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ASSESSMENT OF FERTILIZATION PLANS ON BASIC CROPS. A CASE STUDY

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Abstract

The most effective way to enrich the food resources necessary for humanity is to increase agricultural production per hectare, which can be achieved by introducing new cultivars and high-performance hybrids, by improving the cultivation technology, by calculating the need for nutrients in each crop, and by taking into account the crop, the expected productions and the natural fertility of the soil. This paper aims at evaluating the fertilization plans made on a farm in the town of Curtici, Arad County, Romania, in the main agricultural crops: wheat, barley, maize, and rape. During an annual vegetation cycle, there are several pheno-phases that are characterized by a differentiated consumption of nutrients, which determines the application of different types and doses of fertilizers. The farm is equipped with a series of tractors and agricultural machines with which they work the 600 ha of land and provides various mechanization services to different physical and legal people in the area. The main activity of the farm is the cultivation of cereals. The identified soils were chernozem, preluvosol and alluviosol, i.e., soils that have good and very good natural fertility. Following the calculations made, it turned out that the nutrient requirements were 57.08 t/ha of nitrogen, 78.33 t/ha of phosphorus and 29.80 t/ha of potassium. In wheat, the largest quantity in nutrients is in nitrogen, which plays an essential role in the growth phase, after which the requirement of nitrogen decreases. The productions obtained were different depending on the year, the climatic conditions and the doses of fertilizers applied: in wheat, 7.5 t/ha in 2020 and 8.0 t/ha in 2021; in grain maize, 8.0 t/ha in 2020 and 8.2 t/ha in 2021, with an average of 8.1 t/ha; in barley, between 8.1 t/ha in 2020 and 8.1 t/ha in 2021; and in rapeseed, 3.5 t/ha in 2020 and 3.6 t/ha in 2021. It was found that the application of fertilizers in the recommended doses depending on the crop, on plant growth phase, and on the plant, needs increases the production in all four crops in the study. In conclusion, the correct establishment of fertilization plans is the most useful tool in establishing the recommended fertilizers, taking into account both the natural fertility of the soils on the farm, of their plants, of their nutritional needs, of the expected productions and of the expenses necessary to purchase the fertilizers (whether organic or mineral fertilizers). Thus, making early economic decisions related to what we need to cultivate, on what surfaces, to the works involve in each crop, to the quantities of necessary fertilizers and treatments helps purchase the necessary products in due time and at better prices. This is how one saves considerable price differences, resulting in lower production costs and higher profits.

Key words**:** *evaluation, fertilization plan, fertility, productive potential*

INTRODUCTION

Romania has been among the top 10 producers of maize worldwide since 2018 according to the Food and Agriculture Organization of the United Nations [25] and the most important maize grower within the European Union according to Eurostat [1, 9]. Statistics from the Ministry of Agriculture and Rural Development from Romania indicate that, since the integration in the European Union, both the average yield-per-unit area as well as total production of maize increased at the national level [27], presenting attractive export potential. The possibility to increase exports is relying on the optimization of maize crop performance, in order to ensure high-quantity and -quality maize [14, 6, 26].

To make the most of their productive potential, crops need appropriate water, light, carbon dioxide, and mineral nutrients (nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, and a number of microelements), the soil being the main

source of mineral nutrients and water for plants [2, 3].

The removal of nutrients from the soil by plant absorption, by leisure or by other processes related to the natural dynamics of the soils, result in a decrease of the contents of mobile forms of nutrients and in the gradual decline of the production capacity of the soils [4, 5].This is why it is necessary, as an objective necessity, to compensate, by applying mineral and organic fertilizers, both consumption by the crops and decreased nutrient mobility through natural processes (adsorption, fixation, immobilization in humic substances, etc.) [8].

For both economic and environmental protection reasons, it is necessary to use the correct management and use of the fertilizers at the level of each holding [12]. Awareness of each agricultural producer is required because, in order to achieve large productions, the use of fertilizers must be made on the basis of realistic forecasts, which take into account the soil and climate conditions specific to each area, the productive potential of crops, and the applied technology [13, 15].

