THE INFLUENCE OF POTATO VARIETY AND ORGANO-MINERAL FERTILIZATION ON POTATO STORAGE IN THE APUSENI MTS. AREA

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Abstract: *Potato, in the Apuseni Mts. area, is the most cultivated plant species. By means of its main products, the tubers, it provides the basic ood support for the locals and their livestock throughout the year. For a long period, mountain agriculture has been regarded as a source of healthy and qualitative food products, but devoid of any significant investments in the past, as well as the present. At present, in the poor economic and financial situation in our country, mountain agriculture does not benenfit from investments, although locals in the area rely on agriculture as their main occupation and the sole source of subzistence. This is the reason why young people have left the area and the population is aging and diminishing. For the development of the area and the achievement of qualitative and quantitative superior productions, it is highly necessary to implement ecologically-protective crop technologies employing the natural organic resources in the area, as well as appropriate measures for the storage of tubers in private households. It is well-known that the potato tuber is a living organisms that continues its physical, biochemical and physiological processes after harvesting. These processes, at various degrees of intensity, may lead to serious weigth losses during storage. One of the factors exerting a great influence on storage is the variety. Potato varieties exhibit different behaviours, as the determining factor is the germinal interval and not the duration of the growing period. The germinal interval is characteristic to the variety, as its duration is genetically determined, with no dependence on the duration of the growth period. Varieties with a long germinal interval, resistant to blight, wet and dry rot, show the least losses during storage (Mureşan S., 1976). In terms of external factors, realtive air temperature and humidity in the storage area exert a major influence in the storage of potato tubers. Optimal temperatures for the storage of potato according to employment are: seed 2-4^{o}C, consumption 3-6^{o}C, industrial 8-12^{o}C (Mureşan S., 1980). Temperature in storage areas determines the direction and speed of essential chemical reactions. As such, when temperature is high in storage areas, there is a favourable climate for tuber germination, the intensification of breathing and the creation of a favourable environment for microorganisms.The slow lowering of temperatures leads to tuber sweetening, which continues up to 0^{o}C, when the breathing process stops and the potato becomes sweet. Relative air humidity in storage areas is important to maintain potato turgor and thus optimal air humidity must be maintained to 85-90% in storage areas. Under this limit, tubers lose water and wrinkle, while over this 90% limit, there is an excess of humidity in the tuber mass, thus favouring rot diseases. Differentiated fertilization influences the level of loss due to rot diseases, as balanced NPK fertilization in optimal doses according to plant nutrient requirements leads to reduced losses as opposed to the situation when fertilization is umbalanced, favouring rot diseases and implicitly significant weigth losses and a quality decrease for stored tubers. The objective of the research presented therein envision the influence of the variety and differentiated organo-mineral fertilization on quantitative and qualitative achievement of potato tubers in the mountain area and losses through storage in unequipped areas, cellars that are specific to households in the Apuseni Mts. area. The importance, originality and degree of novelty of this agronomic research are due to yet unsolved problems regarding fertilization combinations in potato crops, when undesirable weather events are increasingly present thus increasing the risk for calamity in cultivated agricultural and horticultural crops. In this respect, the experiments and overall research conducted in the present paper are new, useful and aim at the improvement of unfortunate situations (agrochemical risk-insufficiency-defficiency; excess- toxicity for potato tuber production) and provide with alternatives in the field for the*

differentiation of fertilization systems in order to select practical solutions that are both agrochemically and economically accessible. The implementing of a suitable soil fertilization system that is ecologically-protective for potato in the mountain area must be accompanied by a rigorous agrochemical control that would provide for a diversity of practical solutions in achieving the agrochemical soil-plant optimum and providing the protection of mountain ecosystems. In order to complete this paper, experiments were conducted on differentiated organo-mineral fertilization systems, for the Ostara and Desiree ptato varieties, on a districambosoil, namely a brown acidic soil, located in the high area of the Apuseni Mts. at the basis of the north-north-western slope of the Ariesul Mic river basin.

