INFLUENCE OF SOIL TILLAGE AND SOWING TECHNOLOGY ON SUNFLOWER PRODUCTION

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Summary

Field experiments were conducted during the period 1990-1999 at the Research Institute for Cereals and Industrial Crops from Fundulea (Romania), on a leached chernozem soil with 2.8% organic matter and 33.8% clay content in arable layer.

The paper presents aspects regarding the influence of different soil tillage methods (mouldboard plow, chisel, paraplow, disking), sowing time and plant density, on sunflower yield under non-irrigated conditions.

Conventional tillage had a major action on weed control and ensured the best soil conditions for plant growing. At the same time, we can notice a better air porosity index and low values of bulk density in all layers of soil. No-till method was not beneficial for sunflower cropping.

The results have shown constant yield levels from year to year in mouldboard plow as compared to no-till in which case the yield decreased up to 16.8% after ten years of experimentation. Sowing time and plant density influenced the yield level. Generally climatic conditions (rainfall, air temperature) were the main factors which determined the levels of both yield and quality for sunflower seeds. Sowing in April, in the period 1-10, using 45,000-55,000 seeds/ha led to the highest yield.

Reduced tillage, generally, worsened soil drainage capacity, increased soil compaction, weed infestation and didn't, however, guarantee good conditions for crop growth.

Key words: *sunflower, soil physical properties, seed quality, soil tillage, sowing time, weed infestation, grain yield*

INTRODUCTION

Reduced tillage presents both advantages and disadvantages. Among the most important advantages, there are: controlling soil erosion (SCHERTZ, 1988), decreasing fuel and labour and increasing water infiltration in soil (HILL and BLEVINS, 1973; BLEVINS *et al*., 1983). Among disadvantages, the most significant are the increase of weed infestation and the reduction of grain yield (MILTON *et al*., 1986; SIN *et al*., 1995).

Our objectives were to show the effects of different soil tillage methods on some soil physical properties, on weed infestation, and on sunflower grain yield and grain quality.

MATERIAL AND METHODS

The studies were conducted between 1990-1999 at the Research Institute for Cereals and Industrial Crops, Fundulea. The soil is a medium leached chernozem, well drained, formed on loess, with 33.8% clay content and 2.8% organic matter in arable layer.

The experiments were stationary, arranged in 4 replicates.

Soil tillage methods used were: mouldboard plow (conventional tillage) at 28-30 cm depth, chisel, paraplow, disked and no-tillage.

Studies about the effect of sowing time and sowing density were conducted using the following treatments: sowing at April, 10-15; May, 1-5, and May, 20-25 and 3 levels of sowing density (25,000 seeds/ha, 45,000 seeds/ha and 65,000 seeds/ha).

Observations and measurements concerning changes in soil physical properties, yield components and main indices of yield were also made.

The results were calculated by ANOVA statistical methods for field trials.

Correlation analyses were used to demonstrate the importance of sowing time and sowing density in sunflower management.

RESULTS AND DISCUSSION

Tillage of agricultural soils is defined as the manipulation, generally mechanical, of soil properties in order to modify soil conditions for crop production.

Specific reasons for tilling a soil include: weed control, incorporation of different materials (like amendments, fertilisers, pesticides or crop residues) and modification of soil physical properties, thereby improving soil conditions for crop establishment, growth and yield.

Soil bulk density has a major impact on soil-water relationships and root development and, consequently, on crop growth and yield.

The data from Table 1 show the highest bulk density (1.50 g/cm^3) in no-tillage plots whatever the layers.

It can be seen a moderate compaction indicated of the shaded zone from Table 1 near traffic zones in plowing, chisel, paraplow and disking treatments.

No-till treatment shows a secondary effect on soil compaction in 10-20 cm layer, determined by annual traffic.

Table 1. Effect of soil tillage methods on main soil physical indices (before sowing).Fundulea, 1990-1999.