A special emphasis, especially in areas with high vulnerability to the pollution of water with nitrates of agricultural origin, should be placed on the management of organic and mineral fertilizers, given the particularly complex behaviour of this nutrient and the ease with which it can be leaked in the form of nitrates by infiltration waters and surface leakage [7, 10, 11].

Rapid scientific advances in soil–plant interactions from recent years have generated a ripple effect for trends on fertilizers market [21]. As a consequence, farmers today are presented with a variety of options that promise success for their crops. From mineral to organic components, besides various formulations that stimulate soil biota or plant performance, the list of options is expanding [28].

The evaluation of the need for NPK fertilizers (minerals and organic) is carried out on the basis of the calculation of the optimal economic doses (DOE), the method being formalized in Romania and currently used in the studies executed for different beneficiaries by the County Soil and Climate and Agrochemical Studies Offices [19, 20].

Food security depends on agriculture, and agricultural security depends on water security and fertilizer security [27].

MATERIALS AND METHODS

The necessary activities in carrying out this study consisted in a broad information and documentation from literature, in soil analyses, in the preparation of the germination bed, in sowing, in applying chemical and organic fertilizers, in performing phytosanitary treatments when appropriate, in harvesting, in data interpretation, and in the development of fertilization plans [23].The research was carried out both on the Curtici farm, as well as in the research laboratories of the soil science department of the Life Sciences University in Timisoara, where a series of analyses and interpretations were carried out [16].

The following types of soils were identified on the ground: chernozem, preluvosol and alluviosol and, following the laboratory analyses, it has been established that their natural fertility is good and very good. [17]

The methods used consisted in a series of calculations and interpretations regarding the necessary NPK fertilizers. It was necessary to have good knowledge of the cultivated surface, the practiced crop rotation, the soil type and the main features of the soils, the estimation of the planned crops, the climatic conditions, the specific nutrient consumption for each crop, as well as the moments of application of the organic and mineral fertilizers [18], [22], [24].

RESULTS AND DISCUSSIONS

Research was carried out within an agricultural holding that works 600 ha of land and is based on the territory of Curtici in Arad County.

The fertilization plan for basic crops refers to wheat, barley, maize, and rapeseed. Grain maize is the most extensive crop on the farm, occupying 400 out of the 600 ha. The crop

rotation takes 3 years, from maize and wheat to rapeseed.

The identified soils were chernozem, preluvosol and alluviosol and their different subtypes. Following the laboratory analyses, it was established that the physical, chemical, and hydro-physical properties of these soils allow the cultivation, in good conditions, of wheat, barley, maize and rapeseed, along with the climate conditions specific to the area.

The state of soil fertility in the researched area provides favourable conditions for the growth and development of wheat, maize, barley and rapeseed.

The cultivated cultivars and hybrids are presented in Table 1.

Table 1. The main crop cultivars/hybrids cultivated

Crop	Cultivar/Hybrid
Barley	Dana (Fundulea)
Wheat	Glossa, Miranda (Fundulea)
Maize	DKC 5070, DKC 4943
Rapeseed	Traviata (KWS), Arsenal (Limagrain)

Source: Own determination.

The holding has several parcels cultivated with cereals, as shown in Table 2.

The highest amount of nutrient necessary in wheat is nitrogen because it is the element consumed in the highest proportion.

Table 2. The necessary nutrients for the wheat crop

Topo plot	Total necessary nutrients					
	N		P_2O_5		K_2O	
	kg/ha	t	kg/ha	t	kg/ha	t
A 262	160	7.80	60	3.10	80	4.10
A 347	160	4.30	60	1.60	80	2.10
A 320	160	10.70	100	6.70	80	5.40
A 351	160	5.50	60	2.20	80	2.90
A 352	160	23.00	70	10.00	80	11.50
A 216	160	7.50	120	5.70	80	3.80
TOTAL		58.80	-	29.30	-	29.80

Source: Own calculation.

