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THE INVESTIGATIONS OF THE EFFECT OF DIFFERENT DOSES AND RATIOS OF N.P.K. MINERAL FERTILIZERS ON THE SEED AND OIL YIELD OF SUNFLOWER

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INTRODUCTION

An important problem in sunflower production is not only the dose of the corresponding elements of mineral nutrition but also their mutual ratio. In sunflower this problem is of particular significance as regards the great effect of the individual elements on the growth of vegetative organs and disease occurrences, as well as on the yield, respectively synthesis, content and quality of oil.

However, in sunflower there is relatively a small number of results concerning such investigations in comparison with other plant species. Thanks to different agroecological conditions sometimes various results were obtained by the individual authors. We are going to quote some authors who investigated this problem: Madjaric and Budisic (1960), Vrebalov (1962), Ignjatev (1963), Markovic and Stojanovic (1966), Stojkovic-Dzodan (1967), Onisenko (1968), Tono (1968), John (1970), Rollier (1970-72), Saric et al. (1972). The results obtained by most authors show that the effect of yield increase in sunflower is relatively small and varies from 1 to maximum 4 mtc/ha in relation to check.

Bearing in mind the facts mentioned above, a trial was set up whose significant methods and technique of work were presented in detail in the work of Saric et al. (1971) and therefore this time we discuss briefly the method of work which refers to sunflower.

METHODS OF WORK

The trial was set up in the Institute for Agricultural Research, Novi-Sad - Experimental Field Rimski Sancevi in 4 year rotation in 1965 where the plant species alternated according to the following sequence: winter wheat, sugar beet, maize and sunflower. Twenty variants of nutrition were investigated in the trial which was set up in four replications. The basic plot was 200 sq. m. The trial has been located and every year on the particular plot the same doses and ratios of mineral fertilizers are applied changing only plant species as it is mentioned above. The variety used in the trial was Peredovik and the density of sowing was 70 x 35 cm. The variants of fertilization were as follows:

- | | |
|----------------------|--------------|
| 1. Unfertilized plot | 11. N2 P1 K1 |
| 2. N2 | 12. N2 P2 K1 |
| 3. P3 | 13. N2 P2 K2 |
| 4. K2 | 14. N2 P3 K1 |

5. N2 P2	15. N2 P3 K3
6. N2 K2	16. N3 P1 K1
7. P2 K2	17. N3 P2 K1
8. N1 P1 K1	18. N3 P2 K2
9. N1 P2 K1	19. N3 P3 K2
10. N1 P2 K2	20. N3 P3 K3

Index 1 designates 50 kg/ha, index 2 - 100 kg/ha and index 3 - 140 kg/ha of pure element.

The fertilizers were applied in the following mode: 1/2 of phosphorus and potassium fertilizers was applied before ploughing and the second half of phosphorus and potassium fertilizers as well as one third of nitrogen fertilizers were applied before sowing. The other two thirds of nitrogen fertilizers were applied twice in topdressing (1 at the stage of 3-5 leaves and 11 at the stage of 7-9 leaves).

Oil content was determined by extraction with gasolin after the method of residues.

The results obtained were arranged statistically and according to the method of variance, and are presented in tables.

THE RESULTS OBTAINED AND THEIR EXPLANATION

Seed yield

In table 1 there are presented the results for the individual years showing that the yield varied in dependence both of the conditions prevailing in the individual years and of the variant of nutrition. It should be pointed out that the yield in the first year was the lowest due to storm and hail which affected considerably the plant damage. The best yield and nearly the same was obtained in 1968, 1969 and 1971, whereas it was considerably lower in 1970. It can be stated, taking not in detail and individually the environmental conditions (temperature and precipitations) that in the years when the highest yields were obtained, the climatic conditions were also most favorable. Moreover, the fact should be pointed out that the ratio between check plot and the plots where fertilization was applied, had increased from year to year. Thus for instance, in 1968 this ratio was 100 - 110 %, in 1969 : 100 - 113 %, in 1970 : 100 - 122 % and in 1971 : 100 - 128 %.

If we compare the effect of nitrogen, phosphorus and potassium at their individual application, then the effect of nitrogen was the greatest and in average it amounted to 8 % and in the individual years it was considerably higher even up to 25 %. However, the effect of phosphorus and potassium were the same and ranged on the level of check, both in average and per individual years.

