RESEARCH REGARDING REDUCTION OF SOIL TILLAGE FOR WHEAT AND MAIZE CROPS

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ABSTRACT

Research was developed in the period 1970-1995, within long-term stationary experiments, on cambic chernozem at the Research Institute for Cereals and Industrial Crops of Fundulea. Continuous classical tillage was compared with periodical alternation with surface disk harrow tillage, as well as with other works of soil breaking up with tools without furrow turning (chisel, paraplow). In wheat, yield was not significantly affected by soil tillage method, thus ensuring high fuel savings by temporary ploughing elimination. Surface tillage by disking produced a significant yield decrease in maize, due to increased soil compaction and weed infestation of the crop. Rationalization of ground tillage for wheat and maize crops could be achieved within an adequate crop rotation, in which the land may be prepared for wheat by disking or chiseling and for maize by deeper ploughing.

Key words: bulk density, fuel consumption, ground tillage, total porosity

INTRODUCTION

Research regarding the reduction of ground tillage was determined by the need of reducing fuel consumption and of conserving soil fertility by diminishing the degree of soil compaction.

On normal soil types, with good physical features, yields did not significantly increase by deeper soil tillage in dryland crops (Hulpoi et al., 1969; 1973, Pintilie et al., 1979). The advantages of shallow soil tillage for wheat result from the short period between harvesting the preceding crop and sowing, reduced moisture content in the soil in autumn - which determines a poor plough quality as compared to disked land - and savings of tillage and fuel (Picu et al., 1979).

The present trends in soil tillage are directed to soil conservation. Thus Woorhees (1979) noticed three tendencies that affect the future of soil fertility: increased tractor weight, extension of soil conservation works and more reduced utilization in crop rotation of perennial soil improving crops, factors which greatly influence soil compaction, organic matter content as well as aggregate breaking up and stability.

Experiments carried out under different soil and climate conditions revealed the influence of soil tillage methods on crop yields, physical soil features, weed infestation and economic efficiency (Christianseen et al., 1983; Sin et al., 1986).

Research related to reduction of soil tillage has appeared as a need of agronomical, economical and organizational nature, having the aim to protect soil against water and wind erosion, avoid soil compaction as a result of repeated tractor passages over the land, reduce fuel consumption and carry out technological works within an optimum period of time (Dick et al., 1971).

The present paper presents new data regarding the possibilities of reducing ground tillage and its consequences on wheat and maize yields. Furthermore, some modifications of soil physical traits are revealed as well as crop infestation with weeds.

MATERIALS AND METHODS

Research was developed in wheat and maize under dryland conditions, in the period 1970-1995, on a cambic chernozem of Fundulea, with a content of 2,9% humus and 33% clay in the arable layer. Annual average rainfall quantity was of 566 mm with variations between 310 and 861 mm. Experimental variants included the reduction of ploughing depth from 30 cm (A30) to 20 cm (A20) and replacement of ploughing with works that mobilize the soil less; disk harrowing (D) at 10-12 cm depth, chiseling (C) at 18-20 cm depth and para- plow (PP) at 18-20 cm depth. Determinations have been carried out regarding the bulk soil density, by soil

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sampling in 100 cm^3 cylinders and weed infestation of wheat and maize crops in various phenophases.

Except for ground tillage, in all variants the same cropping technology was applied.

RESULTS AND DISCUSSIONS

Results presented in table 1 show a poor differentiation of wheat yields as regards soil tillage system applied, without affecting yield level.

Table 1. Influence of soil tillage on fuel consumption and wheat and maize yield
Fundulea, 1970-1995

Ground tillage	Wheat		Maize	
	Yield (kg/ha)	Fuel consumption l/ha	Yield (kg/ha)	Fuel consumption l/ha
Annual ploughing 30 cm	4210	36	7100	38
Annual ploughing 20 cm	4330	22	6910	25
D/P 20-30 cm	4360	21	6650	23
DD/P20-30 cm	4260	19	6340	20
DDD/P 20-30 cm	4260	14	6130	18
Annual disking	4140		6010	14
LSD 5%	250		350	

D/P- one year disking, one year ploughing
DD/P- two years disking, one year ploughing
DDD/P- three years disking, one year ploughing
*- Diesel oil consumption for soil tillage

In maize, replacement of ploughing by shallow disk harrow tillage at 10-12 cm, depth for one year, ensures the achievement of a good maize yield without its significant diminution. The replacement of ploughing by disk harrowing for 2-3 years determined a significant decrease of maize yields by 570-970 kg/ha. Substantial yield losses (1090 kg/ha) have been recorded under the variant of tillage for 26 years with the disk harrow. As regards the fuel consumption for ground tillage, data presented in table 1 show that it decreases according as ploughing is replaced by disk harrowing.

Data presented in table 2 regarding the effect of alternating in time the two soil tillage methods (ploughing and disking) point out that wheat uses the ploughing residual effect very efficiently, while maize reacts favourably only to the direct effect of ploughing. By replacing ploughing with disking for a larger number of years, yields decrease non-significantly in wheat and significantly in maize (350-450 kg/ha). In the case of repeated shallow tillage system by disking, increasing yields are obtained according as ploughing interrupts this sequence succession.