In wheat, nitrogen is the nutritional element that enters the formation of production components, having a favourable influence on rooting and twinning of plants. At the same time, it increases the number and mass of the grains in the spike and improves their content in proteins. The largest accumulation of nitrogen occurs in the straw and ear phases, while in the milk phase, the consumption of nitrogen decreases. Tables 3 and 4 present the necessary nutrients as mineral fertilizers in the analysed plots.

Table 3. Mineral fertilization plan in wheat

Topo plot	Total necessary nutrients					
	N		P_2O_5		K_2O	
	kg/ha	t	kg/ha	t	kg/ha	t
A 262	22	1.10	43	2.20	16	0.80
A 347	32	0.80	43	1.10	16	0.40
A 320	32	2.10	83	5.60	16	1.10
A 351	32	1.20	43	1.50	16	0.60
A 352	32	4.60	53	7.60	16	2.30
A 216	32	1.50	103	4.90	16	0.80
TOTAL		11.30	-	22.90	-	6.00

Source: Own calculation.

In case of wheat, it is recommended that fertilizers with phosphorus and potassium to be applied under the ploughed soil, and the complex fertilizers, when preparing the germination bed. Nitrogen fertilizers will be applied fractionally: 50% before sowing and the other half in winter, when the soil is frozen, or in the spring, by mid-March.

Phase fertilization (with foliar fertilizers with macro- and micro-elements), associated with the chemical control of weeds or diseases and pests, results in effective increases in wheat production.

In maize, both complex fertilizers based on NPK (20:20:0) and foliar fertilisers were applied. The complex ones were incorporated in the spring, with the seed by a single passage, while foliar ones, in vegetation when the maize had 6 and 8, respectively, leaves, together with the Adengo herbicide.

Following the fertilization plans established for the 600 ha that the holding cultivates with wheat, maize, barley, and rapeseed, the productions were clearly superior (Table 5 and Figure 1).

Table 4. Fertilization of the main crops during the period 2020-2021

Crop	Type of fertiliser 2020-2021	Dosage (kg) 2020-2021	Type of fertiliser 2020-2021	Dosage (kg) 2020-2021
Wheat	NPK 20:20:0 (Fall)	200	NPK 20:20:0 (Fall)	220
	Urea (Spring)	150	Urea (Spring)	150
	Nitrocalcar (Spring)	100	Nitrocalcar (Spring)	100
	t1 + foliar 25 March foliar fungicide insecticide r microfertiliser	10 l/ha	t1 + foliar 25 March foliar fungicide insecticide r microfertiliser	10 l/ha
	t2 + azospeed 25 May fungicide insecticide azospeed	10 l/ha	t2 + azospeed 25 May fungicide insecticide azospeed	10 l/ha
Maize	NPK 20:20:0, Spring *Simultaneously with sowing – applied per row*	250	270	-
	Foliar Wuxal Zinc, *when the maize has 6 leaves, together with herbcide Adengo*	2	2	-
	Azospeed amino, *when the maize has 8 leaves, together with Nicosulphuron and Mezotrione*	8	8	-
Rape	NPK 20:20:0 (Fall)	250	NPK 20:20:0 (Fall)	200
	Sulphur + Boron (Fall) sulphur boron insecticide in Fall 4-6 leaves + regulator	10 l (5 sulphur, 5 boron)	Sulphur + Boron (Fall)	1-0
	Nitrate 1 + foliar (Spring) 15-20 March	150	Nitrate 1+ foliar (Spring)	150
	t1 + foliar (sulphur boron azospeed before blooming)	15 l (3 sulphur, 2boron 10 azospeed)	t1+ foliar (sulphur boron azospeed before blooming)	15 l (3 sulphur, 2 boron 10 azospeed)
	Foliar - azospeed after blooming	10 l/ha	Foliar - azospeed after blooming	10l/ha
Barley	NPK 20:20:0 (Fall)	200	NPK 20:20:0 (Fall)	250
	Ammonia nitrate – At the end of winter 15-20 March	150	Urea (Spring)	100
	t1 + foliar - 25 March fungicide insecticide foliar	10 l/ha	t1 + foliar - 25 March fungicide insecticide foliar	10 l/ha

Source: Own calculation.

