Module 4.4-2 Calculating nutrient rates for southern Russian wheat using fertilizer use efficiency estimates.

Calculations of nutrient rates based on crop yield goals require estimations of apparent crop recovery efficiency of applied nutrient. Field experiments at the Stavropol State Agrarian University (SSAU) Research Farm, North Caucasus Federal District of Russia, were conducted between 2010 and 2012—the goal was to adapt existing regional approaches to the process of establishing local winter wheat yield goals. Experiments were conducted on a leached chernozem (Luvic Chernozem) of clay loam texture. Soil pH was close to neutral (average pH_{KCl} = 6.7), soil organic matter was medium (5.1 to 5.6%), and the soil had medium levels of available P (average 10 ppm) and K (199 to 216 ppm) extracted with 1% ammonium carbonate [$(NH_4)_2CO_3$] solution.

Nutrient rates were calculated based on winter wheat grain yield goals of 4.0, 5.0 and 6.0 t/ha. According to the approach developed by SSAU, P and K rates were calculated as follows:

Nutrient rate (P_2O_5 and K_2O rate, kg/ha) = $\frac{R - R\kappa_s}{\kappa_f}$ 100, where:

R = nutrient removal in wheat grain plus straw (P_2O_5 and K_2O, kg/ha) at the planned yield goal;

κ_s = coefficient showing P and K recovery from soil reserves, calculated for P as 0.3 for soils testing ≤ 4 ppm increasing to 0.96 at ≥ 19 ppm, and for K as 0.5 for soils testing ≤ 83 ppm increasing to 1.0 at ≥ 291 ppm;

κ_f = coefficient showing apparent crop recovery efficiency of applied nutrient (40% and 70% for P and K, respectively).

Nitrogen rates were calculated using the following updated formula:

N rate (kg/ha) = $\frac{R_{(N)} - R_{(P_2O_5)}\ \kappa_{S\,(P_2O_5)}\kappa}{\kappa_f}$ 100, where:

κ = N removal in wheat grain plus straw/P_2O_5 removal in wheat grain plus straw at the planned yield goal (this ratio is assumed as 3.5 for winter wheat and thus it is estimated that N supply from the soil will be 3.5 times higher than P supply. Essentially this method assumes that soil N supply is proportional to the soil P test, and while it seems to work in the soils of this region it should not be assumed to be relevant elsewhere);

κ_f = coefficient showing apparent crop recovery efficiency of applied N (70%).

These estimates of recovery efficiencies are based on long-term studies conducted in the region. Fertilizer applications included basal rates of K applied as KCl before tillage and P fertilizer as MAP at planting. Nitrogen fertilizer was topdressed in early spring as ammonium nitrate.

Positive effect of fertilizer application on yield components, grain yield and quality of soft red winter wheat is shown in **Table 1** below. The recommended nutrient combination for the yield goal of 6.0 t/ha was most profitable compared to other treatments. The Return on Investment for the treatment receiving $N_{126}P_{80}K_{72}$ was as high as 125%. These results show that region-specific estimations of apparent crop recovery efficiency of applied nutrient may be successfully used for calculating nutrient rates based on winter wheat yield goals.

Table 1. Effect of fertilizer application on grain yield and quality of winter wheat in Stavropol, North Caucasus Federal District of Russia.

Treatment	Yield goal, t/ha	Number of productive tillers/m²	Number of kernels/ spike	Kernel weight/ spike, g	1,000 kernel weight, g	Grain yield, t/ha	Gluten, %	Protein, %
Control	-	373	23	0.98	34.0	2.94	%	10.5
$N_{60}P_{60}K_{30}$	-	394	25	0.97	35.2	4.16	22.3	11.3
$N_{60}P_{34}K_{34}$	4.0	402	27	1.04	36.4	3.90	23.7	11.0
$N_{105}P_{60}K_{60}$	5.0	403	26	1.04	36.7	4.73	25.5	11.5
$N_{126}P_{80}K_{72}$	6.0	432	28	0.99	37.2	5.60	27.0	12.5

Three-year averages (2010-2012) are given for yield components, grain yield and quality parameters. $N_{60}P_{60}K_{30}$ is a blanket fertilizer recommendation for the agro-ecological zone.

References

Esaulko A.N. and E.A. Ustimenko 2014. Better Crops with Plant Food, 1 (98):13-15.

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