At applying two elements it can be concluded that the effect of NP and NK were nearly the same and in average they amounted to 11-12 %, whereas in the individual years this effect was greater and its maximum ranged from 23 to 26 %. When phosphorus and potassium were used together, the effect obtained was nearly the same to that at their individual application and the yield increase was in average for 2 %, thanks mainly to the results of 1967, when these plants were damaged least from storm because they were also the weakest. In other words their mutual effect was on the level of check.

All three elements applied in the same ratios but in different doses produced the following increase of yield: $N_1 P_1 K_1$ - 11 % ; $N_2 P_2 K_2$ - 10 % ; $N_3 P_3 K_3$ - 7 %, whereas the maximal increase of yield was in average 13 % and in the individual years from 7 to 28 % regardless the variant of nutrition. These data show that the effect of applied mineral fertilizers in sunflower was relatively small and therefore the care should be taken at determining the most economic dose and ratio of the individual elements. It should be also pointed out that sunflower yield in the individual years or in average was on the level of the average yield of good estates in Voivodina ; it means that these results may be used also in determining the fertilizers application in sunflower in wide production.

It can be seen from the data presented in table 2 that the differences in yields by years are statistically justified except between 1968 and 1969 when the yields were nearly the same. Likewise, in lot of cases there were significant differences between check and other variants of fertilizers applied as well as between the variants $P_2 K_2$, $P_2 K_2$ and other variants of fertilizers applied. We are not going to consider in detail the particular results in the individual years but we will analyse only the average results.

Table 1 - The interaction of different doses and ratios of NPK mineral fertilizers per years, as well as of the average sunflower seed yield

Variants of nutrition	YEARS					Average	%	LSD	
	1967	1968	1969	1970	1971			5 %	1 %
∅	23,76	29,35	27,79	21,43	23,36	25,14	100		
N ₂	19,00	32,21	31,11	24,47	29,16	27,19	108		
P ₂	24,94	29,41	26,86	21,13	23,13	25,09	99		
K ₂	23,45	28,57	26,82	21,54	22,83	24,64	98		
N ₂ P ₂	23,91	31,53	31,48	25,56	28,94	28,28	112		
N ₂ K ₂	21,72	30,41	30,69	26,22	29,38	27,84	111		
P ₂ K ₂	27,54	30,05	27,02	20,75	23,21	25,71	102		
N ₁ P ₁ K ₁	23,61	31,37	30,98	25,52	28,42	27,98	111		
N ₁ P ₂ K ₁	24,05	30,41	31,30	25,15	28,19	27,82	111		
N ₁ P ₂ K ₂	25,57	30,16	31,16	25,48	28,79	28,23	112		
N ₂ P ₁ K ₁	22,36	31,37	30,91	25,41	28,34	27,67	110		
N ₂ P ₂ K ₁	23,00	32,41	31,44	24,81	30,05	28,34	113		
N ₂ P ₂ K ₂	23,33	31,40	29,85	24,86	29,31	27,83	110		
N ₂ P ₃ K ₁	22,18	32,36	31,29	24,59	29,23	27,93	111		
N ₂ P ₃ K ₃	22,91	31,35	30,82	24,59	29,31	27,79	110		
N ₃ P ₁ K ₁	23,46	29,99	30,17	24,77	28,64	27,40	108		
N ₃ P ₂ K ₁	18,61	30,34	31,27	23,94	29,83	26,61	106		
N ₃ P ₂ K ₂	21,41	28,96	30,32	23,09	29,38	26,63	106		
N ₃ P ₃ K ₂	22,54	29,34	29,14	23,56	29,46	26,80	106		
N ₃ P ₃ K ₃	20,23	30,86	30,40	24,46	29,83	27,15	107		
Prosek	22,90	30,59	30,04	24,10	27,93			0,69	0,90
LSD 0,01		3,11				1,38			
0,05		4,08				1,82			

They show also that significant differences were only between check variant P₂ · K₂, P₂K₂ and other variants, whereas in most cases there were no significant differences among other variants. The highest yield was produced in variant N₂P₂K₁ and in average for five years this increase amounts to 13 %. The application of the lowest and intermediate doses of nitrogen regardless the variant of phosphorus and potassium produced an increase from 10 to 13 %, whereas the application of the highest doses of nitrogen too, with no regards to the variant of phosphorus and potassium, gave an increase from 6 to 8 %. It can be concluded from these results that the gain of mineral fertilizers application on sunflower seed yield was best at lower and intermediate doses of nitrogen fertilizers with no regard to phosphorus and potassium. At any rate, phosphorus and potassium fertilizers must be applied due to the well-known reasons of biological and edaphic climatic nature.

