STUDIES REGARDING THE OPTIMIZATION OF MANURE AND FERTILIZER APPLICATION IN APPLE AND PLUM TREE CULTURES FROM A FRUIT TREE FARM IN THE BACAU COUNTY

STUDII PRIVIND OPTIMIZAREA APLICĂRII ÎNGRĂŞĂMINTELOR NATURALE ŞI CHIMICE LA CULTURA MĂRULUI ŞI PRUNULUI ÎNTR-O EXPLOATAŢIE POMICOLĂ DIN JUDEŢUL BACĂU

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Abstract. *At the present and future stage of means development and production factors at the Joint-Stock Trade Company of BENEŞTI, the farming production will greatly depend on fertilization, which will result in a substantial change in the natural content of production conditions. From the various factors, which influence the apple tree and plum tree production, we have chosen for this study the use of manure and chemical fertilizers; the used methodology will also be presented in the study of other production factors. In order to establish the fertilization rates and types that are going to be administrated, we took into account that the apple tree needs high quantities of nitrogen and potassium, while the plum tree has high yields of fruits when phosphorus and potassium are used. For determining the best fertilizer rates, either mathematical methods on computer or simple calculations may be used. In the second case, we start from the production that is meant to be obtained, the specific consumption of active substance and the stock of active substance that already exists in soil, established according to the agrochemical mapping.*

Rezumat. *În stadiul actual al dezvoltării mijloacelor şi factorilor de producţie la SC BENEŞTI SA, dar şi în perspectivă, producţia agricolă va depinde într-o măsură mai mare de aplicarea îngrăşămintelor, care vor duce la o schimbare substanţială a însăşi conţinutului natural al condiţiilor de producţie.Din multitudinea de factori care influenţează producţia de mere şi prune, am ales pentru cercetarea întreprinsă îngrăşămintele naturale şi chimice, metodologia utilizată, urmând a fi prezentată şi pentru studiul altor factori de producţie.La stabilirea dozelor şi felurilor de îngrăşăminte ce se vor administra s-a ţinut cont de faptul că mărul solicită cantităţi mari de azot şi potasiu, iar la prun se realizează o stimulare a legării fructelor când se foloseşte fosfor şi potasiu.Pentru stabilirea dozelor optime de îngrăşăminte se pot utiliza fie metode matematice cu rezolvarea pe calculator, fie calculaţii simple. În acest de-al doilea caz se porneşte de la producţia prevăzută a se obţine, consumul specific de substanţă activă şi de rezerva de substanţă activă existentă în sol, stabilită pe baza cartării agrochimice.*

MATERIALS AND METHODS

In order to determine the best fertilizer rates, we have used two methods: the classical method, starting from the production estimated to be obtained, the specific

consumption of active substance and the stock of active substance that already exists in soil, established according to the agrochemical mapping and the method of linear programming on computer.

For illustrating the way of optimization by means of these methods, our studies have been conducted on the apple tree and plum tree cultures from an intensive plantation at the Joint-Stock Trade Company of Beneşti Stănişeşti.

RESULTS AND DISCUSSIONS

Among the material resources of industrial origin, used for the development of fruit growing activities, the chemical fertilizers have a special importance in preserving and increasing the productive capacity of fruit growing patrimony. Under conditions of using rationally the fertilizers, they ensure the increase in soil fertility, by its enrichment with some nutrients, especially nitrogen, phosphorus and potassium. Their use in fruit growing production is required by the need to satisfy the greater food demands, especially for fruits and fruit produces, on the condition of knowing soil chemical composition.

The amounts of chemical fertilizers are generally reduced and they are not always spread according to the size and structure of reserves present in soil. A single element is often administered, especially as superphosphates, which have no influence on fruit production, but only in association with nitrogen and potassium. Insufficient amounts of pesticides are also used, which are often spread at random, not when they are necessary for anti-parasitical treatments. Therefore, the chemical control becomes inefficient, the harvest being partially or even totally damaged. The use of insufficient amounts of chemical fertilizers and pesticides, associated to an improper spreading, do not result in resource saving, but in high crop losses, with negative impact on the efficiency of fruit growing activity. These disadvantages are the results of a bad management in using the resources. By using improper rates and inadequate application technologies, they produce the process of soil acidification (ammonium nitrogenous) and humus decay, having as effect the substantial crop diminution.

From the various factors influencing the apple and plum fruit production, we have chosen for our study the use of manure and chemical fertilizers; the used methodology will be also presented in the study of other production factors.

In order to establish the fertilization rates and types that are going to be administrated, we took into account that the apple tree needs high quantities of nitrogen and potassium, while the plum tree has a high yield of fruits when phosphorus and potassium are used.

Calculations were done by using the model presented in table 1.

For obtaining a mean yield per ha of 27000 kg in apple tree and 18000 kg in plum tree, when the above-mentioned amounts of active substance already exist in soil, it is necessary to administer in apple tree, per ha, 340-350 kg ammonium nitrogenous, 625-650 kg superphosphate and 400-450 kg potash salt.

