

Nitrogen fertilization of high oleic sunflower in wet climate

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ABSTRACT

Fertilization may help crops to yield better. To determine whether meteorological and soil conditions influence the productive response of nitrogen fertilization in sunflower a study was conducted in an Italian interregional project (BIOLI). The effects of nitrogen fertilization on two commercial high oleic varieties (Carnia and PR 64 H 61) were investigated in North East (Udine) Italy in 2005-2006-2007. Nitrogen fertilization gave the best yield at the highest level in Udine in wet and irrigated conditions. In Udine the locally selected high oleic hybrid (Carnia) had the best performance. Nitrogen fertilization is suggested only in good weather conditions and in nitrogen-poor soil. Under drought conditions nitrogen influences plant growth but not yield.

Key words: fertilization – irrigation condition – nitrogen – soil condition – sunflower.

INTRODUCTION

As in other crops, sunflower requires NPK fertilization. In Italy, trials with potassium (K) and phosphorus (P) in the last decade did not show any response in the crop due to the naturally high level of potassium in the soil, at least 160 mg/kg of available K₂O (international method), or due to the large quantity of fertilizer applied, in the effort to build up phosphorus levels. For phosphorus, the levels above 10-20 mg/kg of P₂O₅ in the soil (Olsen method) are maintained by annually applying the amount that was removed by the previous crop. In addition, sunflower has only moderate phosphorus requirements and utilizes mycorrhizas (Glass, 1988).

Nitrogen fertilization is very variable and depends on the amount of the element already present in the soil and the potential yield of the environment. Crnobarac et al. (2004) and Monotti (1978) reported that 100 kg/ha was suitable. Malligawad et al. (2004) expressed the importance of nitrogen combined with phosphorus and potassium and reported better yields when the ratio of the first two elements was between 1.5 and 2.0 (results of two experiments). Steer et al., (1994) reported that sunflower has a high nitrogen requirement. Bonari et al. (1992) associated the needs for nitrogen with available water. Laureti and Pieri (1999, 2001) reported that 40-80 kg/ha (depending on the water available) of fertilizer alone or associated with green manuring was enough. Moreover, according to Merrien et al. (1986), the nitrogen of the soil participates by up to 70% in the plant nutrition and is adsorbed particularly from 40th to 80th days from emergence. When flowering starts (60 days after emergence) the 50% of the nitrogen adsorbed is in the leaf. After that, nitrogen moves in the head and finally in the seeds. The coefficient of nitrogen fertilizer utilization in sunflower is 20-30% (60% in wheat) and that coming from fertilizers is adsorbed starting from flowering.

In an effort to contribute to the debate, under an interregional project, three levels of nitrogen were tested.

MATERIALS AND METHODS

To study the response of two high oleic sunflower hybrids (Carnia and PR 64 H 61) against nitrogen fertilization, three different levels of N (0; 60; 100 kg/ha) were used in two field experiments in two locations during 2005-2006-2007, under irrigated conditions at Udine, North East Italy. The experiments were laid in a randomized complete block design with four replicates with an individual plot size of 279 m² (9 x 31 m).

Weather conditions (temperature and rainfall) observed during the experiments are presented in Fig. 1. The average annual rainfall at Osimo is usually half that of Udine. In the experimental year the rainfall at Osimo was normal whereas, in May and June, the levels were below normal in Udine and was necessary to compensate with four irrigations of 30 mm each, every ten days starting from the 10th of May until the 10th June (May 10 and 20; June 1 and 10).