Table 2 - The effect of different doses and ratios of NPK mineral fertilizers on sunflower oil yield
mc/ha

Variants of nutrition	YEARS					Average	%
	1967	1968	1969	1970	1971		
∅	12,51	16,48	15,19	11,89	10,72	13,35	100
N ₂	9,64	17,68	16,36	12,25	14,56	14,06	105
P ₂	13,62	16,67	14,68	11,60	10,82	13,47	101
K ₂	12,36	16,17	14,91	11,68	10,58	13,12	98
N ₂ P ₂	11,94	16,62	15,74	13,15	14,79	14,44	108
N ₂ K ₂	11,12	16,50	15,80	13,37	14,82	14,32	107
P ₂ K ₂	14,47	16,90	15,09	11,42	10,85	13,74	102
N ₁ P ₁ K ₁	12,24	17,08	16,32	13,82	13,66	14,62	110
N ₁ P ₂ K ₁	12,25	16,36	16,13	13,70	13,87	14,46	108
N ₁ P ₂ K ₂	12,80	16,15	16,80	13,36	13,70	14,56	109
N ₂ P ₁ K ₁	11,36	16,89	15,82	13,08	14,27	14,28	107
N ₂ P ₂ K ₁	11,45	17,43	16,29	12,66	15,45	14,65	110
N ₂ P ₂ K ₂	12,28	16,80	15,03	12,67	14,77	14,31	107
N ₂ P ₃ K ₁	11,11	17,21	15,78	12,52	14,96	14,31	107
N ₂ P ₃ K ₃	11,38	16,82	15,87	12,30	14,76	14,22	107
N ₃ P ₁ K ₁	11,93	16,11	15,12	12,41	14,90	14,09	105
N ₃ P ₂ K ₁	9,50	15,99	15,83	11,75	15,53	13,72	103
N ₃ P ₂ K ₂	10,66	15,41	14,49	11,36	15,18	13,42	101
N ₃ P ₃ K ₂	11,08	15,17	14,44	11,67	15,53	13,58	102
N ₃ P ₃ K ₃	10,25	16,42	15,05	12,15	15,75	13,92	104

Oil yield

Since for sunflower production are important both the seed yield and oil yield, therefore the data on sunflower oil yield per hectare are given in table 2. Certainly, the sunflower oil yield depends upon the sunflower seed yield and oil content in it, i.e. percentual oil content. It can be seen from these data that the oil yield varied both by the individual years and in dependence of the nutrition variant. The average maximal increase of oil yield per hectare amounted only to 10 %, in the variant N₂P₂K₁ which had also the highest average of sunflower seed yield. The same maximal oil increase of 10 % was the nutrition variant N₁P₁K₁, i.e. at the lowest dose of fertilizers applied. These data indicate even more to the relatively weak effect of mineral fertilizers applied in sunflower and about the need of finding out economically justified doses of fertilizers which are undoubtedly smaller in comparison to the doses applied for other plant species, particularly for wheat.

Completely same tendencies were obtained in oil yield as well as in sunflower seed yield, i.e. lower and moderate doses of nitrogen had considerably greater effect on oil yield, regardless the applied amounts of phosphorus and potassium, whereas at the application of the highest nitrogen doses there was a tendency of decrease of sunflower oil yield.

