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FERTILIZING AND LIMING SUNFLOWER ON ACID SANDY SOIL

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SUMMARY

In Nord-East Hungary, in a 22-year old field fertilization trial on an acid sandy brown forest soil poor in nutritive power (pH/KCl= 4,6; Humus=0,5-0,6 %), the effect of the main macronutrients was studied on the yield formation and oil output of sunflower. In 1984 a hybrid "HNK-81" was grown. The trial had 32 combinations with 4 replications, and a random-block design. The plots had 5x10= 50 m^2 each with 8 rows and 30 cm in the rows (70x30= 0,21 m^2 growing area). Agrotechnics used on large farms were applied, harvesting was done by hand using 3 rows in the middle of each plot. Plant samples were taken at 4-6 leaves stage (total above ground part), at flowering (first developed leaf beneath the head) and at harvest (seed and head).

The yearly rate of 120 kg/ha N given alone did not increase the yield, N together with 120 kg/ha P_2O_5 and K_2O, resp., did not show a significant influence either. The complete NPK-fertilization nearly doubled the yield and together with 200 kg/ha Ca yearly it became 2,5-fold of that grown on the control plots. The NPKMg treatment (40-80 kg/ha Mg yearly) increased the yield by 3-times, and when applying all the 5 elements the seed yield reached 2,6 t/ha, i.e. there was a 3,5-fold increment both in seed yield and oil output in comparison to the unfertilized plots.

On the NPKCaMg fertilized and limed plots the average height of plants was nearly doubled; the number of plants and the diameter of the heads increased while the appearance of Sclerotinia infection decreased significantly. The sunflower production could be of economic importance in this region, on soils having a pH/KCl/ around 6 and a sufficient pool of mobile nutrients (P, K, Mg) as well as a proper N nutrition. According to our findings, sunflower crop may be "satisfactory" supplied with nutrients when having 3-5 % N; 0,25-0,35 % P; 4-5 % K; 1-1,3 % Ca and 0,4-0,5 % Mg in above ground mass at the stage of 4-6 leave, and 2,5-3 % N; 0,25-0,30 % P; 2,5-3 % K; 2-2,5 % Ca and 0,5-0,6 % Mg in the first developed leaf beneath the head at flowering.

INTRODUCTION

On loamy chernozem soils, and generally on any loamy or even heavier soil with a good total nutrient pool sunflower generally does not show a marked response to any fertilizer because its root system has an agressive nutrient absorbing capacity (Dvoracsek 1986, Kádár 1986). However, on acid sandy soils the growth is often limited, because these soils are very poor in plant nutritive pover. So, the production of sunflower in this area is often economically not profitable (Balogh and Józsa 1986). In this study the effect of liming and fertilization was measured on the growth, crop yield, mineral composition and oil-output of sunflower. Some of the results of this investigation was shown earlier by Csengeriné and Kozák (1985).

MATERIALS AND METHODS

This field experiment was set up on a field of the State Farm Nyírlugos by Láng (1973), in 1963. Crop rotation was: rye-potato (2x4 years), wheat-potato (2x4 years), wheat-lupine-wheat (2x3 years) during the 22 year-period. In 1984 sunflower hybrid HNK-81 was grown. The trial had 32 treatments with 4 replications and represents a random block design with 128 plots. Each plot had 5x10= 50 m^2 with 8 rows and 30 cm in the rows, i.e. 70x30=0,21 m^2 growing area for each sunflower plant. Agrotechnics used on large scale farms were applied, harvesting was done by hand using 3 rows in the middle of each plot. The yearly rate and form of fertilizers used in the experiment are shown in table 1.:

The yearly rates and forms of fertilizers applied in the experiment from 1976.

Element	Average rate, kg/ha	Form of fertilizer (active ingredient %)
N	120	Ca-ammonium-nitrate (28 % N)
P_2O_5	120	Super phosphate (18 % P_2O_5)
K_2O	120	Potassium cloride (60 % K_2O)
Mg	60	Magnesium sulfate (20 % Mg)
Mg	60	Dolomit powder "B" (5,7 % Mg)
Ca	200	Lime,Calcium carbonate (40 % Ca)

Plant samples were taken at 4-6 leaves stage (total above ground part), at flowering (first developed leaf beneath the head) and at harvest (seed and head). The growth and development of sunflower were followed by measuring the number of plants (3 rows,or 30 m); the average height of plants; the diameter of heads; the number of seeds/cm^2 head and the 1000 seed mass. Sampling procedure included 20 plants or leaves per plot taken randomly for making up a composite sample or 20 cores per plot making up a composite soil sample at the ploughed layer. In this paper the average effect of nitrogen, phosphorus, potassium, calcium and magnesium will be shown using eight treatments only, because there could not be detected any significant differences among the effects of different rates of any fertilizers.

RESULTS AND DISCUSSION

The date presented in Table 2 are sufficiently illustrative to show that mineral fertilizers acidify this soil, the pH/KCl/values sink in comparison to the unfertilized plot. Liming and use of dolomit powder can counterbalance the acidification and eve increase the soil pH value. The humus content did not show any significant change in the ploughed layer. At the same time the ammonium-lactate soluble phosphorus and potassium content generally doubled under PK fertilization reaching a "satisfactory" level in the soil. Increased EDTA-Mn values were to be found on fertilized, not limed plots as well.

Table 2.

The pH/KCl value, Humus as well as available phosphorus,potassium and manganese content of soil at the ploughed layer.

