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EFFECTS OF INCREASING N-DOSES ON SUNFLOWER IN TWO-YEAR ROTATION WITH DURUM WHEAT

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To help to understanding of factors limiting nitrogen utilization efficiency of several crops in Southern Italy (Tavoliere Pugliese), yield and quality responses of sunflower (Helianthus annuus l. cv Fiorom 305) at four nitrogen doses (0, 60, 120, 180 kg N ha^{-1}) were compared by control of d.m. and N content distributions among leaves, stems, heads and achenes during the crop cycle. Soil N mineral ($N\text{-}NO_3^-$ + $N\text{-}NH_4^+$) variations as affected by treatments were also examined.
Experimental N doses were split into three equal applications (sowing, 4th and 15th leaf true). Plant density at sowing was 5 plants/m^2 and at harvest 3.9 plants/m^2.
The achenes yield obtained with 60 kg N ha^{-1} (49.74 q ha^{-1}) were significantly different from those with N_0, N_{120} and N_{180} (40.3 and 46 q ha^{-1}). The same behaviour was observed for weight and the diameter of heads.
Other morfological characteristics (weight 1000 achenes, test weight, diameter of heads, plant heights) were unaffected by nitrogen fertilizer. Oil and protein contents tend respectively to decrease and increase with N supply. Oil yield was higher (P= 0.05) with N_{60} (19.46 q ha^{-1}) compared to N_0 (15.67 q ha^{-1}), but N_{120} and N_{180} did not improve oil yield. Protein yield and harvest index were higher in N_{60} (respectively 8.91 q ha^{-1} and 0.487), but the differences were not significant.
From experimental data several parameters were determined which allow the evaluation of N uptake efficiency and N utilization efficiency. N uptake efficiency is $\Delta N_t/N_s$ in which ΔN_t is the difference between N removed by the crop in fertilized and unfertilized plots and N_s is N supply in the same units; N utilization efficiency is $\Delta R_a/N_t$ (or $\Delta R_a/N_s$), in which ΔR_a is yield increase per unit of N (Giardini, 1987). Moreover the following parameters were evaluated: achenes N/total plant N (N_a/N_t); N uptake after anthesis/total plant N (N_{ant}/N_t); achenes yield/achenes N (R_a/N_a); achenes N/N uptake after anthesis (N_a/N_{ant}), using on sunflower method of Moll et al. (1982).
In table I it can be observed that the mean value of N uptake efficiency is 31%, $\Delta R_a/N_t$= 0.29 and $\Delta R_a/N_s$= 0.07 q kg^{-1} N (N utilization efficiencies). For these parameters, the highest values were obtained supplying 60 kg N ha^{-1}. R_a/N_a remain constant in the four treatments, but N_a/N_t is greatly influenced by N doses (maximum value with N_{60}). Increasing the rates of N significantly increased N_{ant}/N_t and decreased N_a/N_{ant}.
During the crop cycle the plants were sampled at the following stages: 15th leaf stage, beginning of flowering, milk stage, dough stage, physiological maturity, harvest. During the milk stage and the end of the dough stage highest daily dry matter accumulation was recorded, with the following increases produced by N doses: N_0= + 49%; N_{60}= + 53%; N_{120}= + 66%; N_{180}= + 136%; d.m. of leaves presents a slight mean increase both in fertilized and unfertilized plots.
High dry matter accumulation in the top of the plants produces a marked d.m. decrease in the stems, mainly with N_{60} (- 33%). In the next period the clear decrease of d.m. of leaves with N_0 (- 63%), d.m. of stems increase in fertilized plots (+ 15%), and a positive trend in the heads with N_{60} (+ 46%), but not with N_{120} were recorded.
N content of leaves showed a continuous decrease during the cycle and a signifi-

cant difference between N_0 and three N applications (2.45 vs. 2.79 g/100 g d.m.). For the heads a first stage (beginning of flowering - milk stage) was observed in which N content decreases and was unaffected by N fertilizer; in the next stage N increase was very marked (depending on achenes formation) and a slight effect of N doses was observed.

N content of stems decreases very quickly (- 75%) until the milk stage, but successively was almost constant; effects of fertilizer on N content of stems was lower than on other sunflower organs.

Soil N mineral ($N\text{-}NO_3^-$ + $N\text{-}NH_4^+$) changes at three depths (0-20; 20-40; 40-60 cm) were also determined. Significant (P= 0.05) effects of N-doses and dates of sampling were recorded on $N\text{-}NO_3^-$ and $N\text{-}NH_4^+$ soil contents, but the effect of soil depth was nonsignificant. Although it was difficult to correlate total N of plants with soil N mineral, $N\text{-}NO_3^-$ content decreases markedly with N_{60} (- 75%), differently by $N\text{-}NH_4^+$ content.

Table 1 - Parameters which allow the evaluation of N uptake efficiency and N utilization efficiency of sunflower (Foggia, 1985).

N-doses	$\Delta N_t/N_s$	$\Delta R_a/N_t$	$\Delta R_a/N_s$	$\Delta R_a/N_a$	N_a/N_t	N_{ant}/N_t	N_a/N_a
N_0	/	/	/	0.27	0.72	0.37	2.24
N_{60}	0.42	0.44	0.14	0.27	0.85	0.39	2.17
N_{120}	0.26	0.33	0.05	0.27	0.76	0.40	2.01
N_{180}	0.24	0.11	0.03	0.27	0.71	0.42	1.70

R_a= q ha^{-1}; N_t, N_s, N_a, N_{ant} = kg ha^{-1}.