Influence of tillage systems on yield and quality of durum wheat in Southern Italy

Pisante M., Basso F.

in

Royo C. (ed.), Nachit M. (ed.), Di Fonzo N. (ed.), Araus J.L. (ed.).
Durum wheat improvement in the Mediterranean region: New challenges

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 40

2000
pages 549-554

Influence of tillage systems on yield and quality of durum wheat in Southern Italy

M. Pisante and F. Basso
Dipartimento di Produzione Vegetale, Università degli Studi della Basilicata,
Via Nazario Sauro 85, 85100 Potenza, Italy

SUMMARY – This paper presents an overview of research carried out in Southern Italy by various Italian researchers on the influence of different tillage systems on yield and quality of durum wheat. The effect of soil tillage treatments on grain yield and quality was described by means of selected data obtained through pluriennal research in the period 1976-1999. The comparisons were carried out in several localities in Southern Italy (Bari, Cerignola, Foggia, Guardia Perticara, Pietranera, Policoro and San Severo) on clay, clay-sandy and sand-silty soils. The compared soil tillage techniques were: conventional tillage (CT), reduced tillage (RT), minimum tillage (MT) and no-tillage (NT). The findings showed that the effects of the several tillage systems on durum wheat yield and quality change mainly in relation to the soil characteristics, but not in relation to the soil texture, and in particular circumstances to the soil moisture at tillage time and to the climatic course. It seems that the effects of the tillage do not change in relation to the general climatic conditions in Southern Italy. Although, some yield components, like test weight and yellow berry percentage were influenced by tillage systems.

Key words: Tillage system, durum wheat, grain yield and quality, Southern Italy.

RESUME – *"Influence des systèmes de labour sur le rendement et la qualité du blé dur dans le Sud de l'Italie". Cet article passe en revue les recherches menées dans le Sud de l'Italie par plusieurs chercheurs italiens sur l'influence de différents systèmes de labour sur le rendement et la qualité du blé dur. L'effet des traitements de labour du sol sur le rendement et la qualité du grain a été décrit au moyen de données sélectionnées obtenues à travers des recherches pluriannuelles sur la période 1976-1999. La comparaison a été effectuée dans plusieurs localités du Sud de l'Italie (Bari, Cerignola, Foggia, Guardia Perticara, Pietranera, Policoro et San Severo) sur des sols argileux, argileux-sablonneux et sablonneux-limoneux. Les techniques de labour du sol comparées ont été : labour conventionnel (CT), labour réduit (RT), labour minimum (MT) et non labour (NT). Les résultats montrent que les effets de plusieurs systèmes de labour sur le rendement et la qualité du blé dur changent principalement en relation avec les caractéristiques du sol, mais non en relation avec la texture du sol, et dans des circonstances particulières avec l'humidité du sol au moment du labour et les conditions météorologiques. Il semble que les effets du labour ne changent pas en relation avec les conditions climatiques générales dans le sud de l'Italie. Cependant, certaines composantes du rendement, telles que le test du poids et le pourcentage de grains jaunes, ont été influencées par les systèmes de labour.*

Mots-clés : *Système de labour, blé dur, rendement et qualité du grain, Sud de l'Italie.*

Introduction

In most crop production systems, soil tillage is an economically important element. It is one of the largest items of expenditure. It influences the physical, chemical and biological soil properties and processes and the development of the long-term productivity of soils. However, tillage is not a growth factor for plants and its effects are mainly indirect and extremely variable. The development of policies and technologies that expand production of cereals as durum wheat on highly erodible land is a prime example of our economic system rewarding farmers for using unsustainable farm management. Recent European Union negotiations about agricultural policy may force Italian farmers to consider reducing tillage intensity and other purchased inputs in order to remain economically competitive. Conservation tillage has been called the greatest soil conservation practice of the 20th century (Blevins *et al.,* 1998). Conservation tillage reduces the intensity of tillage operations and allows farmers to manage crop residues on or near the soil surface (Carter, 1993). Experiences in the application and research of conservation tillage will likely become the favoured approach in the US (Langdale *et al.,* 1992) and recently in many regions in Germany (Tebrügge and Böhrnsen, 1997) because of economical and ecological influences.