Table 2. Effect of ploughing and disking alternation on wheat and maize yield
Fundulea, 1970- 1995

Ground tillage	Wheat		Maize	
	Yield (kg/ha)	Difference +/-	Yield (kg/ha)	Difference +/-
Annual ploughing	4260	-	7110	-
Ploughing once in two years	4370	+ 110	6890	- 22-
Ploughing once in three years	4160	- 100	6760	- 350
Ploughing once in four years	4140	- 120	6690	- 420
LSD 5%		190		320
Annual disking	4070	-	6010	
Disking on ploughed ground once in two years	4460	+ 390	6840	+ 830
Disking on ploughed ground once in three years	4430	+ 360	6340	+ 330
Disking on ploughed ground once in four years	4180	+ 110	6170	+ 160
LSD 5%		220		310

The achievement of constant wheat and maize yields, with small annual variations and reduced costs, is possible also by the utilization of new technological soil tillage variants (Table 3). In wheat the best results in terms of yield and economic efficiency are obtained by soil tillage with tools without furrow turning: chisel and paraplow. Ploughing to a depth of 28-30 cm for wheat leads to a yield decrease and a cost increase by 61%, as compared to the annual ploughing variant of 18-20 cm. Ground tillage with the disk harrow for wheat crop renders better results when the land cultural state permits such works under optimum conditions. Fuel consumption for ground tillage for wheat crop is very differentiated, from 14 to 40 l/ha, respectively from 2,7 l/t to 7,8 l/t of wheat.

In maize crop, yield decreases in the case of paraplow tillage and especially with

repeated disking, while variation of fuel consumption ranged between 14 and 50 l/ha,

Table 3. Influence of tillage methods on yield, fuel consumption and economic efficiency in wheat and maize Fundulea, 1987-1995

Ground tillage and its depth	Yield kg/ha		Fuel consumption				Tillage costs 1000 lei/ha		Yield value 1000 lei tillage costs/ha	
	Wheat	Maize	Wheat		Maize		Wheat	Maize	Wheat	Maize
			l/ha	l/t	l/ha	l/t				
Annual ploughing 20 cm	5150	7100	26	5.0	27	3.8	31	39	36.5	32.7
Annual ploughing 30 cm	5070	7300	40	7.8	50	6.8	50	60	22.2	26.7
Chisel 18-20 cm	5210	7150	18	3.5	20	2.8	36	36	31.8	35.7
Paraplow 18-20 cm	5160	6000	28	5.4	24	4.0	49	42	23.2	29.1
Annual disking 10-12 cm	5090	5660	14	2.7	14	2.5	17	17	65.8	59.9
LSD 5%	210	330								

Note: Tariffs and prices in use in 1995 were applied.

respectively from 2.5 to 6.8 l/t of maize. Chisel tillage ensures high yields with reduced fuel consumption. Although important savings are achieved within the variant of annual disking, the great yield losses do not justify the repeated application of this land preparation method for maize crop, as it leads to strong weed infestation of the crop as well as to increased soil compaction. Soil tillage by disking and renouncement to ploughing is recommended only in spring in order to avoid the exaggerated soil mobilization which leads to soil water losses, increased costs and often delayed sowing.

Research regarding soil compaction, pointed out the bulk density increase under wheat crop in the case of replacing ploughing by disking (Figure 1).

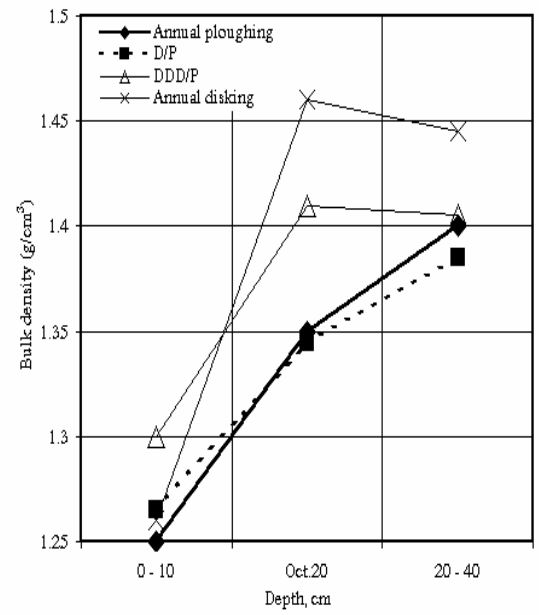

Figure 1. Variation of apparent soil density depending on ground tillage for wheat crop (determination made at harvesting). Fundulea, 1989 – 1995

Compaction becomes more obvious in the layer of 10-20 cm. The increase of apparent density value is directly correlated with the modification of total porosity values. In the case of the annual ploughing variant and in those variants which ploughing alternates with one-two years disking, the values of the respective physical indices range within normal limits.

