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GERMAN-UZBEK
KHOREZM PROJECT

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Improving nitrogen use efficiency with modern means

Nitrogen (N), an essential plant mineral, is applied as N-fertilizer worldwide including Uzbekistan. However, its use can pollute the environment and farmers have to buy it. Scientists in Khorezm have calibrated equipment to estimate exactly how much N a crop needs during the growing season as to improve efficiency, reduce costs and minimize the pollution of precious groundwater resources.

To optimize crop yields, farmers need to match the timing and amount of N-fertilizers applications with the N-demand of crops during their vegetation cycle. To assess how much N winter wheat for instance needs, current applications in Khorezm are based on analyses of soil and sometimes plant tissue. Although the outcomes are reliable, such analyses require sophisticated laboratory equipment, funds and time. Furthermore, the sampling of soil and plant tissue, transport to the laboratory and analyses there are time-consuming. Consequently, farmers rarely obtain timely information on N demand of plants during the season. Hence they apply N-fertilizers without knowing if, and how much N is needed exactly. An over-application of N-fertilizers not only causes unnecessary costs for farmers, but also pollutes the air (ZUR 4) and the groundwater. Moreover, it may affect grain quality (ZUR 6).

SPAD 502 Chlorophyll meter value	Required Nitrogen fertilizer, kg ha^{-1}
<40	100
41-43	96
44-47	72
48-50	48
51-53	36
54-57	12

Table 1: SPAD based N-fertilizer rates at tillering of winter wheat

Testing equipment for measuring N

Scientists in the ZEF/UNESCO project have now tested and calibrated the SPAD-502[1] chlorophyll meter or the "Green Seeker" for local use in Uzbekistan, which is used already by farmers in Europe, the US and India. These easy-to-use sensors are based on measurements that do not destruct the plants and inform the user on the amount of N needed during the growing season. By matching N application rates with crop demand the waste of N can be reduced and thus N use efficiency increased. It is also possible to estimate the spatially variable demand of N within one field. The SPAD meter has been calibrated in Uzbekistan for cotton, winter wheat and short and long duration maize.

Area, ha	Saving, %	Cotton				Wheat			
		N	Ammonium nitrate (N 34,5%)			N	Ammonium nitrate (N 34,5%)		
		ton	Ton	Thsnd UZS	USD*	ton	ton	thsnd UZS	USD*
1	1	0.002	0.006	1.6	1.0	0.002	0.005	1.4	0.9
	5	0.01	0.029	7.9	5.0	0.009	0.026	7.1	4.5
	10	0.02	0.06	15.8	9.9	0.02	0.05	14.2	8.9
100**	1	0.2	0.6	158.1	99.1	0.2	0.5	142.3	89.2
	5	1.0	2.9	790.3	495.5	0.9	2.6	711.3	445.9
	10	2.0	5.8	1,580.6	991.0	1.8	5.2	1,422.6	891.9
Khorezm***	1	188	544	148,264	92,956	60	173	47,230	29,611
	5	938	2,719	741,322	464,779	299	866	236,148	148,055
	10	1,876	5,438	1,482,644	929,557	598	1,732	472,296	296,111

* Exchange rate (as of 29.06.2010) 1 USD = 1595 UZS
***Total cotton area in Khorezm – 98,300 ha, and wheat – 33,200 ha

** An average size of a private farm

Table 2: Potential savings with the SPAD sensor in the Khorezm region.

How to use the SPAD meter?

The SPAD-502 fits into a trouser pocket and weighs 225 g only. Measurements are taken by simply inserting a leaf in the measuring head (see picture). The leaf does not have to be cut and can thus be re-measured throughout the growing season.

SPAD measurement in winter wheat at heading stage

Advantages of using the SPAD meter

SPAD meter readings assess the N status of crops any time between tillering and heading stages of winter wheat- instantly and with high precision. This is useful, because winter wheat needs N for tillering and stem elongation. When the total N amount in the leaf is assessed by the SPAD meter, the amounts of N needed at the different growing and production stages can now be rapidly derived (table 1). This increases N use efficiency of the N-fertilizers applied.

A higher efficiency also means a decrease in the amount of N-fertilizers applied during the cropping season. For instance, only a 10% decrease in N-fertilizers application will save a farmer about 60 kg of ammonium nitrate per ha of cotton and 50 kg per ha of wheat, or USD 9-10 per ha in monetary value (table 2). Hence, if SPAD sensors were used on an average farm of 100 ha, the farmer could annually save up to USD 1,000 per year on N fertilizers alone.

On a regional level, annual savings could amount to around USD 930 thousand on cotton fields alone and around USD 296 thousand for all wheat fields.

To provide all farmers in Khorezm with such a sensor[2], a total investment of USD 2.6 million would be needed. Given the annual savings on N-fertilizers use in the Khorezm region, this investment would be paid off in less than two years.

Conclusions

In Uzbekistan, the SPAD-502 sensor has been calibrated for winter wheat, cotton and long and short duration maize. The sensor accounts for in-field diversity, seasonal variations and different crop varieties while providing economic benefits to farmers without polluting the environment. The sensor not only helps to match N demand of plants and application rates: When used during shooting and heading of winter wheat, it can also predict wheat grain yields accurately.

1 Mentioning brand names does not indicate an endorsement of this device by the authors.

2 One SPAD meter costs approximately USD 455.

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