RESPONSE TO N FERTILIZATION OF WINTER SEEDED SUNFLOWER IN SOUTHERN SPAIN

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SUMMARY

Sunflower has been traditionally considered a spring crop but recent experiments have demonstrated that is possible and profitable to grow sunflower as a winter crop under the climatic conditions of the South of Spain.

To contibute to the knowledge of the of nitrogenous fertilization on the winter-sunflower, field studies were conducted with six application rates (0, 40, 80, 120, 160 and 200 Kg N/ha) at the "Campiña" region, on clay (Typic Chromexerentes) soils.

Fertilizer did not modified significantly N concentration in the top most mature leaf at flowering but shortened the vegetative period and anticipated anthesis 3-5 days in fertilized plots.

Oil content of seeds decreased with increasing dosages of nitrogen and there was a trend to increase grain yields with N rates. The relationship between grain yield and N applied, improved, when residual soil nitrate was included in the calculations.

Nitrogen uptake was highly increased by N-fertilizer applications. Grain yield divided by total N uptake (GNR) was used to estimate N utilization efficiency that was higher at control and 40 Kg N/ha treatments.

Futher research is on the way to establish the most desirable winter sunflower management fertilization in the "Campiña" clay soils.

INTRODUCTION

The spring-seeded sunflower (Helianthus annuus L.) yield responses to N fertilizer application, in the dry-lands of the South of Spain, is poor (González, 1992). Recently it has been demonstrated that is possible to grow sunflower in this area as a winter crop (Gimeno et al., 1989). The favorable grain and oil-yield responses to winter planting in a mediterranean environment could be explained because plants have increased probabilites to avoid high-evaporative demand periods and high air temperatures during flowering and seed filling periods.

There is no available information which describes the response of winter-sunflower to applications of N fertilizer. The goal of this study was to determine the amount of N fertilizer needed to achieve better yields, increase N efficiency use, and estimate the response to residual inorganic N levels in the soil in order to improve N fertilizer managements.

MATERIAL AND METHODS

A previous field study was arranged in 1988 on a Cordoba loam, Fluventic Xerochrept, soil and following studies were conducted from 1990 to 1991 at the "Campiña" region, on two clay, Typic Chromoxeret, soils (Table 1).

Table 1. Main properties of soils used in the field experiments

Location	Depth cm	pH 1:2,5		P avail. ppm	K avail. ppm	Textural class	CO_3 Ca %	O.M. %	N inorg.	
		H_2O	Cl_2 Ca						N-NO_3 Kg/ha	N-NH_4 Kg/ha
CORDOBA (88)	0-25	8,0	7,7	6	155	Loam	19	1,0	5	46
	16-50	8,2	7,6	3	139		19	--	6	45
MONTESINA (91)	0-25	8,2	7,4	14	400	Clay	28	1,2	11	47
	26-50	8,0	7,6	8	486		23	0,9	18	40
TOMEJIL (91)	0-25	8,0	7,5	7	418	Clay	26	1,6	7	14
	26-50	8,0	7,4	6	341		26	1,0	12	20

Wheat was grown on the experimental sites prior to the study. Before planting the soil was mould plowing and disking. In the spring, the plots were cultivated once.

The treatments were arranged in a randomized complete block design with four replications. All the plots received at planting 26 Kg P/ha and 50 Kg K/ha. The same sunflower hybrid was planted in all plots (Florasol in 1991 and Monro-45 in 1988). Planting dates are shown in Table 2. Row spacing was 0,70 m and the individual plots were 4,20 x 10 m in size, plant density was about 53.000 plants/ha. Nitrogen was broadcasted at rates 0, 40, 80, 120, 160 and

200 Kg N/ha, and incorporated into the soil prior to planting.

Soil samples were collected duplicated, prior planting, to a depth of 0,50 m in 0.25 m increments. Samples were composited in each plot and used to evaluate the N inorganic according to Kempers (1974) and Griess-Ilosvay, modified by Bremmer and Edwards (1965), methods.

Table 2. Rainfall and planting dates.

