

## **SOIL TILLAGE DEPTHS AND CROPS ORGANIC FERTILISATION: EFFECTS ON PRODUCTIVE PARAMETERS OF SUNFLOWER AND DURUM WHEAT IN MEDITERRANEAN ENVIRONMENT**

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### **Abstract**

The aim of the long-term research described is to determine the effects of two soil tillage depths (40-45 cm and minimum tillage) and of three crop fertilisation strategies (mineral, organic and mixed) on yield and quality of sunflower and durum wheat, cropped in a two-year rotation. The experiment was conducted at Foggia (Southern Italy). The experimental treatments were compared on plots on 40 m<sup>2</sup> each, distributed in a split-plot design, with three replications. The trial has given good results, whether with minimum tillage, or from organic fertilisation. In fact, the responses obtained so far have shown that, contrary to what found in similar trials carried out in Italy, minimum tillage gave productions statistically not different from those of traditional tillage. A similar behaviour has been observed for fertilisation treatments, above all in sunflower, while in wheat the organic fertilisation achieved grain yields lower than those from the treatments which received both mineral and mixed fertiliser.

Additional Keywords: MSW-compost, crops rotation, productions, quality.

### **Introduction**

In Italy the intensive agronomical practices have been extremely common until a few years ago, but lately they began to be less widespread. In fact, as time passed, the application of deep soil tillage, plentiful mineral fertilisers and chemical herbicides, crop residue burning and continuous cropping have resulted in a progressive deterioration of soil fertility (Convertini *et al.*, 1997), degradation of aggregate stability (Lynch and Elliot, 1983), increased soil compaction (Stelluti *et al.*, 1998), nitrate losses and gravitational water pollution (Shepherd *et al.*, 1993), with negative consequences not only on the soil properties, but also on the environmental conditions. Therefore, it should be opportune to employ the practices of conservative agriculture, instead of those of the conventional one.

In the last few years, a further problem for the environment is represented by the disposal of municipal solid waste. In the light of these considerations, the Agronomical Research Institute has been carrying out several long-term experiments, one of which studies the effects of different soil tillage depths and evaluates the possibility to replace, *in toto* or partly, the mineral fertilisation with organic fertilisers, as Municipal Solid Waste-compost from selected collecting. The results so far obtained in Italy on the soil tillage appear contrasting because of the great variability of Italian soils, while the responses obtained using MSW-compost on the whole can be considered interesting (Giusquiani *et al.*, 1995; Leita and Sequi, 1999; Ferri *et al.*, 2000), even if it is necessary to study in time the effect of composts application on the heavy metals accumulation and on the N balance (Baffi *et al.*, 1999).

The aim of our research is to evaluate the possibility to apply the minimum tillage and the MSW-compost, as fertilisers or soil conditioning, to typical Mediterranean crops (durum wheat, sunflower, sugar beet, tomato).

In this paper the results from the first two crops are reported.

### **Materials and Methods**

#### *The site*

The experiment, started in 2001 and still in progress, is being carried out at Foggia (41° 27' latitude, 3° 04' longitude, 90 m above sea level), in a typical flat area of Southern Italy, the Apulian Tavoliere, on the Experimental Farm of the Institute. The soil is a silty-clay Vertisol of alluvial origin, classified as Typic chromoxerert, fine, mesic (Soil Taxonomy-USDA, 1975), with satisfactory contents of total N (0.139%) and available phosphorus (77 ppm) and a good supply of exchangeable potassium (1685 ppm) and organic matter (2.32%). The climate, classified as "accentuated thermomediterranean" (FAO – Unesco classification), is characterised by scanty rains, mainly concentrated in the winter months, summer temperatures often higher than 40 °C and winter ones lower than 0 °C, by late frost (in April) and strong windiness (NW in winter, SW in summer).

#### *Experimental*

On plots of 40 m<sup>2</sup> each, laid out in a split-plot design with three blocks, the following treatments were applied:  
- two soil tillage depths: traditional tillage, 40-45 cm deep (TT) and minimum tillage (MT);

- three N fertilisation strategies: the optimal N rate for sunflower and wheat in the trial area (100 kg N/ha) is distributed as mineral fertilisation (100min), with NH<sub>4</sub>NO<sub>3</sub>, half before the sowing time, half as a top dressing; organic fertilisation (100com), with MSW-compost, all before sowing; mixed fertilisation (100mix), with 50% of compost supplied before sowing and 50% of mineral N, as a top dressing. Treatments 100com and 100mix have been given so as to provide sunflower and wheat 100 N units/ha. In accordance with normal local practice, all the trial fields besides received 100 kg P<sub>2</sub>O<sub>5</sub>/ha at the time of main soil ploughing. Experimental treatments have been applied in the two-year rotation sunflower-durum wheat. The sunflower (cv. Oliogen) was sown in March 2001 with a 50 cm row spacing and a theoretical seed density of 6.6 plants m<sup>-2</sup>. The sowing of wheat (cv. Simeto) was carried out in November 2001 with a 15 cm row spacing and 200 kg seed ha<sup>-1</sup>. Only sunflower plots were irrigated in coincidence of the most important vegetative phases, with a total water amount of 1850 m<sup>3</sup>/ha.