The agrochemistry laboratories establish the amount of fertilizers, which must be administered, starting from the nitrogen (IN), phosphorus (P/ppm) and potassium index (K/ppm) and the mean estimated yield.

The same recommendations of the agrochemical laboratory specify that the organic fertilizers will be applied once in 2-3 years, at rates varying between 30 and 50 t/ha (tab. 2).

Table 1

Calculation of fertilizer rates used for apple tree and plum tree, under conditions of the Joint-Stock Trade Company of Beneşti

No.	Specification	Apple tree			Plum tree		
		N	P	K	N	P	K
1.	Estimated mean yield (kg/ha)	27000			18000		
2.	Necessary of active substance kg/a.s. /t active	13.85	17.14	20	12.50	15.62	18.75
	kg/as/ha	374	462	540	225	281	337
3.	Active substance present in soil kg/ha	270	315	372	140	160	225
4.	Difference to be added	104	147	168	85	121	112
5.	Losses by leaching and transf. in soil %	8	15	10	8	15	10
	kg/ha	8.3	22	17	7	18	11
6.	Active substance to administer (kg/ha)	113	170	185	82	140	122
7.	Industrial fertilizer type	Ammonium nitrate	Super-phosphate	Potash salt	Ammonium nitrate	Super-phosphate	Potash salt
8.	Fertilizer content active substance %	33-34.5	16-22	40-50	33-34.5	16-22	40-50
9.	Established rate industrial fertilizer (kg/ha)	350	650	450	300	600	300

Table 2

Manure rates in t/ha for apple tree and plum tree plantations

Clay content (A%)	Value of the nitrogen index (IN)						
	0.5	1.0	1.5	2.0	2.5	3.0	3.5
10	41	25	19	16	15	14	13
15	61	37	29	25	22	21	20
20	71	43	33	28	26	24	23
25	77	46	36	31	28	26	25
30	81	49	38	33	29	27	26
35	84	50	39	34	30	28	27
40	86	52	40	35	31	29	28
45	88	53	41	35	32	30	29
50	89	54	42	36	32	30	29

Data given by the agrochemical study carried out in 2007, in the analysed area, show values of the nitrogen index (IN) comprised between 2.30 and 3.25, and the clay content in the first 30-50 cm of soil has values comprised between 33-39%, indicating a necessary of 30 t/ha manure.

The nitrogen rates to be applied in apple tree and plum tree plantations will be calculated according to the estimated harvest (IN) (tab. 3).

Taking into account the estimated harvest of 27 t/ha of apples and IN of 2.5, on the average in soil, the nitrogen rate, which has to be applied is of 94 kg/ha, and in plum tree, at a estimated harvest of 18 t/ha, the nitrogen rate will be of 104 kg/ha.

For the calculation of phosphorus rates, we took as base the values of the estimated harvest (t/ha) and the soil supply with mobile phosphorus P (ppm) (table 4).

In case of establishing phosphorus rates, at a yield of 27 t/ha in apple tree and at a very weak and weak supply degree with phosphorus, the best rate is of 110 kg/ha, and in plum tree, at an estimated yield of 18 t/ha, it is of 125 kg/ha. At potassium and phosphorus, the rates of active substance are also established according to the values of estimated harvest and soil supply with mobile potassium, K(ppm) (table 5).

Table 3

Optimum rates of nitrogen in kg a.s. /ha for fruitful apple tree and plum tree plantations

Species	Estimated harvest t/ha	Value of the nitrogen index (IN)						
		0.5	1.0	1.5	2.0	2.5	3.0	3.5
Apple tree	26	125	104	97	94	91	90	89
	27	129	107	101	97	94	93	92
	28	132	110	103	99	97	95	94
Plum tree	16	135	113	105	101	99	98	97
	17	139	116	108	105	102	101	100
	18	141	118	110	107	104	103	102

Table 4

Optimum phosphorus rates in kg a.s./ha for fruitful apple tree and plum tree plantations

Species	Estimated harvest t/ha	Value of the P index (ppm)									
		5	10	15	20	25	30	35	40	45	50
Apple tree	26	262	146	108	80	77	69	64	60	56	54
	27	269	150	110	87	79	71	65	61	58	56
	28	276	154	113	93	81	73	67	63	59	58
Plum tree	16	286	163	120	99	86	78	71	67	63	60
	17	293	167	123	106	88	80	73	68	65	62
	18	300	171	125	112	90	82	74	70	66	64

Table 5

Optimum potassium rates in kg a.s./ha for fruitful apple tree and plum tree plantations

Species	Estimated harvest t/ha	Value of the K index (ppm)							
		60	80	100	120	140	180	220	260
Apple tree	26	198	175	162	153	147	138	132	126
	27	206	180	167	158	151	142	136	130
	28	210	186	172	162	155	146	140	134
Plum tree	6	218	194	179	169	162	152	146	138
	7	224	200	184	174	166	156	150	140
	8	230	205	189	178	170	160	154	142

Considering that in the investigated area, the soils with the mean potassium supply (175-257 K ppm) are prevalent at a yield of 27 t apples/ha, 136 kg a.s. potassium/ha are necessary, and in plum tree, at an estimated yield of 8 t/ha, 154 kg/ha are necessary.