Materials and methods

Five experimental fields located in different sites (two in Apulia region: Foggia and San Severo; two in Basilicata region: Guardia Perticara and Policoro and one in Sicily island: Pietranera) and characterised by different soil properties were selected in Southern Italy in relation to available data results (Caliandro *et al.,* 1992; Basso and Postiglione, 1994; Basso *et al.,* 1996, 1998) for more years with a minimum of two years of experimental period (Table 1).

Table 1. Characteristics of the field sites under investigation

Field sites	Lat. N	Long. E	Alt. (m a.s.l.)	Precip. (mm per year)	Soil	Trial	Tillage systems			
							CT	RT	MT	NT
Foggia	41º 27’	15º 04’	76	571	Clay	1983-1986	‡	‡	‡	
Guardia P.	40º 34’	16º 12’	700	642	Sand clay	1976-1980	‡		‡	
Guardia P.	40º 34’	16º 12’	700	593	Sand clay	1981-1988	‡	‡	‡	‡
Guardia P.	40º 34’	16º 12’	700	740	Sand clay	1990-1995	‡	‡	‡	
Pietranera	37º 85’	13º 76’	170	542	Clay	1979-1986	‡		‡	‡
Policoro	40º 02’	16º 08’	25	507	Clay sand	1983-1986	‡	‡	‡	
San Severo	41º 42’	14º 80’	81	450	Sand silty	1991-1993	‡	‡	‡	

In Southern Italy different soil tillage methods were used for drilling of small grain cereals (durum wheat), and in this review several names for tillage systems are used. Therefore, the methods decribed in this paper are defined as follows:

Conventional tillage (CT): mouldboard ploughing in summer or autumn a normal depth of 40-50 cm, followed by seed bed preparation with harrowing and after this sowing.

Reduced tillage (RT): mouldboard ploughing to a maximum depth of 20-25 cm, followed by seed bed preparation with harrowing and after this sowing; or chiselling at maximum 60 cm depth followed by harrowing.

Minimum tillage (MT): cultivator (disc harrow or rotovator) at 10-15 cm depth.

No-tillage (NT): direct drilling in un-tilled soil where straw has been removed or burned and weeds have been controlled by use of chemicals.

Results analysis of a pluriennal research conducted in five field sites distributed in Sicily island and Southern Italy was conducted to ascertain the effects on grain yield production and quality of durum wheat obtained with alternative tillage systems respect to conventional tillage.

Finally, selected data of grain quality of durum wheat is investigated in 1999 in Apulia region in four different sites (Bari, Cerignola, Foggia and San Severo) with two tillage systems: CT and NT (Fares and Di Fonzo, 1999).

Results

The analysis of grain yield results reported in Table 2 shows that the differences registered among the different tillage systems are not of statistical significance. In fact, in the experimental fields in the plain of Apulia region (Foggia and San Severo) the grain yields obtained in the investigated periods, even if they result different between them, show no difference among the different tillage systems. The same observations can be made for the hilly area of Basilicata region (Guardia Perticara), where productions decrease passing from the conventional tillage to no tillage in the first period (1976-1988); these observations can be confirmed in the second period (1990-1995) passing from conventional tillage to minimum tillage.

Table 2. Grain yield obtained in different field sites in Southern Italy (t/ha)

	Field sites	Trial period	Tillage systems			
			CT	RT	MT	NT
Plane	Foggia	1983-1986	2.2[a]	2.6[a]	2.7[a]	–
	San Severo	1991-1993	3.3[a]	3.4[a]	3.1[a]	–
Hilly	Guardia P.	1976-1988	2.3[a]	2.1[a]	1.7[ab]	1.3[b]
	Guardia P.	1990-1995	4.1[a]	3.9[a]	3.0[b]	–

At Policoro, Foggia and Pietranera sites, located in Southern and Sicily island, characterised by clay-sandy soil the first and vertic type of soil the others, the grain yield obtained with MT and CT showed non-significant differences; the angular coefficient of the regression is equal to 0.995 and not different from 1 (Fig. 1).