Location	Planting date	Harvesting date	Rainfall Prior to planting mm	After planting mm	Total mm
CORDOBA (88) S-1	28-XII-87	25-VI-88	433	194	627
S-2	22-I-88	3-VII-88	509	135	644
S-3	17-II-88	10-VII-88	557	89	646
S-4	15-III-88	10-VII-88	558	88	646
MONTESINA (91)	18-XII-90	15-VII-91	213	344	557
TOMEJIL (91)	27-XII-90	30-VII-91	156	308	464

At flowering the top most mature leaf of 35 plants were sampled, dried, ground and analysed for mineral content. Grain was harvested by hand for representative sections of each plot. The harvested portion of each subplot was (0,7 x 2 x 8) m^2. Once cleaned, grain samples were retained for moisture, oil and N content analysis. At Tomejil, a subsample of ten plants/plot were removed and divided in, grain, "heads", "leaves" and "stems". The subsamples were dried, weighed and representative amount were ground and retained for N content analysis.

Climatological data was collected in the nearest meteorological station.

Data collected in the study was summarized and statistically analysed for ANOVA.

RESULTS AND DISCUSSION

The rainfall in the 1990-91 period (Table 2) was lower than average and its distribution anomalous, with surplus in autumn-winter and scarcity in spring.

The concentration of N in the top most mature leaf at flowering is not significantly affected by N additions (Table 3). In general, the lowest values are found in the control and 40 Kg N/ha treatments. All the levels are considered below the critical range, according to the data collected by Reuter and Robinson (1986).

Table 3. Concentrations of N in leaves, grain, stems and heads as affected by fertilizer N rate.

N applied Kg N/ha	% N						
	Top-most mature leaf		Grain		Leaves	Stems	Heads
	Tom.	Mont.	Tom.	Mont.	Tom.	Tom.	Tom.
0	2,49	2,18	2,28	2,58	0,77	0,25	0,71
40	2,42	2,31	2,62	2,73	0,84	0,28	0,71
80	2,59	2,35	2,95	2,84	1,02	0,35	0,89
120	2,54	2,25	2,99	2,91	0,99	0,42	0,99
160	2,60	2,34	3,08	3,06	1,05	0,46	1,06
200	2,67	2,31	3,19	2,94	1,07	0,42	0,90
	NS	NS	**	0,10	**	**	**
LSD(0.05)			0,29	0,3	0,15	0,10	0,12

NS indicates a probability level > 0,10, * and ** indicates a probability level < 0,05 and < 0,01 respectively.
LSD values apply only to comparisons of means. An LSD value is shown only if the effect of N was significant at the 0,10 level or less.

The vegetative period is significantly shortened by N fertilizer and the flowering stage is anticipated 3-5 days. When the planting dates were delayed this effect diminished (Table 4); by contrast, Hocking and Steer (1982) did not found any effect of N stress on the timing of floret initiation, anthesis or seed maturity in sunflower sown in midsummer.

Oil content of seeds decreased with increasing dosages of nitrogen (Table 5) as it is well known in the spring and summer sown sunflowers (Simanskii, 1961, Coic et al., 1972, Vicentini and Anelli, 1973, González and Insua, 1976, Robinson, 1978) but did not change significanty the total oil produced.

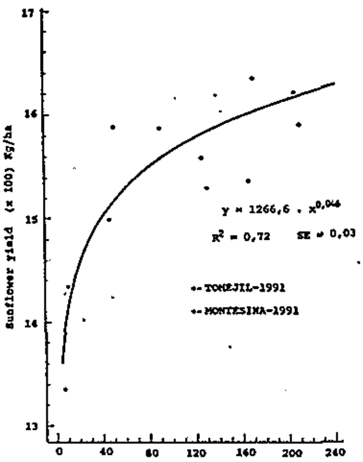
Table 4. Mean anthesis anticipation (50% plants with flowers) from the most delayed plot (MDP) as affected by N rate.