Key words**:** *soil, fertilization, unequipped storage area, potato*

INTRODUCTION

The paper emphasizes the influence of the soil and differentiated organo-mineral fertilization on potato, placed on a districambosoil (brown acidic soil) in the area of the Apuseni Mts. on tuber production and storage losses in an unequipped storage area (cellar). The cellar is an area for the preservation of agricultural products obtained in an individual household, specific to the household system of locals in the mountain area.

Practically, the research resided in the study of the effect of differentiated systems for organo-mineral fertilization in Ostara and Desiree potato varieties through long-term field experiments, followin quantitative and qualitative achievement of tuber productions per surface unit and losses through tuber storage in an unequipped cellar system.

The potato varieties under experiment belong to different precocity groups, being cultivated in the mountain area under study due to their suitability to less favourable pedoclimatic conditions and the development of most cultivated agricultural plants.

Potato tuber preservation in an unequipped storage area (cellar) by locals in the area of the Apuseni Mts. must meet the requirements of potato tubers throughout a whole year, as the essetial food suppror the population.

The type of cellar employed in the three experimental years for the storage of potato tubers in the experiments belongs to locals in the area. It is 4.0 m high and partially underground, with one entrance at the end of the cellar. The door is well-isolated, double, to prevent cold from entering the cellar and maintain constant temperature througout the entire tuber storage period.

Stands are located therein, of boards 2-3 cm apart from eachother. The stands are located along the length of the cellar, while the 0.7 m wide access hall is opposite. The stand is built at a distance of 30 cm from the earth flooe on wood poles, while the grades are board and wire.

Small double air-tight windows help prevent cold from etering in winter and wooden shutters to prevent light from entering are placed in the upper part of the cellar and are aimed at airing and ventilating the tuber mass.

The assessment of the main preservation factors, respectively temperature by means of the thermograph and humidity by means of the hygrometer, was conducted on a daily basis.

Agriculture is the basic occupation of the inhabitants of the Apuseni Mts. area and plays a fundamental part in their subzistence. In this respect, the present paper aims at presenting the influence of organo-mineral fertilization on tuber productions in the Ostara and Desiree potato varieties and average losses through storage in classical areas, namely cellars.

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MATERIAL AND METHODS

The experiment was conducted in coditions similar to those employed to obtain potato productions in the mountain area, as it was placed during three experimental years in a brown acidic soil (districambisoil) located in the high subarea of the Apuseni Mts, between the Găina Cruce (altitude 1465 m) and Curcubăta Mare (altitude 1848 m) peaks at the basis of the north-north western slope of the Ariesul Mic river basin. The experimental field was placed in the inferior part of the mountain climate area (under the beech and mixed forest levels). From a geomorphologic and geologic point of view, solification processes occur in this area, as well as dealkalinization and decarbonatation phenomena, clayfication and acidic humus accumulation in the forms of „acidic mull" and „moder". The geolithologic substratum resides in metamorphic rocks, crystalline schists, conglomerates with loam and ferruginous sandstone insertions

The experiment was polyfactorial with two factors, placed according to the subdivised lot method wih the following graduations:

Factor A: potato variety with graduations: a_1 – Ostara, a_2- Desiree

Factor B: level of fertilization with graduations:

b_0 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 0 t/ha stable manure (Unfertilized C.);
b_1 – 40N + 40 P_2O_5 + 40 K_2O (kg s.a./ha)+ 0 t/ha stable manure;
b_2 – 60N + 60 P_2O_5 + 60 K_2O (kg s.a./ha)+ 0 t/ha stable manure;
b_3 – 80N + 80 P_2O_5 + 80 K_2O (kg s.a./ha)+ 0 t/ha stable manure;
b_4 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 10 t/ha stable manure;
b_5 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 20 t/ha stable manure;
b_6 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 30 t/ha stable manure;
b_7 – 40N + 40 P_2O_5 + 40 K_2O (kg s.a./ha)+ 20 t/ha stable manure;
b_8 – 60N + 60 P_2O_5 + 60 K_2O (kg s.a./ha)+ 20 t/ha stable manure;
b_9 – 80N + 80 P_2O_5 + 80 K_2O (kg s.a./ha)+ 20 t/ha stable manure;

In the case of polyfactorial experiments with two factors, the first with a graduation and the second with ten graduations, a number of 20 variants resulted (table 2).