Soil physical properties (Indices)	Soil tillage methods	Soil layer (cm)				
		0-10	10-20	20-30	30-40	0-40
Bulk density (g/cm^3)	Plowing (Control)	1.26	1.35	1.46	1.44	1.40
	Chisel	1.25 a†	1.39 a	1.47 a	1.46 a	1.39 a
	Paraplow	1.31 a	1.42 a	1.49 a	1.46 a	1.42 a
	Disking	1.35 a	1.45 b	1.44 a	1.43 a	1.41 a
	No-tillage	1.51 b	1.53 c	1.49 a	1.48 a	1.50 b
	LSD (P=0.05)	*0.10*	*0.09*	*0.08*	*0.09*	*0.09*
Total Soil porosity (%)	Plowing (Control)	52.9	46.9	45.7	46.5	48.1
	Chisel	53.5 a	48.2 a	44.7 a	45.5 a	47.9 a
	Paraplow	51.2 a	45.8 a	44.6 a	45.7 a	46.8 a
	Disking	49.6 a	47.0 a	46.4 a	46.5 a	47.4 a
	No-tillage	43.5 c	42.7 b	44.3 a	45.1 a	43.9 b
	LSD (P=0.05)	*4.5*	*3.2*	*3.4*	*2.9*	*4.1*
Air soil porosity (%)	Plowing (Control)	21.3	11.6	9.2	8.1	12.3
	Chisel	22.2 a	12.8 a	11.5 a	10.3 a	14.2 a
	Paraplow	18.4 a	11.7 a	6.4 a	8.5 a	11.2 a
	Disking	15.6 a	7.5 a	6.5 a	6.7 a	9.1 a
	No-tillage	9.5 c	9.3 a	7.4 a	5.6 a	7.9 b
	LSD (P=0.05)	*6.8*	*5.4*	*4.2*	*2.7*	*4.3*

†The values in each column followed by the same letter are not significantly different at the P=0.05 confidence level according to Duncan's new multiple range test.

Total soil porosity (%) and air porosity (%) are indirectly correlated with bulk density. We can notice a significant decreasing of porosity under no-tillage which was maintained in all depth layers (Table 1).

Regarding the available water at sowing time, it is obvious that conventional tillage and no-tillage resulted a higher soil water conservation, as compared with disked method (Table 2). The explanation of this similar effect is determined by the maintaining of crop residues on the soil surface in no-tillage treatment, which decreased soil water evaporation and increased water infiltration on 0-150 cm layer of soil.

Table 2. Effect of soil tillage methods on available water (m^3/ha) at sowing time. Fundulea, 1990-1999.

Soil tillage methods	Soil layer (cm)			Average (cm)
	0-50	50-100	100-150	0-150
	m^3/ha			
Plowing (Control)	805	734	682	2221
Chisel	755 a†	733 a	678 a	2166 a
Paraplow	782 a	736 a	713 a	2231 a
Disking	743 a	696 a	657 a	2096 b
No-tillage	706 b	723 a	738 a	2167 a
LSD (P=0.05)	93	84	78	85

† The values in each column followed by the same letter are not significantly different at the P=0.05 confidence level according to Duncan's new multiple range test.

In no-till and disked plots, weed infestation increased significantly up to 80.2% at beginning of the growing period and up to 379.4% at harvesting, as compared to conventional tillage (Figure 1). An intermediary weed infestation was found in the case of chisel and paraplow treatments. The mouldboard plowing decreased the weed infestation down to 57.4% as compared with no-tillage treatment. Direct drilling resulted in the highest weed infestation before first weeding (14.3 g/m^2) and at harvesting (135.9 g/m^2 of weed dry matter).