Location	MONTESINA 91	TOMEJIL 91	CORDOBA			
Dates MDP DAP	27-V-91 160	23-V-91 147	S-1 22-V-88 136	S-2 21-V-88 127	S-3 31-V-88 108	S-4 13-VI-88 90
N applied Kg N/ha	0 40 80 120 160 200	0 40 80 120 160 200	0 50 100 150	0 50 100 150	0 50 100 150	0 50 100 150
Mean anthesis days	2,3 5,0 6,3 5,8 6,8 6,8	1,7 5,4 6,4 6,6 6,8 7,3	1,5 5,3 5,6 6,3	1,8 7,3 6,8 8,0	2,0 3,0 2,0 3,0	1,0 3,0 3,5 3,5
LSD(0.05)	** 1,5	** 1,4	** 1,7	** 2,2	* 1,4	** 1,2

DAP days after planting.

The effects of applied fertilizer N on sunflower grain yield are shown on Table 5. Analysis of variance indicate no significant effects of N fertilization on yield. There is a trend to increase yields with N fertilizers and maximum measured yields were found at 40 Kg N/ha on Montesina and 40-80 Kg N/ha on Tomejil, were the soil has the lowest residual inorganic N (Table 1).

Fig. 1. Relationship between sunflower yield and fertilizer N + residual $N\text{-}NO_3^-$



Several fuctions were fitted to the combined data by use of regression analyses in an effort to describe the relationship between grain yield and residual inorganic N and applied N fertilizer. The best fit, as measured by r^2 and standar error of the estimate (SE) is found when it is summarised the $N\text{-}NO_3^-$ of the first 0,25 m of the soil and the N from treatments (Fig. 1). The total inorganic N in the top 0,25 m or 0,50 m did not improve the relationship.

For improvement of N fertilizer recomendations residual soil $N\text{-}NO_3^-$ should be measured and included in the calculations for best results.

N fertilizer highly modified N concentration of plant parts at harvest: (Table 5). The lower concentrations were found at the lower N rate and in the absence of added N fertilizer. For higher rates there were no significant differences among treatments.

Dry matter yields of plant parts, all but stems, were not affected by N fertilization. The mean values are given as footnotes in Table 5. Most of the N was located in grains and this must be considered in fertilizing the following crop.

The grain yield to N uptake ratio (GNR) show in Table 5 indicates that the higher N efficiency was found at control or 40 Kg N/ha treatements.

Table 5. Grain yield, oil content and N uptake as affected by N rates.
(Yields reported on a 0% moisture basis and uptake in above ground plant material).

	Grain yield Kg/		Oil %		N uptake (Kg/ha)					
N applied Kg N/ha	MONTESINA	TOMEJIL	MONTESINA	TOMEJIL	GRAIN	LEAVES	STEMS	HEADS	TOTAL	GNR
0	1435	1336	45,0	45,8	27,4	4,5	2,6	5,8	40,2	30,4
40	1589	1500	44,6	45,7	37,4	5,8	3,5	6,2	53,0	27,2
80	1589	1647	44,1	45,3	43,3	7,5	5,1	7,8	63,7	22,9
120	1530	1559	44,1	44,9	45,0	8,1	6,3	9,1	68,5	22,0
160	1635	1537	44,0	44,3	45,8	9,7	6,8	10,0	72,3	20,7
200	1590	1621	43,1	44,3	46,4	7,4	6,1	8,6	68,5	21,3
	NS	NS	NS	**	**	*	**	**	**	**
LSD (0,05)	—	—				2,9	2,3	2,2	15,2	3,6

Mean grain yield 1429 Kg/ha, Leaves 743 Kg/ha, Stems 1374 Kg/ha, Heads 906 Kg/ha
GNR grain yield to nutrient ratio
NS indicates a probability level >0,05, and ** a probability level <0,01.
LSD values apply only to comparisons of means for treatments.

These results can be used as a preliminary reference for sunflower production using more economical and environmentally acceptable nutrient management practices.

RESUMEN

Se han estudiado *los efectos de la fertilización* N en el girasol de invierno. El abono anticipa la floración 3-5 días e incrementa las extracciones de N. Las máximas cosechas y más eficiente uso del N se da con las dosis más bajas de fertilizante aplicado.

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