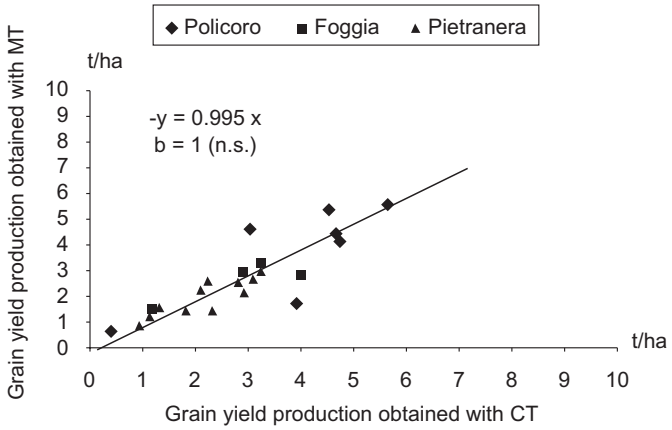

Fig. 1. Grain yield obtained by MT (harrowing) or CT (ploughing) in Policoro, Foggia and Pietranera (from Caliandro *et al.,* 1992).

The grain yields obtained with CT and NT in Pietranera field (Fig. 2) are not different between them (angular coefficient of regression 0.953 and not different from 1).

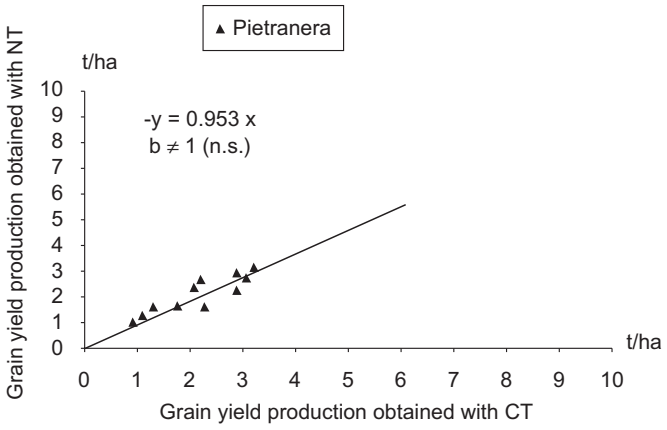

Fig. 2. Grain yield obtained by NT (direct drilling) or CT (ploughing) in Pietranera (from Caliandro *et al.,* 1992).

Also the yield results obtained in Policoro and Foggia with RT and CT showed non-significant differences between the tillage systems. The angular coefficient of regression is 0.934 and not different from 1 (Fig. 3).

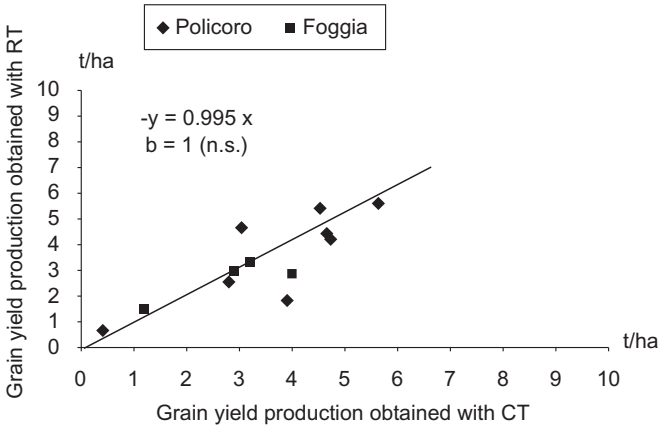

Fig. 3. Grain yield obtained by RT (chiselling) or CT (ploughing) in Policoro and Foggia (from Caliandro *et al.,* 1992).

Regarding the components of grain production, test weight (results reported in Table 3), does not show statistical difference in relation to the soil tillage systems.

