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THE ESTIMATION OF NITROGEN RATE (KG/HA) FOR WINTER WHEAT AND SUNFLOWER CROPS, IN AN AGRICULTURAL FARM LOCATED IN BOTOŞANI COUNTY

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Abstract

The aim of this paper is to present the estimation of nitrogen rate - N (kg/ha) for two agricultural crops – winter wheat and sunflower, as part of a rotation that includes soybean – winter wheat – sunflower, in a farm located in Botoşani county, on a phaeozem soil type, whose characteristics have previously determined. The estimation is based on the method introduced by Davidescu D., which establishes the fertilizers rates in accordance to agrochemical indicators, by calculation, taking into account the following indicators: the quantity of N extracted from soil in relation to the predicted yield - N_{ex} (kg); the soil total reserve in N - N_t (kg) and the coefficient of N using from fertilizers (%). By calculation, it was estimated that the N rate for winter wheat after soybean in rotation is 36 kg N/ha and the nitrogen rate for sunflower after wheat is 136.16 kg N/ha, for the considered region, its specific soil type and the predicted yield. The results in case of winter wheat indicated the influence of the leguminous crop in rotation, that provides a significant nitrogen intake in soil reserve. Thus, the residual nitrogen from previous crop (one of the components of soil nitrogen reserve) is 61.25 kg/ha at wheat after soybean, compared to only 19.16 kg/ha in case of sunflower after wheat.

Key words: *nitrogen rate, soil nitrogen reserve, plant specific consumption, predicted yield, winter wheat, sunflower.*

INTRODUCTION

Regarded as the most important mineral element which highly influences the crop productivity, especially in the case of winter wheat, nitrogen can be absorbed both from the soil reserve, provided mainly from organic matter mineralization, from biological processes of nitrogen fixation, as well as from mineral fertilizers (Davidescu et al., 1987; Hera and Borlan, 1975; Lăcătuşu, 2006; Roman et al., 2011). However, the application of optimum rates in case of nitrogen, as well as for the other macronutrients like phosphorus and potassium, may represent a delicate issue, since there are many factors to be considered, such as: the level of the predicted yield and its specific consumption, the soil content in easily absorbed by plants nitrogen and its mobility in soil, remaining nitrogen from the previous crop, climate characteristics, etc. For Romania's conditions, the optimum level of nitrogen rate in case of winter wheat is between 50-160 kg/ha, according to Hera, cited by Bîlteanu, 1989, cited by Roman, 2011.

There are specific calculation methods for estimating the necessary nitrogen rate, taken into account the particularities of the different crops and other different indices such as drought indicator, root spreading coefficient etc. (Davidescu, 1999).

One method considers the following elements: plant specific consumption (kg N/t) - Cs, predicted yield (t/ha) - Rs, soil intake (kg/ha) - Ns, manure intake - Ng and a correction indicator depending on the previous crop – Npr, respectively: $D_N = Cs \times Rs \times Ns - Ng \pm Npr$ (Roman et al., 2011).

Another calculation method is based on the difference between the level of N extracted from soil by plants and the soil total reserve in nitrogen, all in relation to the coefficient of nitrogen using from fertilizers, according to formula: D_N (N rate) = $(N_{ex} - N_t)/C_u \times 100$ (kg/ha), where: N_{ex} represents the nitrogen extracted from soil, necessary for expected yield (kg); N_t is the total nitrogen reserve in soil (kg); C_u is the coefficient of nitrogen using from fertilizers (%) which, according to standards, has a value rated between 38-71% (Davidescu and Davidescu, 1999). This relation method has the particularity to consider, also, the residual nitrogen after harvesting and the nitrogen lost through the leaching process.

In this context, the present paper presents an estimation of the necessary of nitrogen rate by calculation method, based on soil agrochemical indicators, in order to establish the adequate level of fertilization for two crops - winter wheat and sunflower, on a phaeozem soil type, at an agricultural farm located in Mitoc - Botoşani county, Romania.