The biologic material employed for the experimentation was the elite Ostara and Desiree category, sorted before planting and employing only healthy tubers, with a 40-70 g weigth.

In choosing the cropping system for potato cultivation, its biologic traits were considered, as well as the high requirements for the preparation and structuring of the soil. As such, during the three experimental years, the previous crop was rye, which was early removed from the land, thus providing the opportunity for potato cultivation through summer ploughing at a 15-20 cm depth.

During the three experimental years all specific works in terms of potato crop technology were performed for autumn-winter consumption.

Before harvesting, frontal and vaccial removals were conducted, as required by experimental tecique rules.

Harvesting was conducted manually, 10-15 days from the physiologic maturation of each variety, sufficiently enough for tuber periderma (peel) to suber. Once each variant was harvested, soil samples were collected and underwent physico-chemical analysis according to the ICPA method for agrochemistry laboratories (ICPA, 1981).

In order to assess weigth losses in the case of potato tubers, as well as observations for the entire duration of storage, samples were formed of 80 kg potato tubers, cleaned of soil, healthy, of various sizes belonging to each variety and every fertilization variant. Samples were

packed in raffia sacks of 10 kg each and stored in a cellar stand for seven months, from October 1st to May 1st of the next year. Loading and unloading the stands with potato tubers were performed manually.

Production determination was conducted by weighing for each variant, referencing tuber production to the surface unit (hectare), the production was transported, stored and capitalized in raffia sacks.

RESULTS AND DISCUSSIONS

a. Physico-chemical characterisation of the DISTRICAMBOSOL (brown acidic soil) under study

The districambosol soil under study is located in the heart of the Apuseni Mts. at the basis of the north-north western slope of the Ariesul Mic river basin. From a morphologic point of view, as a consequence of natural solification processes, as well as human intervention, the soil exhibits along the depth of the profile the specific genetic horizons for mountain acidic soils, Ao-A/B-Bv_1-Bv_2(G)-R.

The districambosol soil, under potato cultivation during the experimental period in the locality of Avram Iancu is representative for the Apuseni Mts. area. It exhibits the physical and chemical traits of the soil class it belongs to and the acidic soil type (table 1). It reacts at the limit of the strong acidic state (aound the value of pH 5.0) in the supeficial horizon, with tendencies of slight increase in depth, according to the essential processes involved in the solification-dealkalinization and acidification processes.

With regard to soil evolution, the high mobile-Al concentration at soil-surface and in depth is apparent, which fits this soil within the limits for correction requirements through amendments and protective fertilization.

The content of exchangeable hydrogen (E_H) represents ove 60% of the total cationic exchange ability (T), which supports dealkalinization. Thus, there is a stringent requirement for ecologically-protective fertilization measures for agricultural and horticultural plants in the mountain area.

Suprinsingly, the soil exhibits a high humus content, but in a rough, unevolved form, expressed through a sufficiently high C/N ratio. This proves an average pace of humification, as well as mineralization determined by the specific mountain environmental conditions. This humic stability relies on the C-rich components and is relevantly supported by soil acidity, the representation of fulvic acids in the soil complex, as well as Al and Fe hydrate oxides. The expression of R_2O_3 representation may forecast a tendency towards the fixation-immobilization of certain nutritive ions (such as the phosphate ones), which increases the practical interest for the sufficient and correct application of organo-mineral fetilizers, in accodance to a rigorous agrochemical study.

From an agrochemical point of view, the soil has an average nitrogen supply in the superficial horizon and weak supply of this element in depth on the profile. It has a poor phosphorus supply and an everage potassium one.

Regarding the physical characteristics of the soil, there is a highlight on the soil profile of a loamy to a loamy-dusty one, but also a certain level of compaction- compression in the superior horizon (A_o) determined by a shallow processing.

The soil subscribes a category of acidic and poorly fertile soils that require special soil fertilization measures that allow for ecologic protection, as well. This is applied for the main nutritive elements according to the specificity of the mountain area where this soil is predominant and according to specific and overall plant consumption requirement.