At harvesting, the main parameters of both crops (plants height, ears length, fertile, sterile and total diameters of heads, 1000 seeds weight, harvest index, grain and achenes yields) were measured. On samples of plants collected from each plot and oven dried at 70 °C for 48 hours, protein content, oil level and mineral composition of sunflower and wheat were determined. The data obtained during the first two trial years (2001 and 2002) were submitted to a separate analysis of variance for each of the two crops (SAS/STAT, 1998); the differences among the means were evaluated by the Student-Newman-Keuls test.

### Results and Discussion

For clearness of exposition, only the effects of the main experimental factors are presented in this paper, not including the interactions between them. Table 1, in which the most important quantitative and qualitative parameters of sunflower are reported, shows that soil tillage depths did not determine any significant difference from the point of view of both production and quality of the oleaginous crop. These findings are very interesting because, contrary to what has been found in similar trials carried out in the same trial area (Maiorana *et al.*, 2001) or in other Italian environments (Giambalvo *et al.*, 1999), minimum tillage (MT) gave achenes yield, 1000 seeds weight and oil content more or less the same as those following the deep soil ploughing (TT) and an higher protein content, thus showing its capability to provide good results.

**Table 1. Effects of the treatments on yields and quality of sunflower**

Soil tillage	Achenes yield (t/ha)	1000 seeds weight (g)	Protein content (%)	Oil content (%)
TT	32.33a	53.17a	18.61a	52.79a
MT	32.41a	51.60a	19.98a	52.03a
<b>Crop fertilising</b>				
100min	33.82a	52.23a	19.65a	51.86a
100com	31.99a	52.75a	19.66a	53.00a
100mix	31.30a	52.17a	18.58a	52.37a

Values with different letters in each column are significantly different at P ≤ 0.05 (SNK test)

Regarding the different ways of sunflower fertilisation, the effect of experimental treatments has been very small: in all sunflower characteristics there was a tendency to show similar values (Table 1). The presence of equivalent responses and, consequently, the absence of differences statistically significant to analysis of variance seem to point out the effectiveness of both organic (100com) and mixed (100mix) treatments. Nevertheless, this result could be attributed to the fairly good soil fertility of trial environment and to the shortness of sunflower vegetative cycle; in fact, chiefly the latter did not allow a clear effect of both treatments that can to reveal themselves only over the time. The results of the following wheat crop have confirmed this surmise. The responses of durum wheat, shown in table 2, point out that MT treatment has determined the same lack of significant differences already observed in sunflower, confirming to be a good alternative to traditional soil tillage; in fact, for this crop there was a tendency to present almost the same values whether for straw production and grain yield, or for qualitative parameters.

**Table 2. Effects of the treatments on yields and quality of durum wheat**

Soil tillage	Straw production (t/ha)	Grain yield (t/ha)	1000 seeds weight (g)	Protein content (%)
TT	63.09	50.02	53.11	13.51
MT	64.40	50.71	53.59	13.01
<b>Crop fertilising</b>				
100min	66.33	54.44a	50.88c	11.92b
100com	60.49	43.77b	55.41a	14.75a
100mix	64.41	52.87a	53.77b	13.11b

Values with different letters in each column are significantly different at  $P \leq 0.05$  (SNK test)

Contrary to what has been observed in sunflower, in wheat the three treatments of fertilisation resulted in very high grain yield, 1000 seed weight and protein content. The first parameter significantly increased passing from 100com (43.77 t/ha) to 100mix (52.87 t/ha) and 100min (54.44 t/ha), but there were no significant differences between the last two treatments. On the other hand, the less productive 100com reached the significantly highest 1000 seed weight (55.41 g) and protein content (14.75%), probably because of lower grain yield. On the whole, the results until now commented indicate that conservative practices of soil tillage and plants fertilisation can be fruitfully applied to typical crops of Southern Italy without compromising the productive and the qualitative performances.

### Conclusions

The responses obtained from this research in the first two trial years have pointed out the following:

- i) minimum tillage has been able to ensure in sunflower and durum wheat yields and quality of products almost the same of those obtained with the deepest soil tillage at 40-45 cm;
- ii) MSW-compost, at a parity of N units per hectare applied to both crops, has allowed to obtain very interesting results, especially in sunflower;
- iii) among the fertilising treatments, it is of particular note that the mixed fertilisation has always reached, either in sunflower or in durum wheat, responses statistically equal to those of mineral fertilisation and that it can be used in those conditions in which is unadvisable an exclusively mineral or organic fertilisation.

Referring to MSW-compost, in addition to the yielding aspects, its application enhances soil organic matter content and allows to reduce the risks of environmental pollution due to the accumulation in the soil of the mineral N not adsorbed by plants; in fact, this compost works out its chemical effects (release of nutritive elements) and physical ones (improvement of soil structure) very slowly, in more cropping cycles. Besides, from the economic point of view, further benefits are represented by the possibility to spread the compost in an only application, before sowing time, so reducing the number of agronomical practices, and to bring down the fertilising costs per unit of active principle. It is planned to continue the trial to assess long-term effects of experimental treatments, above of these concerning the crops fertilisation with organic and mixed fertilisers, because it is too early to expect reliable information and also to well determine whether and how much sunflower and wheat differ in their responses.

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