MATERIALS AND METHODS

In order to establish the nitrogen rate, it was considered the relation introduced by Davidescu and Davidescu (1999), previously mentioned. This method is based on estimation of soil nitrogen total reserve, which can be used by plants during their vegetation. The estimation was made in accordance to the soil characteristic features, previously determined for arable horizon (Am in this particular case, 0-30 cm), respectively: pH (H_2O) - 7.11; humus content (%) – 4.8; bulk density – 1.21 g/cm^3 (tefan et al., 2012). The total nitrogen reserve in soil is related to nitrogen provided by different sources, such as: the nitrogen provided by rainfalls (and atmospheric dust), the nitrogen provided by symbiotic and non-symbiotic bacteria, nitrogen provided by humus mineralization process, residual nitrogen provided by previous crop and also, the nitrogen provided by organic fertilizers. In estimation of the total nitrogen reserve in soil, it is also taken into account the nitrogen lost through leaching, according to the formula:

$N_t = (N_p + N_b + N_s + N_h + N_r + N_0) - N_l$, where: N_p – N provided by rainfalls; N_b – N provided by non-symbiotic bacteria activity; N_s – N provided by symbiotic bacteria activity; N_s refers to leguminous crops which, after harvesting, provide a significant amount of nitrogen in soil, as a result of symbiosis with nitrogen retainer bacteria; the specific amount of nitrogen retained in soil by the previous leguminous crop varies, mainly depending on the symbiotic bacteria activity, depending also by other factors, such as low or increased temperatures which can negatively influence the symbiotic process; Voss and Shrader, 1984; Schepers and Mosier, 1991; Bundy et al., 1993 cited by Matias and Larry, 1995 state that "soybean harvested for grain can supply an average of 45-67 kg N/ha to a following crop (1-1.5 kg/ha of N for 60 kg/ha of soybean harvested)"; other data state that, for soybean case and in favourable conditions, symbiosis determines the accumulation in soil of a nitrogen amount rated between 60-168 kg/ha (Muntean et al., 2001), while Davidescu (1999) estimated that soybean may fix in average up to 100-120 kg N/ha; also, according to additional data, the specific amount of N retained by soil as a supply for next crop is 20 kg N/to of principal product for soybean, 35 for beans, 25 kg for peas, 6 kg for alfalfa (kg N/to of principal product) (www.icpa.ro); N_h - N provided by humus mineralization process; N_r - residual N provided by previous crop; No – nitrogen provided by organic fertilizers; N_l – nitrogen lost through leaching (estimated between 2 – 15 kg/ha/yr). In calculation, there has also been considered the humus content in nitrogen (%), usually between 3.5-5%, at 4.84% (Borlan et al., 1994).

Regarding the specific consumption of the two crops – Csp (kg N/to), it has been considered that, the medium exports of nutrients (kg nutrients/t principal and secondary yield) is 26.5 in case of winter wheat (grains - straw is 1:1.3) and 36.5 in case of sunflower (seeds – strain is 1:3) (ICPA Bucharest, 2003).

The winter wheat variety considered is *Gasparom*, a biological creation of Suceava Agricultural Research and Development Station, certified in 1998, adapted at Moldova climate conditions; its productive potential can reach over 7 to/ha.

In case of sunflower, the variety considered is *Neoma*, a Syngenta medium early hybrid, with high yield potential and a good adaptability for the cultivated area.

RESULTS AND DISCUSSIONS

The nitrogen estimated rate for winter wheat

In case of winter wheat, there have been considered the following elements: the previous crop is soybean, with a specific consumption

(Csp) of 70 kg N/ha and an obtained yield of 2.5 to/ha.

The nitrogen provided by rainfalls is depending on the amount of annual precipitation and the rainfall content in nitrogen, respectively: $N_p = p \times Kp$, where p is precipitation (mm) and Kp is the coefficient of precipitation content in N and conversion in kg/ha N (usually between 0.02 – 0.03 – specific estimations state that, every 100 mm provide approximately 2 kg N/ha). For Botoşani County, the average annual rainfalls values are between 600 - 650mm/year. Considering Kp value of 0.025, the determined N_p level in this case is 14 kg/ha.

N_b value, reflecting the nitrogen provided by non-symbiotic bacteria, is calculating based on the relation between number of days with temperatures over 8°C and the daily accumulation of nitrogen: N_b (kg/ha/yr) = Z × K_b, where Z-days; K_b-coefficient of daily accumulation of nitrogen (0.2-0.3 kg N/ha/year). For the researched area there are approximately 175 days with positive and over 8°C temperatures, resulting N_b value estimated at 35 kg/ha/yr.

N_s indicates the nitrogen resulted by symbiotic bacteria activity; estimating an average of 1 kg/ha N supply for 60 kg/ha soybean harvested, respectively 20 kg N/t principal product, it results that, in case of 2.5 kg/ha yield, the soybean N supply in soil is approximately 40 – 50 kg/ha, beneficial for winter wheat with soybean as previous crop.

N_h (kg/ha) reflecting the nitrogen provided by the process of humus mineralization, is based on relation: $N_h = (H \times Cm \times K_h) / 10$, where: H –the humus soil reserve (t/ha); Cm – humus content in nitrogen (%) and K_h – humus annual decomposition coefficient (0.012 for non-row crops and 0.018 in case of row crops). Since the soil humus content was previously determined at 4.8%, soil reserve in humus (to/ha) was estimated at 174.2 to/ha, with the following relation: % humus × bulk density (BD) × depth (m) × 100. As a result, the estimation of N_h is 1.01 kg/ha.

