FERTILIZING SUNFLOWER ON CALCAREOUS CHERNOZEM SOIL

E. Gál, I. Kádár and J. Vörös*
Research Institute for Soil Science and Agricultural Chemistry;
*Research Institute for Plant Protection
H-1022 Budapest, Herman Ottó út 15, Hungary

SUMMARY

In the Region of Mezőföld, on a calcareous loamy chernozem soil ($CaCO_3$ 5%, Humus 3 %) a field experiment was set up to study the different crops.In 1982 (9th year of the experiment) a sunflower hybrid of the variety "Koflor-2" was grown. The trial had 4 levels of N, P and K resp., and included all combinations with 64 treatments.

The biomass of the green sunflower plants at the stage of 6-8 leaves increased 2-2,5 fold as a result of NP fertilization. At the harvest time, however, the NP effects were no more evident.The same time, the oil content of the seeds decreased by 4-5 %. The NP fertilization resulted some provable changes in the fatty acid composition: the quantity of stearic and oleic acids enhanced, while that of palmic and linoleic acids decreased. An influence of the K levels could not be proved on this loamy, with available potassium medium supplied soil.

Sunflower plants on the untreated control plots were far less infected by Macrophomina (30 % incidence vs. 70 %), Alternaria and Embellisia (10 % vs. 20 %) than were the ones grown on plots with high NPK levels. On soils similar to the studied one with good nutrient reserve, sunflower does not need much fertilizer within an intensiv crop rotation, using its roots nutrient absorbing capacity from previously applied fertilizers. Overfertilization may not effect the seed yield but deteriorate the quality and decrease the diseases resistance.

MATERIALS AND METHODS

On a calcareous chernozem soil ($CaCO_3$= 5 %; Humus= 3 %), in 1973 a field experiment was set up to study the effect of NPK fertilization on different crops. In the 9th year of the experiment, in 1982, sunflower hybrid "Koflor-2" was grown on the site, which is medium supplied with available N and K, and poor in available P in the ploughed layer.

Fertilizers were applied as NH_4NO_3, superphosphate and potassium cloride at the rate shown in table 1:

Fertilizers applied in field experiment during 9 year period 1973-82

NPK/Levels	0	1	2	3
N (yearly)	0	100	200	300
N (total)	0	900	1800	2700
P_2O_5 (total)	0	1000	2000	3000
K_2O (total)	0	1000	2000	3000

As a result of 9-year fertilization, up to 1982 build up 4 levels of available NPK content in the ploughed layer: poor, medium, statisfactory and high as it can bee seen in table 2:

Available NPK content in the soil after 9 year, in 1981, mg/kg

NPK/Levels	0	1	2	3	$LSD_{5\%}$
Ammonium-lactate soluble P and K, at the 0-20 cm					
P_2O_5	93	195	352	495	36
K_2O	137	200	248	365	23
KCl-soluble NO_3-N at the soil profile					
0-20 cm	23,5	43,7	64,8	86,7	8,0
20-40 cm	15,8	31,9	47,2	66,5	8,0
40-60 cm	8,3	14,8	22,0	31,0	5,4
0-60 cm, kg/ha	143	271	402	553	67

The trial had 4-4 levels of N, P, and K resp., and included all combinations with 64 treatments in 2 replications, representing a field experiment 4^3 type with 128 plots. Agrotechnics used on large scale farms were applied, harvesting was done by a plot-combine harvester. Plant samples were taken at 6-leaves stage (total above ground part), at flowering (first leaf beneath the head), at harvest (seeds, head and stem separatelly) 20-20 plants or plant parts per plot.

RESULTS AND DISCUSSION

At the early 6 leaves stage the PK fertilization increased the above ground mass 2-2,5 times, while at harvest time the PK-effects disappeared completely. However, a moderate but provable N-effect could be observed in seed yield. The NP fertilization resulted in 4-4,5 % oilcontent dropping as well in the seed, so the oiloutput was not effected at all, as it shown in table 3:

Effect of fertilization on the yield and oiloutput of sunflower "Koflor 2"

Treatment	P_0	P_1	P_2	P_3	$LSD_{5\%}$	Mean
Air-dry weight, plant parts above the soil, kg/ha (at the stage of 6 to 8 leaves)						
K_0	108	182	174	177		160
K_1	132	213	250	205	53	200
K_2	107	216	200	233		189
K_3	149	245	230	269		223
Mean	124	214	214	221	27	193
Seed yield, air-dry weight, t/ha, at harvest						
N_0	2,97	2,97	2,98	2,83		2,94
N_1	2,88	3,07	3,11	3,11		3,04
N_2	3,17	3,19	3,30	3,16	0,34	3,20
N_3	3,31	3,27	3,54	2,95		3,27
Mean	3,08	3,12	3,23	3,01	0,17	3,11