The effect of mineral fertilizers in dependence of the plant species

Variants of nutrition	WHEAT		SUGAR BEET				MAIZE		SUNFLOWER			
	Yield of grain		Yield of root		Yield of sugar		Yield of grain		Yield of seed		Yield of oil	
	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%	mc/ha	%
∅	33	100	489	100	85	100	74	100	25	100	13	100
N ₂	40	122	542	111	89	104	80	109	27	108	14	105
P ₂	33	101	511	105	89	104	73	99	25	99	13	101
K ₂	33	101	506	103	90	107	72	97	25	98	13	98
N ₂ P ₂	42	127	568	116	94	111	82	112	28	112	14	108
N ₂ K ₂	41	123	546	112	93	110	81	110	28	111	14	107
P ₂ K ₂	33	101	519	106	92	109	71	96	26	102	14	102
N ₁ P ₁ K ₁	40	122	550	112	95	112	79	107	28	111	15	110
N ₁ P ₂ K ₁	41	124	567	116	99	116	79	107	28	111	14	108
N ₁ P ₂ K ₂	41	125	561	115	98	115	80	109	28	112	15	109
N ₂ P ₁ K ₁	42	128	570	117	96	114	82	112	28	110	14	107
N ₂ P ₂ K ₁	43	130	575	118	97	114	83	112	28	113	15	110
N ₂ P ₂ K ₂	43	131	577	118	98	115	81	110	28	110	14	102
N ₂ P ₃ K ₁	42	129	586	120	99	117	81	109	28	111	14	107
N ₂ P ₃ K ₃	40	123	586	120	100	118	82	112	28	110	14	107
N ₃ P ₁ K ₁	41	125	572	117	93	109	84	115	27	108	14	105
N ₃ P ₂ K ₁	41	125	579	118	93	110	84	114	27	106	14	103
N ₃ P ₂ K ₂	41	125	583	119	94	111	81	110	27	106	13	101
N ₃ P ₃ K ₂	41	124	582	119	93	110	81	110	27	106	14	102
N ₃ P ₃ K ₃	42	127	595	122	97	114	82	111	27	107	14	104
	1,44						3,03		1,38			
	1,90						3,98		1,62			

Tab. 3 - The effect of different doses and ratios of NPK mineral fertilizers in relation to the yield depending upon the plant species (the average of 5 years : 1966-1971).

The results obtained presented on table 3 show that the effect of mineral fertilizers depended upon the plant species. The highest yields increase for 5 years was in wheat and amounted to 31 %, then in sugar beet 22 %, maize 15 % and finally in sunflower only 10 %. It should be pointed out that all four plant species did not react equally on the application of the particular kind of fertilizers. Wheat, maize and sunflower did not react on the application of phosphorus and potassium fertilizers, whereas sugar beet did although slightly. As regards nitrogen, wheat reacted mostly to it and considerably more than the other plant species, whereas the other three plant species reacted nearly the same. The highest yields of wheat were obtained at applying moderate doses of NPK, of sugar beet and maize at moderate and highest, whereas of sunflower at the lowest and moderate doses. However, from the economic point of view, certainly that these ratios are even more expressive in favor to more profitable application of mineral fertilizers. In other words, if one plant species reacted nearly the same on the minimal and moderate dose, then it is certain that the application of minimal doses is more justified both from the biological and economical standpoint. These results show clearly that different plant species react very differently on mineral fertilizers, which is the reflection of specific physiologico-biochemical processes during the life of corresponding plant species.

CONCLUSION

In sunflower production there is an important problem both of the rates of the corresponding element of mineral nutrition and their mutual ratio. This problem is of particular significance for sunflower, as regards that there is a great effect of the individual elements on the growth of vegetative organs and disease occurrence, as well as on the yield respectively synthesis, content and quality of oil.

Bearing in mind all this mentioned above, a trial was set up in 1965 in rotation, as follows: sunflower - wheat - sugar beet - maize - sunflower, etc..., with an elementary table of 200 sq m. The trial was set up for indefinite time, and on this occasion we are going to present five-year results of sunflower.

The effect of mineral fertilizers application in sunflower was relatively small, especially in comparison with other plant species. During five years there was an average maximal increase of seed yield in sunflower for 13 %, in wheat for 31 %, sugar beet for 22 % and maize for 15 %.

In the trial we investigated 20 variants of mineral nutrition. The influence of the individual elements on sunflower yield was different. A maximal increase of yield was when only nitrogen was applied - 8 %, whereas at the application of only phosphorus or only potassium the yield was for 1-2 % lower than check.

As regards the double combinations, it can be concluded that the combinations NP and NK produced nearly the same yield and that the increase was 11 and 12 % in relation to check, respectively 4 % in relation to nitrogen application only, whereas at the combination PK the yield was only for 2 % higher than check.