Treatment	pH/KCl	Humus %	AL-P_2O_5 mg/kg	AL-K_2O mg/kg	EDTA-Mn mg/kg
Control	4,6	0,52	66	70	56
N	3,9	0,40	78	100	97
NP	3,9	0,51	140	110	74
NK	3,8	0,50	80	130	71
NPK	3,9	0,51	142	132	64
NPKCa	4,8	0,50	160	150	53
NPKMg	4,6	0,45	140	140	60
NPKCaMg	5,9	0,50	170	132	68
$LSD_{5\%}$	0,8	0,15	35	32	28

Data concerning effect of fertilization and liming on the yield and mineral composition of sunflower at 4-6 leaves stage and at the beginning of flowering are presented in Table 3. Plant analyses are useful in determining the nutritional status of crops. Unfortunately, there are very few data to judge the nutrient status of sunflower. Characterizing the "satisfactory" level of nutrition we can assess it as 3-5 % N; 0,25-0,35 % P; 4-5 % K; 1-1,3 % Ca and 0,4-0,5 % Mg at 4-6 leaves stage (above ground part). The same "satisfactory" level will be at flowering (first developed leaf beneath the head): 2,5-3 % N; 0,25-0,30 % P; 2,5-3,0 % K; 2-2,5 % Ca and 0,5-0,6 % Mg in the green, air-dry plant tissue.

On the very acid, one-sidedly fertilized plots plants grew badly, plant density and the height of plant were low. On the limed and well sufficiently fertilized NPKCaMg plots, however, the diameter of the heads, as well as the seed yield and the oil-output increased significantly. Applying about 100-150 kg N; 100-120 kg P_2O_5 and K_2O; 40-80 kg Mg, as well as 200 kg Ca per hectar and year on this soil 2,5-2,6 t/ha seed yield of sunflower can be got.

CONCLUSIONS

The production of sunflower in this area can be economically profitable if the soil available phosphorus, potassium and magnesium content is satisfactory and pH/KCl value of the ploughed layer is maintained by liming at 5,5-6,0, as well as a proper nitrogen nutrition is secured.

Table 3

Effect of fertilization and liming on the yield and mineral composition of sunflower

Treatment	Air-dry weight g/20 plants	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
		%					mg/kg			
At 4-6 leaves stage, above ground part, 31 May, 1984										
Control	10,2	2,94	0,27	4,56	1,24	0,40	1200	321	74	9
N	7,8	3,16	0,20	3,68	0,74	0,34	1090	542	96	18
NP	12,8	3,31	0,29	3,64	1,13	0,42	1176	548	76	11
NK	10,7	2,78	0,23	3,78	0,98	0,36	1348	535	77	10
NPK	12,3	3,09	0,27	4,83	1,11	0,38	1147	502	73	10
NPKCa	11,0	2,52	0,26	3,96	1,11	0,33	1174	313	71	11
NPKMg	14,0	5,22	0,35	5,21	1,31	0,50	1119	363	61	10
NPKCaMg	12,2	2,95	0,30	4,67	1,21	0,48	1336	306	66	9
$LSD_{5\%}$	3,8	0,62	0,08	1,20	0,30	0,15	340	100	18	4
Mean	11,4	3,25	0,27	4,29	1,10	0,40	1199	429	74	11
At beginning of flowering, developed leaf beneath the head, 17 July, 1984.										
Control	14,9	2,46	0,28	2,45	2,22	0,53	165	366	32	16
N	11,9	2,56	0,25	2,18	1,54	0,57	140	382	40	20
NP	21,1	2,26	0,24	1,98	2,08	0,59	149	439	39	13
NK	18,8	3,19	0,27	2,92	1,62	0,50	145	421	38	17
NPK	22,7	2,67	0,27	2,76	2,07	0,50	145	423	39	15
NPKCa	26,4	2,75	0,27	3,06	2,41	0,44	182	391	36	14
NPKMg	24,2	2,92	0,32	2,62	2,26	0,62	150	389	43	19
NPKCaMg	26,1	2,13	0,24	2,26	2,32	0,57	162	362	34	16
$LSD_{5\%}$	6,5	0,40	0,07	0,82	0,45	0,16	35	120	8	7
Mean	20,8	2,62	0,27	2,53	2,07	0,54	155	397	38	16

Table 4

Effect of fertilization and liming on groth, yield-structure, seed yield and oil-output of sunflower, Nyirlugos, 1984.

Treatment	Plant-number Piece/10 m	Height of Plant, cm	Diameter of head, cm	Seed-number Piece/cm² head	1000 Seed Mass, g
Control	68	92	11,1	2,6	65
N	60	60	10,9	2,7	68
NP	69	75	11,2	2,9	70
NK	69	74	11,3	2,3	74
NPK	73	110	13,4	3,8	67
NPKCa	75	141	15,4	5,3	69
NPKMg	80	140	15,0	5,0	68
NPKCaMg	82	157	16,3	5,1	68
$LSD_{5\%}$	8	35	2,4	1,2	7

Treatment	Seed yield kg/ha	/%/	Oil content %	/%/	Oil-output kg/ha	/%/
Control	750	100	44,8	100	336	100
N	640	85	41,9	94	268	80
NP	947	126	42,4	95	402	120
NK	763	102	41,2	92	314	93
NPK	1430	191	43,8	98	626	186
NPKCa	1847	246	44,8	100	827	246
NPKMg	2270	303	45,3	101	1028	306
NPKCaMg	2645	353	45,6	102	1206	359
$LSD_{5\%}$	540	72	2,2	5	217	65

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