Table 1

The main physico-chemical traits of the districambosoil (brown acidic soil) under study on the N-NW slope of the Ariesul Mic river in the Apuseni Mts.

(Experimental years 2008-2010) Properties	Horizons (thickness - cm)				
	Ao 0 – 20 cm		Ao 0 – 20 cm		Ao 0 – 20 cm
Chemical					
pH in (H_2O)	5,00	5,10	5,25	5,30	-
Mobile- Al (me)	2,68	2,36	1,20	1,10	-
Exchangeable H (S_H, me)	10,20	9,15	9,00	8,20	-
Exchange bases (S_B, me for 10g soil)	9,02	8,30	9,20	9,25	-
Cationic exchange capacity (T, me)	19,22	17,45	18,20	17,45	-
Humus (%)	5,20	3,78	1,21	1,08	-
Alkali saturation degree (V%)	47	48	51	53	-
Nitrogen index (I_N)	2,44	1,81	0,61	0,57	-
Mobile P (ppm)	7,80	5,15	4,20	3,15	-
Mobile K (ppm)	120	105	89	74	-
Carbon/nitrogen ratio (C/N)	24	17	16	15	-
Ca (me)	7,02	7,15	7,45	7,78	-
Mg (me)	2,10	1,14	0,80	0,44	-
K (me)	3,20	3,00	2,45	1,70	-
Na (me)	0,15	0,12	0,10	0,10	-
Concentration of humic acids/of fulvic acids (CAH/CAF)	0,65	0,54	0,28	0,20	-
Hydrate iron and aluminum oxides (R_2O_3%)	4,00	3,25	2,80	2,00	-
Physical					
Skeleton (%)	3	5	15	20	45
Coarse sand (2,0-0,2mm) %	24,4	28,6	18,8	25,4	-
Fine sand (0,2-0,02 mm) %	14,2	13,0	22,2	27,2	-
Dust (0,02-0,002 mm) %	36,5	33,9	41,2	36,2	-
Clay (%)	24,9	24,5	17,8	11,2	-
Apparent density (DA g/cm^3)	1,09	1,25	1,30	1,32	-
Texture	L	L	L	L	-

b. Average tuber productions achieved in the potato crop for the period under study

Statistic data processing of average tuber productions obtained during the experimental period (2008-2010) allow for a correct assessment of the effects of differentiated organo-mineral fertilization in Ostara and Desiree potato varieties under cultivation in the pedoclimatic area of the Apuseni Mts. (table 2)

The data presented (table 1) regarding average tuber productions for the two potato varieties under testing in the experimental conditions of the Apuseni Mts. area, there can be observed a certain eveness of production obtained due to negative climate phenomena during the growth period.

Average production resultsfor the three experimental years in varieties under experiment were inferior to the were inferior to the variety's genetic potential, which mostly expresses the negative effect of climate imbalances lately and the low soil fertility in the mountain area, which hindered the expression the variety's productivity traits. The analysis of the differentiated effect of fertilization (organic and organo-mineral) the experimental results obtained on a multiannual basis, shed light on the positive significance of increased fertilizer

doses, as well as relevant differentiations determined by the nature and structure of fertilizing assortments applied and the biologic potential of assortments.

Table 2

Effect of organo-mineral fertilization on average tuber productions for the Ostara and Desiree potato varities in the Apuseni Mts area (2008-2010 period)