In maize crop, an increase of the apparent density in the soil was recorded within the variant of soil tillage by disking as compared to the annual ploughing variant, respectively the alternation of one year ploughing-one year disking (Figure 2).

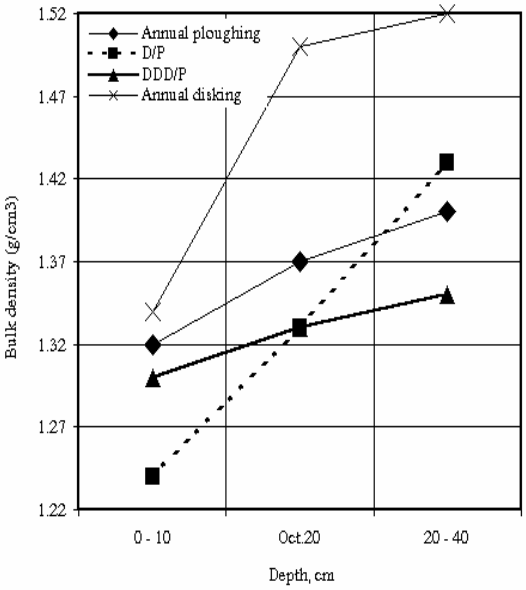

Figure 2. Variation of apparent soil density depending on ground tillage for maize crop (determination made at harvesting). Fundulea, 1989 – 1995

The most evident modification of the bulk density values takes place in the case of tillage only by disking which determines soil compaction and the corresponding differentiation of total and aeration porosity.

Research regarding weed infestation of the crop emphasizes the contribution of ploughing to its decrease (Figures 3 and 4).

As ploughing was gradually replaced by disk harrowing, an increased weed infestation of wheat and maize crops, and a proliferation of perennial species was observed. By an annual alternation of ploughing with shallow tillage, weed infestation may be reduced below the economic damage level.

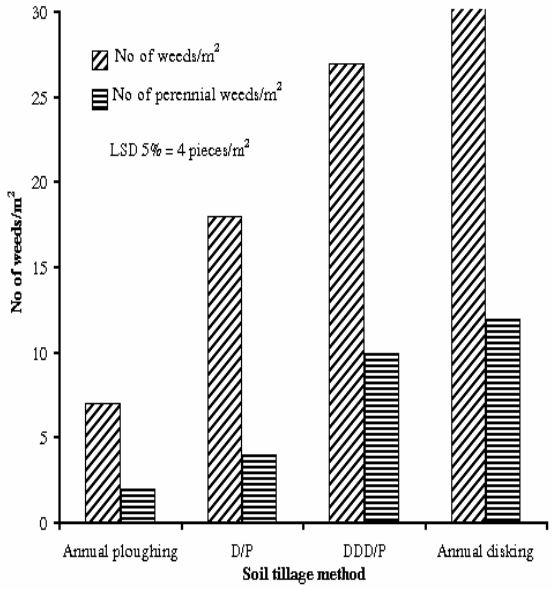

Figure 3. Influence of ground tillage on weed infestation of wheat crop (determinations made at harvesting). Fundulea, 1989 – 1995

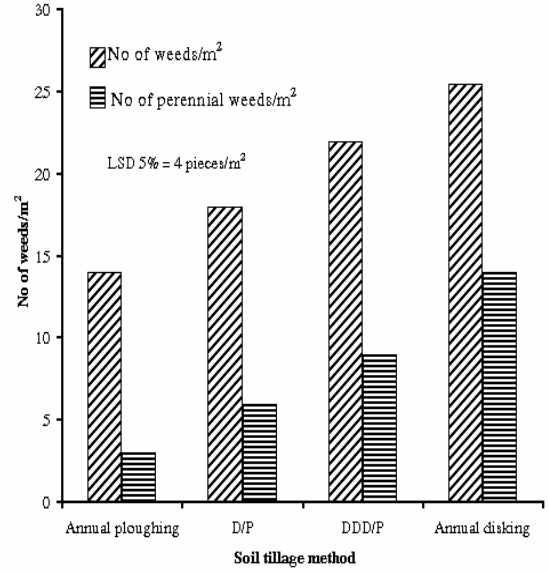

Figure 4. Influence of ground tillage on weed infestation of maize crop (determinations made at harvesting). Fundulea, 1989 – 1995

CONCLUSIONS

Wheat crop reacted poorly to the differentiation of ground tillage, while ploughing could be replaced by shallow tillage or by works without furrow turning. In this case similar yields are obtained but with lower costs as fuel consumption is reduced.

Repeated replacement of ploughing by shallow tillage determined a strong soil compaction in the layer of 10-20 cm and an increase of weed infestation.

Reduced ground tillage, without significantly affecting yield level, is possible by reducing ploughing depth, by replacing ploughing with disk harrowing or tools that do not turn furrow (chisel, paraplow). Reduction of ground tillage is possible only within a crop rotation in which, by a certain crop sequence, alternation of soil tillage methods is ensured.

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