Table 5. The average productions in the main crops in 2020 and 2021

Crop	Mean production (kg/ha)		Mean production (kg/ha)
	2020	2021	
Barley	7,500	8,000	7,750
Wheat	8,000	8,200	8,100
Maize	8,100	8,200	8,150
Rapeseed	3,500	3,600	3,550

Source: Own calculation.

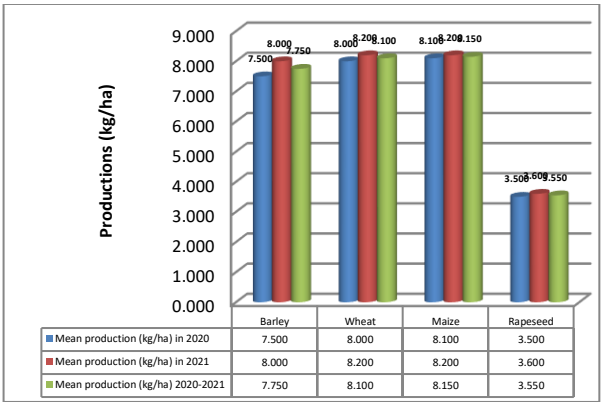

Fig. 1. Productions in the main crops in 2020 and 2021
Source: Own calculation.

CONCLUSIONS

The main activity of the farm is the culture of cereals. The holding was founded in 2002 and, at first, 273 ha were cultivated, and a series of mechanization services were provided to different (physical and legal) people in the area, after which it expanded its area, so that it is currently working 600 ha.

The holding has several land plots, located both in the town of Curtici and in the neighbouring communes, of which in the present study we referred to 6 plots, respectively 262, A 347, 320, A 351, A 352, and 216.

The need for nutrients was 57.08 t/ha nitrogen, 78.33 t/ha of phosphorus, and 29.80 t/ha, potassium. In wheat, the largest quantity in nutrients is nitrogen, which has an essential role in the growth phase, after which it decreases.

The fertilizers with phosphorus and potassium are applied in the fall during ploughing, the complex ones, during the preparation of the germination bed, and nitrogen ones, at the beginning of spring.

In grain maize, the fertilizers used were micro-granulated ones containing NPK (20:

20:0), Foliar Wuxal Zinc, and Azospeed Amino. These were applied differently, namely: complex fertilizers, 250 and 270 kg/ha, respectively, in spring while sowing, applied per rows; Wuxal zinc foliar, 2 l/ha, when maize had 6 leaves, along with the Adengo herbicide; Azospeed amino, 8 l/ha when maize had 8 leaves, along with Nicosulphuron and Mezotrione.

In rapeseed, in addition to complex fertilisers and nitrogen-base ones, there was also sulphur and boron in the fall, along with a foliar fertiliser, in spring, and after blooming, Azospeed, in both years of research.

The productions were different from one year to another, according to the climatic conditions and the doses of fertilizers applied, as follows:

-In wheat, 7.5 t/ha in 2020 and 8.0 t/ha in 2021, respectively.

-In grain maize, between 8.0 t/ha in 2020 and 8.2 t/ha in 2021, respectively, with an average of 8.1 t/ha.

-In barley, between 8.1 t/ha in 2020 and 8.1 t/ha in 2021, respectively.

-In rapeseed, between 3.5 t/ha in 2020 and 3.6 t/ha in 2021, respectively.

It was thus found that the application of fertilizers increases production in all crops.

In conclusion, the correct establishment of fertilization plans is the most useful tool in establishing the recommended fertilizers, taking into account both the natural fertility of the soils on the farm, of their plants, of their nutritional needs, of the expected productions and of the expenses necessary to purchase the fertilizers. Thus, making early economic decisions related to what we need to cultivate, on what surfaces, to the works involve in each crop, to the quantities of necessary fertilizers and treatments helps purchase the necessary products in due time and at better prices. This is how one saves considerable price differences, resulting in lower production costs and higher profits.

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