No.	Variety	Fertilization variant	Average production (t/ha)	%	Difference	Significance
1	Ostara	b0 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 0t/ha stable manure (control)	17,65	100,0	0,00	Mt.
2		b1 –40N+$40P_2O_5$+ $40K_2O$ (kg s.a./ha)+ 0t/ha stable manure	19,59	111,0	1,94	***
3		b2 – 60N+ $60P_2O_5$+ $60K_2O$ (kg s.a./ha)+ 0t/ha stable manure	22,95	130,1	5,31	***
4		b3 – 80N+ $80P_2O_5$+ $80K_2O$ (kg s.a./ha)+ 0t/ha stable manure	24,10	136,6	6,45	***
5		b4 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 10t/ha stable manure	17,75	96,03	0,10	-
6		b5 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha) +20t/ha stable manure	17,95	96,60	0,30	-
7		b6 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha) +30t/ha stable manure	18,16	97,80	0,51	-
8		b7 –40N+$40P_2O_5$+ $40K_2O$ (kg s.a./ha)+ 20t/ha stable manure	19,98	113,2	2,34	***
9		b8 – 60N+ $60P_2O_5$+ $60K_2O$ (kg s.a./ha)+ 20t/ha stable manure	24,96	141,4	7,31	***
10		b9 – 80N+ $80P_2O_5$+ $80K_2O$ (kg s.a./ha)+ 20t/ha stable manure	25,54	144,7	7,89	***
1	Desirée	b0 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 0t/ha stable manure (Control)	18,28	100,0	0,00	Mt.
2		b1 –40N+$40P_2O_5$+ $40K_2O$ (kg s.a./ha)+ 0t/ha stable manure	20,80	113,8	2,52	**
3		b2 – 60N+ $60P_2O_5$+ $60K_2O$ (kg s.a./ha)+ 0t/ha stable manure	25,23	138,0	6,95	***
4		b3 – 80N+ $80P_2O_5$+ $80K_2O$ (kg s.a./ha)+ 0t/ha stable manure	26,69	146,0	8,41	***
5		b4 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 10t/ha stable manure	18,35	100,4	0,07	-
6		b5 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha) +20t/ha stable manure	18,68	102,1	0,40	-
7		b6 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha) +30t/ha stable manure	18,89	103,3	0,60	*
8		b7 –40N+$40P_2O_5$+ $40K_2O$ (kg s.a./ha)+ 20t/ha stable manure	21,34	116,7	3,06	***
9		b8 – 60N+ $60P_2O_5$+ $60K_2O$ (kg s.a./ha)+ 20t/ha stable manure	26,67	145,9	8,39	***
10		b9 – 80N+ $80P_2O_5$+ $80K_2O$ (kg s.a./ha)+ 20t/ha stable manure	27,69	151,4	9,40	***

Ostara	DL (p 5%)	0,76
	DL (p 1%)	0,03
	DL (p 0,1%)	0,39
Desiree	DL (p 5%)	0,50
	DL (p 1%)	0,69
	DL (p 0,1%)	0,92

First and foremost, a positive effect resides i the nutritive fertilizing value of organo-mineral combinations with an organic substratum (20 t/ha stable manure), as well as a mineral

support of nitrogen, phosphorus and potassium, systems that reveal the summing up and synergic effect of these combinations for tuber production. This combined positive effect is due to the initial level of precarious soil fertility, which is representative for the area, as well as the potato crop capacity that can positively capitalize organo-mineral interactions.

Compared to the highly significant effects of differentiated fertilization systems based o the organo-mineral interaction of nutrients, single fertilizations, either mineral nitrogen, phosphorus or potassium based ones or solely organic ones with manure prove the limiting factor of these interventions and their inability to meet with normal specific and overall consumption levels multi-annually for normal tuber productions.

Solely organic fertilization proves to be partial in terms of their fertilizing effects and a limiting of the approach on these solutions for the potato cultivation technology in the Apuseni Mts. Area where this crop is relevant in obtaining basic food for the population in the area.

Despite this limitation, the population in the mountain area is too poor to afford the purchase of mineral fertilizers, thus being forced to practise subsistence agriculture, with limited natural resources from household animal husbandry. Natural organic fertilizers employed in the area are highly diversified assortments, from plant residues to animal residues, composts or natural elements that first exhibit an input of organic matters and substances that are incorporated into the soil and have complex positive results on low-quality soils that are specific to the area, as well as the quality of agricultural and horticultural products.