Table 3. Test weight (kg/hl)

Field sites	Trial period	Tillage systems		
		CT	RT	MT
Guardia P.	1981-1984	83.0[a]	82.3[a]	82.4[a]
San Severo	1991-1993	80.4[a]	80.3[a]	80.6[a]

The grain quality components were determined in some localities in Apulia region (Table 4) and show significant differences between the CT and MT. For the test weight the highest values registered in Bari and Cerignola (77.8 kg/hl; 77.3 kg/hl) have been achieved with the MT. The lowest value has been obtained in San Severo with CT (71.8 kg/hl). Also the highest value for the weight of 1000 seeds (47.2 g) has been achieved with the MT in Cerignola, while the lowest value has been obtained in Foggia with the same tillage system. Regarding the protein content of the grain of durum wheat, the highest percentage (18.4 %) has been registered in Foggia with CT, while the lowest percentage (10.5) has been obtained in Cerignola with MT. Also the percentage of glutein content has reached 14% with CT in Foggia site; the lowest percentage (5.8) has been registered in Cerignola with MT.

Table 4. Durum wheat grain quality component obtained in some localities of Apulia region with CT and MT in 1999

Field sites	Tillage systems							
	CT				MT			
	Test weight (kg/hl)	Weight 1000 seeds (g)	Protein (% d.m.)	Glutein (% d.m.)	Test weight (kg/hl)	Weight 1000 seeds (g)	Protein (% d.m.)	Glutein (% d.m.)
Foggia	74.6[ab]	36.3[b]	18.4[a]	14.0[a]	72.6[b]	34.7[d]	16.5[a]	11.9[a]
San Severo	71.8[b]	39.8[ab]	14.4[b]	9.7[b]	72.6[b]	41.4[b]	12.5[c]	8.2[bc]
Cerignola	75.7[a]	42.6[a]	12.0[c]	6.4[c]	77.3[a]	47.2[a]	10.5[d]	5.8[c]
Bari	74.3[ab]	39.2[ab]	13.8[bc]	8.5[bc]	77.8[a]	39.8[c]	14.3[b]	9.5[b]

At last, the interaction “years x tillage systems” obtained in Guardia Perticara field during the period 1981-1984 (Basso *et al.,* 1987) has resulted significant on the grain quality component yellow berry

percentage. In the three periods considered significant differences resulted only in the period 1983-1984, where the highest yellow berry percentage (12) has been obtained with NT (Fig. 4).

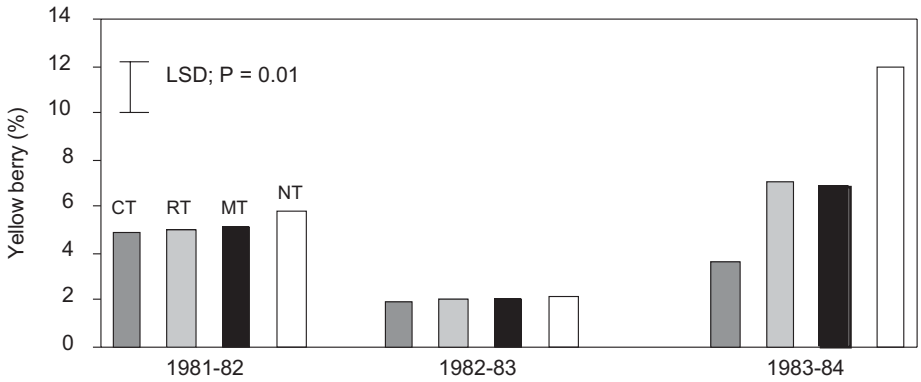

Fig. 4. Yellow berry percentage. Significant at P = 0.01; interaction “years x tillage systems”.