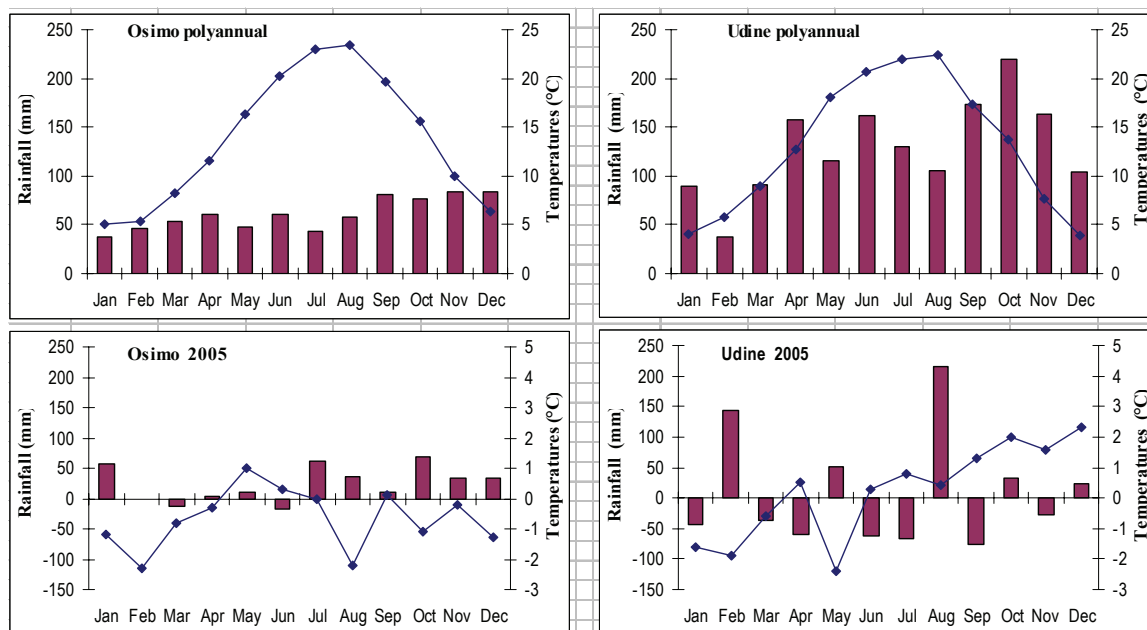


Fig. 1. Rainfall (mm) and mean temperatures (°C) in 2005 compared with the previous polyannual period of 20 years for Osimo and 10 years for Udine.

Soil tests showed high phosphorus and potash levels in both locations but low nitrogen content, especially in Udine (Table 1).

Table 1. Chemical properties of experiment field soils

	Osimo	Udine
Sand g/kg	133	400
silt g/kg	472	430
clay g/kg	395	170
nitrogen g/kg (N)	1.1	0.2
Phosphorus mg/kg (P)	11	41
potash mg/kg (K)	423	200

The soil was a Vertisol in Osimo with good water availability down to a deep level, whereas the soil was gravelly at Udine with good water availability only in the upper 50 cm and very poor water availability at deeper level. To satisfy crop water requirements, four irrigations (30 mm each) were done in May and June in Udine.

RESULTS AND DISCUSSION

Sunflower yield in Italy is greatly dependent on the amount of water stored in the soil and on the amount and distribution of rainfall during the vegetative period. In the summer of 2005 rainfall at Osimo, before blooming and seed filling, was below average so the yield was less than expected based on the plant size. In fact, during the whole cycle the better fertilized plots were always greener, taller and with larger leaves (Table 2). The only datum recorded for this aspect, plant height, was in fact influenced by nitrogen; the plants were taller with higher doses of nitrogen at both Osimo and Udine.

Table 2. Sunflower response to nitrogen fertilization

Nitrogen kg/ha	Yield t/ha		Oil content %		Oil yield t/ha		Thousand-seed weight g		Plant height cm
	Osimo	Udine	Carnia	PR64 H61	Osimo	Udine	Osimo	Udine	
0	2.14	2.27	47.4	48.1	0.91	1.01	62.3	48.2	165
60	2.24	2.27	49.0	47.8	0.96	1.02	62.8	47.6	173
100	2.24	3.28	45.8	47.9	0.94	1.42	62.6	55.6	178
LSD	0.31		1.3		0.14		4.07		4

The data recorded agree with those of Blanquet et al. (1987) who found a weak response whenever water availability was less than 200 mm during the crop cycle. In Udine, on the contrary, the highest nitrogen dose gave the best yield, but the intermediate dose (60 kg/ha) did not differ from the control (Table 2).

The highest yield was due to improved seed weight and number of seeds per plant. The positive response of nitrogen in Udine could be related to the very low nitrogen level in the soil. The improvement in Osimo was not evident because seed set was negatively influenced by the scarcity of rainfall during blooming; the subsequent good meteorological conditions of above average rainfall only produced an increased seed size.

The seed oil content changed as a function of fertilization only in Carnia (Table 2), whose value decreased at the highest nitrogen rate, but not in PR 64 H 61. Oil yield showed the same figures as seed yield, with the higher value only in Udine at the highest nitrogen fertilization.

In spite of good water availability the crop in Udine did not reach the same thousand seed weight (TSW) due to the large number of seeds set.

Yield differences were not observed in the hybrids used in the experiment at Osimo (Table 3) whereas at Udine the locally selected hybrid (Carnia) was significantly more productive than PR 64 H 61 probably due to its higher capacity to set seed. Carnia had also the best oil content at Udine and consequently the best oil yield, whereas at Osimo no differences were found.

Table 3. Variety differences

Varieties	Yield t/ha		Oil content %		Oil yield t/ha		Thousand-seed weight g		Plant height cm	
	Osimo	Udine	Osimo	Udine	Osimo	Udine	Osimo	Udine	Osimo	Udine
CARNIA	2.39	2.81	45.2	49.6	0.89	1.27	60.4	47.7	153	185
PR 64 H 61	2.24	2.17	48.3	47.5	0.99	1.07	64.7	53.2	177	175
LSD	0.25		1.1		0.11		4.07		5.0	

For plant height, PR 64 H 61 was little influenced by water availability, whereas Carnia was more sensitive

CONCLUSIONS

According to the literature, the response of sunflower to nitrogen fertilization is influenced by weather conditions during the season and the natural nitrogen level in the soil.

Under drought conditions and medium natural soil nitrogen content, the response of the crop was evident in the size of the plant but not in its yield. On the contrary, excessive growth could cause lower water use efficiency, but this was not evident in the trials.

Under good water conditions and low nitrogen content in the soil, sunflower responded positively to fertilization; the highest dose improved the amount of seed set, seed size, and, consequently, yield.

The results among the varieties tested were similar in Osimo and significantly different in Udine where the most productive local variety was used.

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