A thorough study of the complex approach on the efficiency of differentiated fertilization systems in potato crop for representative soils in the Apuseni Mts. Area, with limited levels of fertility and productive capacity, requires for a rigorous control and study on the evolution of these basic soil traits, from a qualitative point of view, as well as establishing certain risk domains. Solutions of single fertilization, be it mineral or organic, can determine impact states of acidification and limited nutrient supply compared to the organo-mineral fertilization system, able to improve the soil's traits, its buffering capacity. In these conditions, an important agrochemical aspect is highlighted with reference to the application of complementary mineral fertilization, for potato crop in the mountain area, on a suitable organic substratum provided through systematic organic fertilization to the soil achieved through the employment of organic fertilizers from personal households.

The organic support provided through the systematic application of manure in 20t/ha doses, offers the favourable and meliorating environment of soil physical and chemical traits. In this context, the complementary application of mineral fertilizers determines a higher bioavailability of nutrients and their better capitalization by potato plants and implicitly superior qualitative and quantitative productions.

The analysis of the level of tuber wigth losses through storage in an unequipped storage area (cellar) for the two experimental varieties in the mountain area, under differentiated organo-mineral fertilization, the following can be depicted: the highest weigth losses in stored tubers occur for both varieties in variants where the level of fertilizatio falls under the plants' nutritive requirements and where the lowest productions per surface unit were also ecountered . Small losses through storage of 615,8 g/10 kg tubers in Ostara and 633,3 g/10 kg tubers in Desiree, were encountered in balanced fertilization variants for $80N + 80P_2O_5 + 80K_2O$(kg s.a./ha) + 20 t/ha stable manure, which meet the requirements for specific ad global nutritive consumption of both variants under study.

CONCLUSIONS

The districambosoil (brown acidic) specific to the mountain area exhbits an acidic to stringly acidic trait where the activity of microorganisms involved in humus sythesis is blocked

by active forms of acidity (H^+ ; Al^{3+} ; Mn^{2+}), as bioaccumulation is partial and one-sided and thus this soil is considered a poorly-fertile soil for potato.

Systematic organic fertilization for mountain area plants modifies positively and sustainably the acidic reaction (specific to mountain soils) through its neutralization, the coarse humus content, the nutritive element regime, the alkalinization of the adsorptive complex of the soil and implicitly its physico-chemical traits;

Organo-mineral fertilization, which is the most compatible with the biologic and nutrition requirements of the potato, enhances the bioavailability regime of soil nutritive elements on a organic support background, meliorates the acidic reaction of the soil, maintains and enhances soil fertility in the mountain area;

In the mountain area, animals are bred in a household system, and the quantity of natural fertilizers obtained alongside mineral fertilizers, through a positive organo-mineral fertilization can provide the fetilization of important land surfaces in order to obtain ecologic agricultural productions, on the one hand ad maintain and enhance the fertility of soils in the area, on the other;

The causal effect of physiologic and biochemical processes involved in the quantitative assessment of weigth losses is quatified in a differentiated manner, as a consequence of genootypic and productive traits of the two varieties under study and fertilization applied in their crop technology;

Differentiated organo-mineral fertilization influences the level of storage losses in an unequipped storage area (cellar), as in the case of balanced NPK doses on an organic background applied to the soil, which essentially expresses the nutritive requirements of plants and thus losses are smaller compared to the case of low fertilization where weigth losses are higher after storage.

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BIBLIOGRAFY

1. BUNESCU V. et al., 2000, Solurile Munților Apuseni,Cartimpex, Cluj-Napoca;
2. CONSTANTINESCU ECATERINA, VELICAN V. et.al., 1969, Cartoful, Agro-Silvică Publishing House, Bucharest;
3. MAXIM N., 1972, Condițiile de sol şi climă pentru cultura cartofului în România, PhD thesis, Agronomic Institute, Bucharest;
4. MĂRGHITAŞ MARILENA, M.RUSU, TANIA MIHĂIESCU, 2005, Fertilizarea plantelor agricole şi horticole, AcademicPres, Cluj-Napoca;
5. MUREŞAN S., 1976, Repausul germinal şi capacitatea de păstrare a soiurilor noi de cartof, ICCS Annals Braşov, The potato, vol.VI;
6. RUSU MIHAI et al., 2005, Tratat de Agrochimie, Ceres, Bucharest;
7. TEACI D., 1970, Bonitarea terenurilor agricole, Ceres, Bucharest;