N_r (kg/ha) is calculated based on relation: N_r= previous crop yield (t/ha) × Csp × k_{rem}, where k_{rem} represents the coefficient of remanence (0.15 for non - leguminous crops and for 0.35 leguminous crops). For 2.5 to/ha average yield and taking into account the soybean specific consumption indicator, N_r is determined at 61.25 kg N/ha.

In case of No, this is equal to 0, since no organic fertilizers were applied.

N_l was estimated at 10 kg/ha/yr (limits between 2– 15).

Considering all the previously mentioned indicators, the determination of soil nitrogen reserve (N_t) on this specific soil is 141.26 kg.

N_{ex}, calculated as a produce between predicted yield and its specific consumption (Csp), is determined at N_{ex}=159 kg N/ha (the predicted yield is 6 to/ha for *Gaşparom* winter wheat variety and for the region specific conditions).

As a result of that, the nitrogen rate resulted by calculation is estimated at 75.6 kg/ha (table 1).

The nitrogen estimated rate for sunflower

In case of sunflower, the following elements have been considered: the previous crop is winter wheat, with a specific consumption (Csp) of 26.5 kg N/ha and a 6 to/ha as a predicted yield.

Also, the predicted yield in case of *Neoma* sunflower variety is 3.5 to/ha.

In estimation of the nitrogen rate, the determination indicates the following values:

N_{ex} related to sunflower predicted yield and specific consumption is 127.75 kg N/ha.

N_p and N_b values are similar to those corresponding to the winter wheat, respectively N_p is 45 kg/ha and N_b 35 kg/ha/yr.

N_s is considered 0, taking into account that, in rotation, sunflower comes after winter wheat as a previous crop, so there is not any nitrogen resulting from symbiosis.

N_h resulted by calculation is 1.51 kg N/ha (k_h is 0.018 for row crops).

N_r resulted by estimation is 19.16 kg N/ha (the specific consumption is 36.5 kg N/to and k_{rem} is 0.15). No is also 0, due to the fact that organic fertilizers are not considered for application. According to the mentioned considerations, the N rate resulted by calculation is estimated at 136.16 kg/ha (Table 1).

Table 1.The estimation of nitrogen rate (kg/ha) based on specific agrochemical indicators

Previous crop	Annual crop	Predicted yield (t/ha)	Specific consumption (Cs)	Soil indicators (0-30 cm)			N_t(kg)							N_{ex} (kg)	Cu (%)	D (kg/ha)
				pH (H_2O)	% Hum.	Rh (t/ha)	N_p (kg/ha)	N_b(kg/ha/yr)	N_s (kg/ha)	N_h (kg/ha)	N_r (kg/ha)	N_o (kg/ha)	N_l(kg/ha/y)			
soybean	Winter wheat	6	26.5	7.11	4.8	174.2	14	35	40	1.01	61.25	0	10	159	50	36
Winter wheat	Sun-flower	3.5	36.5	7.11	4.8	174.2	14	35	0	1.51	19.16	0	10	127.75	50	136.16

As it resulted by determination, the level of nitrogen rate estimated at 36 kg/ha in case of winter wheat, considerable low, is deeply influenced by the significant nitrogen intake of leguminous crop in rotation, which offers the possibility of reducing the quantity of applied nitrogen.

As it could be observed, the residual nitrogen level from previous crop (N_r) is 61.25 kg/ha at wheat after soybean, which is significant comparing to only 19.16 kg/ha, in case of sunflower after winter wheat in rotation. Such difference emphasizes the role of introducing leguminous crops in rotation.

CONCLUSIONS

The nitrogen values of 36 kg/ha for winter wheat, respectively of 136 kg/ha for sunflower present theoretically importance, as they should be considered as a guidance in application of nitrogen fertilizers, as part of the crop technology corresponding to considered area.

It is important to mention that, in the estimation of optimum nitrogen rates, a considerable importance resides in the climate characteristics for the reference year (which can enhance the nitrogen leaching).

If we refer to plant specific consumption (Cs), it is to specify that - as agricultural practice has showed – sometimes, for the same species, there may be registered differences regarding the value of this indicator, even if they are not evident enough to modify the value of N_{ex}.

Also, according to this relation it is to consider that, when manure is applied, the nitrogen rate should also be decreased, due to its contribution to soil intake in nitrogen.

Finally, the fertilization technology may also influence the level of the predicted yield, beside other factors.

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