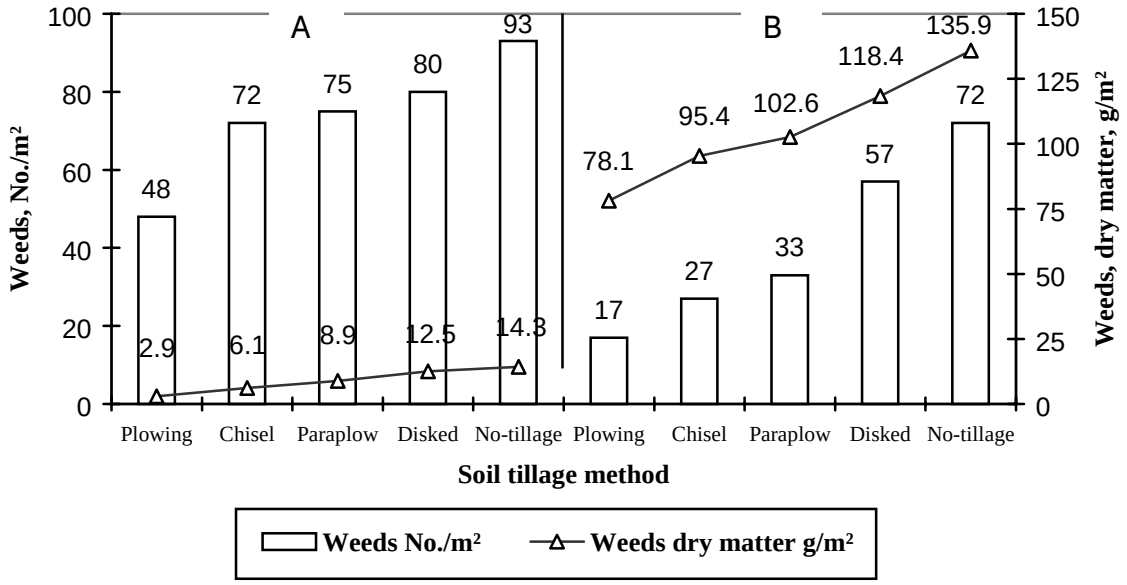

Fig.1. Effect of soil tillage method on weed infestation in sunflower crop.
Before first weeding (A)and at harvesting time (B).

The tillage methods by their influence on the soil physical properties, on available water content at sowing time and on weed infestation influenced the seed yield. Sunflower seed yields were not significantly different for mouldboard plow, chisel, paraplow and disked treatments, except no-tillage where the seed yield was lower by 3.8 dt/ha as compared with mouldboard plow treatment (Table 3).

Table 3. Effect of soil tillage methods on sunflower yield and on seed quality indicators. Fundulea, 1990-1999.

Soil tillage methods	Seed yield	Oil content	Oil Yield	Seed quality indicators	
	dt/ha	%	kg/ha	weight of 1000 seeds, g	weight of hl, kg/100 l
Plowing (Control)	22.6	49.45	1115.3	48.7	40.7
Chisel	21.1 a†	50.70	1068.0 a	48.2 a	39.5 a
Paraplow	22.9 a	50.70	1165.8 b	48.5 a	38.8 b
Disked	21.6 a	50.48	1092.0 a	47.6 a	39.3 a
No-tillage	18.8 b	50.18	941.5 d	47.4 a	39.2 a
LSD (P=0.05)	3.5		44.6	1.7	1.6

† The values in each column followed by the same letter are not significantly different at the P=0.05 confidence level according to Duncan's new multiple range test.

Three variants of sowing time were tested: sowing in April 10-15, in May 1-5, and in May 20-25 period.

The highest values of seed yield were recorded for the first sowing time (April, 10-15) in all years (1990-1999).

Delaying sowing time resulted in a significant yield decrease of 1.2 dt/ha for sowing in May 1-5 and of 2.4 dt/ha for sowing in May 20-25. Relationships between seed yield in the case of sowing under optimal conditions and delay of sowing show a direct correlation having coefficients of correlation of r = 0.882*** respectively r = 0.816** (very significantly and distinct significantly), (Fig. 2).

