betriebsmittelliste.de/bml_suche.html) and applied to both areas in combination.

For molybdenum the following pure nutrient fertilizers are available: Provita molybdenum (Beckmann & Brehm GmbH), Folicin-Mo (JOST GmbH) and LEBOSOL®-molybdenum (Lebosol Dünger GmbH). LE-BOSOL® molybdenum (15.6 % water-soluble molybdenum) was selected for spraying and, after consultation with the regional consultant, 0.25 l was sprayed with 400 l of water per hectare and application date. EPSO Top® (K+S KALI GmbH) with 16% MgO water-soluble magnesium oxide and 13% S water-soluble Sulphur with an application rate of 20 kg in 400 l water per ha and application date was selected as the Mg-/S fertilizer.

The first fertilization took place on 16.07.14, approx. 60 days after sowing. The second application on plot 1 three weeks later on 04.08.14. In each case one control strip was left unfertilized.

The costs for the one-time fertilization were:

Fertilizer:1 x 0.25l Lebosol molybdenum= 15 €/ha

1 x 20 kg EPSO Top = 7 €/ha

Labor cost: 1x spraying with 12 m, each ½ h per ha: 20 €/ha

Test report

A: malnourished range   B: target range   C: oversupplied

					Assessment of the nutritional status		
Element	**Unit**	**min***	**max***	**Actual value**	**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 of FG 2003

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

Test report

A: malnourished range   B: target range   C: oversupplied

					Assessment of the nutritional status		
Element	**Unit**	**min***	**max***	**Actual value**	**A**	**B**	**C**
Nitrogen	% TS	4,50	5,50	**4,13**			
Calcium	% TS	0,60	1,50	**1,09**			
Phosphorus	% TS	0,35	0,60	**0,29**			
Potassium	% TS	2,50	3,70	**2,16**			
Magnesium	% TS	0,30	0,70	**0,26**			
Sodium	% TS	n.d.	n.d.	**0,03**			
Sulphur	% TS	0,40	0,75	**0,22**			
Boron	ppm	25,0	60,0	**23,3**			
Manganese	ppm	30,0	100	**78,1**			
Copper	ppm	10,00	20,0	**11,50**			
Zinc	ppm	25,0	60,0	**23,9**			
Iron	ppm	n.d.	n.d.	**79,3**			
Molybdenum	ppm	0,50	1,00	**0,60**			
Cobalt	ppm	0,01	0,40	**0,02**			

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 of FG 2003

Figure 3: Results of leaf analysis of area 2 with Sulphur deficiency and slight magnesium deficiency (Institute for Agricultural and Environmental Analysis, 2014).

One week after the 2nd application, leaf samples of fertilized and unfertilized plants were taken to determine differences due to the fertilization. In comparison to the control of the 1 and 2 times fertilized variants, no increasing effect on the concentration of the fertilized elements in the leaves could be detected (Table 1). This can be explained by the weather conditions in this year. At the time of the first sampling the soil was extremely dry, but shortly afterwards the weather conditions were very humid again until the second sampling. This probably also led to a rapid relocation of the nutrient elements. It was also reported by other companies that an effect could only be observed in extremely dry years. According to the area consultant of K+S, it is often difficult to see direct effects in the leaf for magnesium, because the Mg values fluctuate only within a very narrow range. However, yield differences may nevertheless occur. In addition, it is also known from Canada that leaf fertilization for soy has not become generally accepted despite numerous attempts (see above). However, we wanted to see for ourselves and were encouraged by the initially very low values of individual nutrients. In addition, it was also the wish of the affected farmer to carry out a first trial, which we naturally supported.

Area 1	**unfertilized**	**1 x fertilized**	**2x fertilized**
Mg [% TS]	0, 18	0,13	0,11
S [% TS]	0,2	0,21	0,22
Mo [ppm]	2,3	0,6	1,2
Area 2	**unfertilized**	**1 x fertilized**	
Mg [% TS]	0,2	0,19	
S [% TS]	0,2	0,22	
Mo [ppm]	1,4	0,5	

Conclusion:

Although leaf fertilization is often used as an emergency measure in case of deficiency symptoms in other crops, it rarely shows the desired effects in soybean cultivation. An evaluation of the literature from the USA and Canada already showed that there is no clear evidence of the desired effects.

In these main growing areas, leaf fertilization is not used for soy. On the one hand, the scientific tests do not provide any meaningful results. On the other hand, it is also clear that in practice there are no positive effects. A large farmer from Canada, Fiete Suhr with 300 ha of his own land and more than 3000 ha with contractors, clearly reports no positive effects of leaf fertilization on the yield. Further, in our experiment no increased amount of nutrients in the leaves could be observed after leaf fertilization. However, the test presented here is only to be seen as a small experiment which is not statistically reliable. Further research is indispensable in order to better understand the leaf fertilization of soy and possibly be able to apply it in a targeted manner.

In summary, it can be said that in most cases foliar fertilization of soy has not achieved the expected effects and therefore the benefits of foliar fertilization are lower than the costs.

A balanced nutrient availability in the soil is still the most important factor and cannot be compensated by short-term leaf fertilization. A quote from the USA describes foliar fertilization for soy as
"Dessert, but not meat and potatoes." (Dan Conroy, Nachurs/Alpine Solutions, Marion, Ohio)

Sources

Marschner, H. 1995. Mineral nutrition of higher plants. 2nd edition London: Academic Press.

Mallarino, A. P. 2008. What about foliar fertilization for soybean this year? http://www.extension.iastate.edu/CropNews/2008/0703Mallarino.htm

Mallarino, A. P., Mazhar, U. H., Wittry, D. and Bermudez, M. 2001. Variation in Soybean Response to Early Seas-pn Foliar Fertilization among and within Fields. Agronomy Journal, 93 (1220-1226).

Mazhar, U. H., Mallarino, A. P. 1998. Foliar Fertilization of Soybean at Early Vegetative Stages. Agronomy Journal, 90 (763-769).

Rosolem, C.A., Silverio, J.C.O., und Primaves, O. 1982. Soybean foliar fertilization: II. Effects of NPK and micronutrients. Pesquisa Agropecuária Brasileira, 17 (1559-1562).

For comprehensive information on all aspects of soy cultivation visit:

Imprint
Author: Kristina Bachteler
Editorial assistance: M. Miersch
Publisher: Taifun-Tofu GmbH
Bebelstraße 8 | 79108 Freiburg | Tel. 0761 152 10 13
soja@taifun-tofu.de

Taifun Zentrum für Sojaanbau

Funded by the Federal Ministry of Food and Agriculture on the basis of a resolution of the German Bundestag within the framework of the BMEL Protein Crop Strategy.

ptble Projektträger Bundesanstalt für Landwirtschaft und Ernährung

Gefördert durch: Bundesministerium für Ernährung und Landwirtschaft

aufgrund eines Beschlusses des Deutschen Bundestages