Cont. Table 3

Treatment	P_0	P_1	P_2	P_3	$LSD_{5\%}$	Mean
	Oil-content of the seed /in %/					
N_0	49,8	50,1	49,6	49,6		49,8
N_0^1	49,4	49,1	47,7	46,6	0,5	48,2
N_1^2	49,1	48,0	45,8	46,3		47,3
N_2^3	48,2	48,0	46,4	45,7		47,1
Mean	49,1	48,8	47,4	47,0	0,3	48,1
	Oil-output, t/ha					
N_0	1,48	1,49	1,48	1,40		1,46
N_0^1	1,42	1,51	1,48	1,45	0,22	1,46
N_1^2	1,56	1,53	1,51	1,46		1,52
N_2^3	1,60	1,57	1,64	1,35		1,54
Mean	1,52	1,52	1,53	1,42	0,11	1,50

Note: The $LSD_{5\%}$-values are the same for the rows and the columns.

The state of nutrition influenced also the resistance of sunflower to some kind of diseases. The Macrophomina infection rate increased with the NK levels from about 30 % to 60-70 %. The appearance of Alternaria showed a similar tendency, while that of Embellisia was stimulated by the rising N and P fertilizer levels.

Table 4: Effect of fertilization on the resistance to some plant diseases of sunflower, % of infected plants.

Treatments	N_0	N_1	N_2	N_3	$LSD_{5\%}$	Mean
			Macrophomina			
K_0	29,8	58,6	41,7	54,9		46,2
K_0^1	38,6	51,7	53,6	49,2	13,6	48,3
K_1^2	41,1	46,1	50,4	62,3		50,0
K_2^3	45,5	56,1	49,8	69,2		55,2
Mean	38,8	53,1	48,9	58,9	6,8	49,9
			Alternaria			
K_0	14,3	22,4	11,8	24,8		18,3
K_0^1	16,8	26,7	18,6	19,9	13,2	20,5
K_1^2	14,9	26,8	19,8	24,4		21,4
K_2^3	28,0	22,3	31,7	20,4		25,6
Mean	18,5	24,6	20,5	22,3	6,6	21,5
			Embellisia			
P_0	8,6	18,0	11,7	17,4		13,9
P_0^1	12,4	12,4	16,8	20,5	9,4	15,5
P_1^2	10,5	11,1	18,6	16,7		14,2
P_2^3	14,3	15,5	16,1	19,9		16,4
Mean	11,4	14,2	15,8	18,6	4,7	15,0

The sunflower heads droped their seeds to different degrees depending on the state of nutrition. On the untreated plots the heads dropped only 4-5 % of their seeds, while on the fertilized ones this percentage mounted up to 20-25 %. Dropping of seeds was influenced in the first place by N-fertilization, and to a lower but

still provable degree by K-fertilization.

Table 5: Effect of fertilization on the dropping-out-of-seeds of sunflower, % of plant number.

Treatment	N_0	N_1	N_2	N_3	$LSD_{5\%}$	Mean
P	5,9	10,2	9,2	12,6		9,4
P_0	4,0	21,2	19,6	23,4		17,0
P_1	4,8	22,7	19,7	18,4		16,4
P_2	7,4	20,2	15,8	18,3		15,4
P_3					9,0	
K_0	4,5	13,2	15,9	15,9		12,4
K_1	4,9	17,8	13,4	18,6		13,6
K_2	5,2	20,4	15,9	16,6		14,5
K_3	7,6	23,0	19,1	21,6		17,8
$LSD_{5\%}$		9,0				4,5
Mean	5,6	18,6	16,1	18,2	4,5	14,6

The composition of the fatty acids in the sunflower-oil changed also with the different NP levels: stearic and linoleic acids content rose, while that of palmic acid decreased on the increasing NP levels.

CONCLUSIONS

The studied chernozem soil is poorly to medium supplied with available nutrient (soil testing data), but possesses a rather big total nutrient pool, which allows the sunflower plants to cover their nutrient requirements basically without fertilization. Therefor, on soils similar to the studied one or even heavier, with a nutrient pool convenient for sunflower having an extraordinary nutrient absorbing capacity, it is not necessary to apply fertilizers, expecially when sunflower is only one member of a crop-rotation.

Increasing fertilizer levels (first of all N and P) moderately increased the sunflower yield, but on the other hand reduced the oil content and contributed to a higher incidence rate of infection and diseases. Sunflower plants from untreated plots were for less infected by Macrophomina (30 % vs. 70 %), Alternaria and Embellisia (10 % vs. 20 %) than were the ones grown on plots with high fertilizer doses.

REFERENCES

Kádár I., Lukács P., Thamm B., 1983, Influence of fertilization on the crop yield and quality of sunflower. Proc. 16th ISF Congr. Fat Science. 167-174. Budapest.

Kádár I., Vörös J., Szilágyi J., 1983, A talaj tápanyagellátottságának hatása a napraforgó termésére, ásványi tápelemtartalmára és betegségellenállóságára. XXV. Georgikon Napok. In: A talajtermékenység fokozása. I. rész. 329-337. Keszthely.