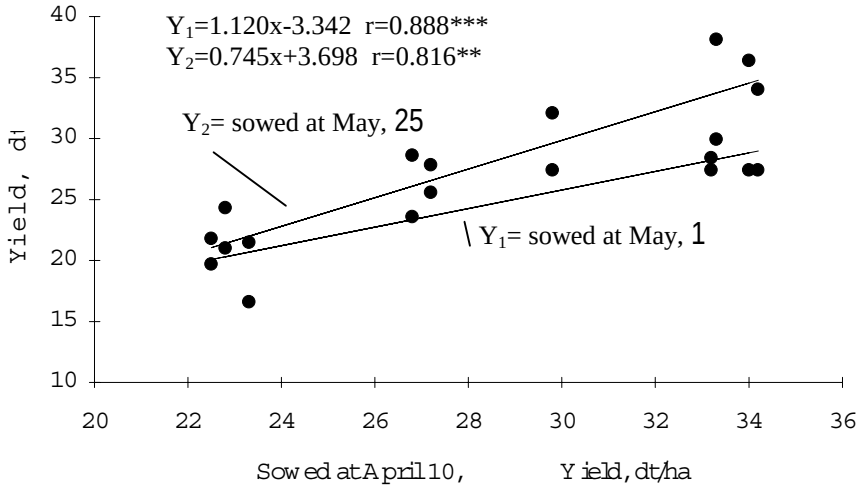

Fig. 2. Relationships between best time of sowing (sowed at April, 10) and delay of sowing on sunflower yield. Fundulea, 1990-1999

Sunflower production was also influenced by sowing density (ZAFFARONI and SCHNEITER, 1991). Our experiment confirmed an optimum density for sowing at 45,000 seeds/ha. Using a lower density, till 25,000 seeds/ha, could result in a yield decrease by 4.5 dt/ha. A little increasing of yield production was possible if it was applied a high density of sowing, of over 45,000 seeds/ha, untill 55,000 seeds/ha variant.

Studies regarding relationships between different levels of plant density showed a good arrangement for plant if it was used at sowing densities between 45,000 and 55,000 seeds/ha.

Data from Figure 3 confirm the existence of direct relations between yield and density at sowing, as confirmed by the two coefficients of correlation (r = 0.953*** and r = 0.990***) with their respective statistical significance.

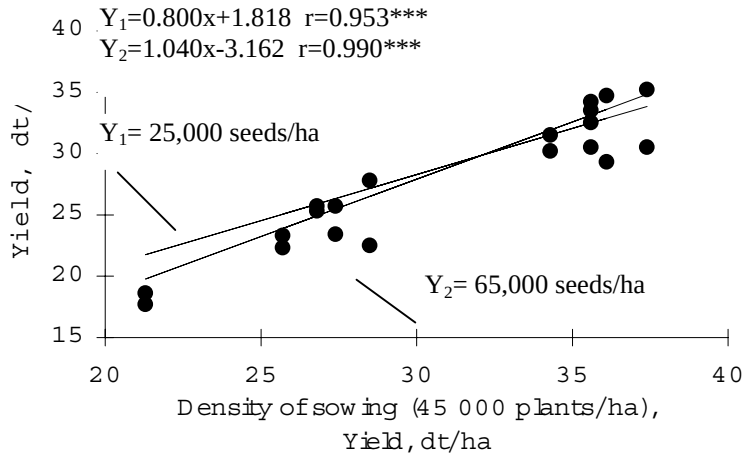

Fig. 3. Relationships between optimum sowing density (45,000 plants/ha) and different variants sowing density on sunflower yield. Fundulea, 1990-1999.

CONCLUSIONS

Reduced tillage generally worsened soil drainage capacity, reduced the available soil water, increased soil compaction and weed infestation, and, consequently, didn't guarantee proper conditions for crop growth.

More information on soil tillage systems will be necessary in sunflower cropping for improving the seed quality and the level of yield.

Time of sowing and plant density had a great influence on sunflower yield. Delayed sowing and low plant density cannot assure satisfactory yields.

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