Conclusions

The tillage systems used will depend on available equipment, rotation sequence, crop residue management and, to some degree, soil type and the environment. All of these factors also affect germination and in consequence plant density, in particular in dry areas, as Southern Italy and Sicily island. Generally, reduced tillage and no-tillage increases surface residues for soil conservation, increases organic matter levels over time, increases water infiltration and retention (De Franchi *et al.,* 1994). Conventional tillage increases the erodibility of soil, decreases surface residues, decreases the amount of organic matter over time. Finally the durum wheat grain yield production varied in this particular environment according to both rainfall distribution in the single years and above all to the amount of available water during the spring season. On the other hand, no significative differences in grain yield were found between conventional and reduced tillage systems and between minimum and no-tillage systems, while sometimes significant differences in quality components of grain are registered in favour of conventional tillage. But considering the higher costs of this system the advantages of the better quality do not justify the application of this intervention at high energetic input level.

Longterm experiments and long term monitoring are necessary methods for achieving the best tillage systems in order to improve agronomical, economical and environmental aspects and maintain a productive and sustainable agriculture.

References

Basso, F., De Franchi, A.S., Pisante, M., Basso, B. and Landi, G. (1998). Influenza delle modalità di lavorazione del terreno sul processo erosivo e sulla produzione di sistemi colturali della collina meridionale. XXXII Conv. Annuale SIA, Ancona, 15-18 September. *Riv. di Agron*. (in press).

Basso, F., Pisante, M. and Basso, B. (1996). Influenza dei residui colturali e delle lavorazioni del terreno, sull’accrescimento e produzione del favino da seme (*Vicia faba minor* Beck) e frumento duro (*Triticum durum* Desf.). *Riv. di Agron.,* 30(3): 212-221.

Basso, F. and Postiglione, L. (1994). Aspetti agronomici della conservazione dei terreni in pendio: Sistemazioni e lavorazioni. *Riv. di Agron.,* 28(4): 273-296.

Basso, F., Postiglione, L. and Carone, F. (1987). Influenza delle modalità di lavorazione di un terreno declive sottoposto a rotazione: Favino da seme-frumento duro. Erosione e risultati produttivi. *Riv. di Agron.,* 21(4): 237-243.

Blevins, B.L., Lal, R., Doran, J.W., Langdale, G.W. and Frye, W.W. (1998). Conservation tillage for erosion control and soil quality. In: *Soil and Water Conservation,* Pierce, F.J. and Frye, W.W. (eds). Ann Arbor Press, Chelsea, MI, pp. 51-68.

Caliandro, A., Rizzo, V., Mosca, G., Stefanelli, G., Manzini, S., Bonari, E., Mazzoncini, M., Bonciarelli, F., Archetti, R., De Giorgio, D., Basso, F., Postiglione, L., Rubino, P., Lo Cascio, B. and Venezia, G. (1992). Risultati sperimentali ottenuti su cereali a paglia con diverse tecniche di lavorazione al terreno. *Riv. di Agron.*, 26(3): 215-222.

Carter, M.R. (1993). *Conservation Tillage in Temperate Agro-Ecosystems.* Lewis publishers, Boca Raton, FL.

De Franchi, A.S., Amato, M., Pisante, M. and Graziano, F.S. (1994). Osservazioni sulla variazione di alcune caratteristiche fisiche (struttura e umidità) di un terreno declive in relazione a diverse modalità e colture. *Riv. di Agron.,* 28(4): 427-432.

Fares, C. and Di Fonzo, N. (1999). *Caratteristiche produttive e qualitative del frumento duro coltivato con differenti agrotecniche in Puglia.* Report Regione Puglia Servizi di Sviluppo Agricolo, Foggia.

Langdale, G.W., West, L.T., Bruce, R.R., Miller, W.P. and Thomas, A.W. (1992). Restoration of eroded soil with conservation tillage. *Soil Technol*., 5: 81-90.

Tebrügge, F. and Böhrnsen, A. (1997). Crop yields and economic aspects of no-tillage compared to plough tillage: Results of long-term field experiments in Germany. In: *Experience with the Applicability of No-Tillage Crop Production in the West-European Countries. Proceedings of the Fourth Workshop,* Tebruegge, F. and Boehrnsen, A. (eds), Boigneville (France), 12-14 May. Wissenschaftlicher Fachverlag, Giessen, pp. 17-24.