The optimization of fertilizer rates may be also done by means of economic-mathematical methods, respectively, the linear programming. The used function of production is a second-degree polynomial function, with an independent variable allowing the establishment of the influence of a single factor of production on the production level and efficiency.

The base equation of the linear function with an independent variable is:

1. $f(y) + a_0 + a_1 \times 1$

- Where y = apples yield (t/ha);
- x_1 = natural fertilizers (rates); one rate = 5 t manure
- a_0, a_1 = coefficients of regression function

Based on the data obtained under conditions of the studied fruit growing farm, which concern the amounts of applied manure and the obtained apple yield, the calculation table was drawn with the expressions necessary to determine the coefficients (table 6).

Table 6

Calculation of expressions necessary for determining the coefficients in apple tree

f	Fertilizer rates x_1	Apples yield t/ha (y)	x_1^2	X_1Y
1	0	24.500	0	0
1	1	24.845	1	24.85
1	2	25.330	4	50.66
1	3	25.925	9	77.77
1	4	26.445	16	105.78
1	5	26.895	25	134.47
1	6	27.290	36	163.74
1	7	27.570	49	192.99
1	8	27.760	64	222.08
1	9	27.540	81	247.86
1	10	27.360	100	273.60
n	$\sum x_1$	$\sum y$	$\sum x_1^2$	$\sum x_1 y$

For the plum tree, we have used data from table 7, using the same calculation methodology and obtaining the solved equation of the function.

$Y = -0.0014\ x^2 + 0.1395\ x + 4.4349$

$R^2 = 0.96$

Taking into account the aspects resulted after the analysis of the additional use of manure rates on production, we may conclude that the best use is of 42 t/ha.

Table 7

Calculation of expressions necessary for determining coefficients in plum tree

f	Fertilizer rates x_1	Plum yield t/ha (y)	X_1^2	X_1Y
1	0	14.750	0	0
1	1	15.025	1	15.025
1	2	15.485	4	30.97
1	3	16.010	9	48.03
1	4	16.570	16	26.28
1	5	17.050	25	66.28
1	6	17.530	36	85.25
1	7	17.950	49	125.65
1	8	18.145	64	145.16
1	9	17.930	81	161.37
1	10	17.710	100	177.10
n	$\sum x_1$	$\sum y$	$\sum x_1^2$	$\sum x_1 y$

For this we are used the date from the tables 8 şi 9:

Table 8

Correlation between mean aple yield and amount of manure

Variant	Fertilizer rate t/ha – x_1	Mean yield kg/ha - y	Mean yield per rate (kg) - y	Marginal yield per rate (kg) y^m
1	-	24,500	-	-
2	5	24,845	69	69
3	10	25,330	83	97
4	15	25,925	95	119
5	20	26,445	97	104
6	25	26,895	96	90
7	30	27,290	93	79
8	35	27,570	88	56

Table 9

Correlation between mean plum yield and amount of manure

Variant	Fertilizer rate t/ha – x_1	Mean yield kg/ha - y	Mean yield per rate (kg) - y	Marginal yield per rate (kg) y^m
1	-	14.750	-	-
2	5	15.025	55	55
3	10	15.485	74	92
4	15	16.010	90	105
5	20	16.570	91	112
6	25	17.050	92	96
7	30	17.530	93	96
8	35	17.950	91	84
9	40	18.145	85	39

CONCLUSIONS

At the present and future stage of the development of production means and factors at the Joint-Stock Trade Company of BENEŞTI, the farming production will greatly depend on the economic means additionally invested, which will lead to a substantial change in the natural content of the production conditions.

Our study has shown that the proposed changes concerning the way of using manure and chemical fertilizers are the main ways of reaching the aims of profitableness and the increase in the obtained yield from the quantitative and qualitative viewpoint.

The optimization of fertilization, accompanied by the improvement in technical endowment and organization, and by the modern management, adapted to the real conditions of the area, represents the safest ways of economic efficiency, of reaching the obtained yield in apple and plum trees to the biological variety potential, as it is shown by the fruit-growing farm of Beneşti Company.

The establishment of viable fruit-growing farms, highly connected to the competition market, which have the best dimensions and are able to organize the fruit growing activity in accordance to the new international techniques and technologies, as well as setting up new organization types of these fruit growing farms represent a structural policy requiring the interference of State by corresponding economic means, for ensuring the remodelling of fruit growing farms.

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