At the application of the all three elements of NPK mineral fertilizers, the greatest yield was obtained at the smallest rate, where the increase of yield amounted to 11 % whereas the medium respectively the greatest rate produced the yield for 1 % respectively 4 % less than the lowest rate.

From the results obtained it can be seen that nitrogen has a decisive role in yield formation but with its permanent increase there does not come to an increase of yield but contrary to its decrease.

As regards the NPK ratio it is very difficult to conclude which is the best, but from the results obtained it can be said that this ratio should be in favor of nitrogen, bearing certainly in mind the total NPK rates.

As concerns the oil percentage in sunflower seed, its maximum ranged to 4,4 % within 20 variants respectively different combinations of nitrogen, phosphorus and potassium. Nitrogen had the smallest effect on the increase of oil percentage, and the oil percentage decreased with the increased rates of mineral fertilizers.

Maximal increase of oil yield was for 10 % in relation to check. At the maximal rates of NPK application, the increase of oil yield was from 1 to 5 %.

Besides, these indicators in this trial we investigated other physiologico-biochemical respectively agrochemical-microbiological changes in soil, which took place during the last 5 years of this trial.

BIBLIOGRAPHY

IGNJATEV K.B. - Udobrenie maslanych kultur. Maslanye i efiromaslanye kulturi - Moskva 1963.

JOHN H. M. - Effect of nitrogen rates and plant spacing on sunflower seed yield and other characteristics. Proceedings of the IVth International Sunflower Conference - June 23-25, 1970 - Memphis, Tennessee (U.S.A.)

- JOCIC B. i dr - Proučavanje uticaja različitih količina i odnosa NPK mineralnih đubriva na prinos suncokreta. Dokumentacija za tehnologiju i tehniku u poljoprivredi. Sv. 7-8, 1971.
- MADJARIC Z. i BUDISIC M. - Utjecaj gnojidbe mineralnim gnojivima na prinos suncokreta u Slavoniji. Agronomski glasnik br. 1-2, 1960.
- MARKOVIC N. i STOJANOVIC Z. - Utvrđivanje najpovoljnijeg odnosa NPK đubriva za šećernu repu i suncokret na crnozemu i gajnjaci - Zemljište i biljka vo. 15, n° 3 - 1966.
- ONISENKO A. M. - Vlijanje mineralnih udobrnij na urožaj semjan podsolnicnika i ih kacestvo. Sbornik naučno-istraživačkih radova po maslacnim kulturam. Maj 1968, Krasnodar.
- PERKOVIC M. i dr. - Proučavanje uticaja različitih količina i odnosa NPK mineralnih đubriva na prinos suncokreta. Dokumentacija za tehnologiju i tehniku u poljoprivredi, sv. br. 5 1970.
- ROLLIER M. - Etude de la fertilisation azotée du tournesol - Informations Techniques CETIOM - 3ème trimestre 1970.
- ROLLIER M. - Etude de la fertilisation du tournesol - Informations Techniques CETIOM - n° 24, 1971.
- SARIC M., SENBORN B. i JOCIC B. - Uticaj različitih količina i odnosa azoté, fosfora i kalijuma na prinos i kvalitet ozime pšenice sorte Bezostaja 1. Savremena poljoprivreda br. 10, 1971.
- SARIC M., JOCIC B. i VERESBARANJI I. - Proučavanje uticaja različitih količina i odnosa NPK mineralnih đubriva na prinos i kvalitet ulja suncokreta. Agrohemijska 1-2, 1972.
- STOJKOVIC - DZODAN A. - Uticaj ekoloških činilaca i đubriva na prinos semena i sadržaj ulja u važnijih sorata suncokreta na Kosovu. Zajednica naučnih ustanova Kosova i Metohije. Studije, knjiga 1, 1967, Pristina.
- VREBALOV T. - Tehnološki proces visokoprinosnih sorata suncokreta. Suncokret - rezultati i problemi daljeg unapređenja proizvodnje visokorodnih sorata. Jugoslovenski savetodavni centar za poljoprivredu i sumarstvo 1962. Beograd.
- TANO F. - Recherche sulla concimazione minerale del girasole. Sementi elette, n° 6, 1968.