Four machines for sod-seeding in comparison: first results of operational and technical tests in Basilicata

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Abstract
Our study was carried out to evaluate four different seeders for sod-seeding by a qualitative and quantitative comparison of their performances on cereal crops in Basilicata.
The application of sod-seeding, alias no tillage, it may represent a valid alternative to traditional seeding in areas with high cereal vocation, as a guarantee against production costs, safeguarding the productive and environmentalists aspects in the south of Italy, where there is a great crop specialization and higher environmental risk resulting from intensive farming operations.
So, were organized tests with four different seeders: Gaspardo-Directa, Amazone AD 300, Alpego ASI 303 and Laseminasodo. Relating to this study, the most important difference, between these machines we considered, was the coulter body.
We analysed the technical and operational characteristics of the seeders, the distribution regularity of the seed and the parameters concerning the harvesting.
The results were interesting for all machines, the operational capabilities have been certified on values equal to 1,8 ha/h, satisfactory values regularity of longitudinal and transverse distribution of the seed considering that the value of plants emergency was close to 90%. About yield obtained, some data collected showed a higher value compared with that obtained with the traditional seeding in the same soil conditions.
The results of our trials confirmed that with sod-seeding is possible to guarantee sustainability, energy saving, ability to establish the time of execution and therefore more timely intervention, so we can conclude that the qualitative and quantitative standards can be achieved satisfactory provided if there is a better choice of the machine depending on the physical characteristics of the soil, in particular a better choice of coulter body which is the essential element of a successful plants emergency.

Keywords: sod-seeding, seeders, sustainability.

Introduction

Lately the intensive farming caused sea changes in the ecosystems if we think to the gradual, but unstoppable, impoverishment of organic substance and to the alteration of soil structure, resulting from its ponderous exploitation. We refer to operations previous the traditional sowing, carried out by equipments reaching high depths and causing changes in the equilibrium of soil system.
Studies done by Bonari et al (1992) underlined as the adoption of cultivation methods can help along the correct equilibrium among solid, liquid and gaseous phase, illustrating traditional cultivation and sod-seeding.

Subsequently Hakansson et al. (1996) compared the methods of conventional cultivation with minimum tillage, analysing the characteristics of seedbed, fundamentally clay.

It resulted a considerable influence by reduced cultivation as superficial ploughing to 20 cm of depth and sod cutter to 13 cm, on the physical characteristics (volumic apparent mass)

as well as permeability and aeration characteristics, resilience to penetration. The latter is helpful to valuate the effect of reduced cultivations on the roots development.

Last decades it assisted to an increasing diffusion of new cultivation methods grounded on reduction intensity and number of interventions. An example can be provided by sod-seeding application, that consists in a valid alternative to methods of conventional cultivation especially in those areas, as that object of our investigation, known as a cereal vocated, because assures a reduction of production costs and safeguard of productive and environment aspects.

With this new method the preparation techniques are only harrowing, thanks to peculiar compliance of the seeders which compared to traditional seeders are gifted by lister discs, that penetrate some centimetres (4-10 cm), releasing subsequently the seed by adductor organs.

The aim of our study was to evaluate four different seeders for sod-seeding by a qualitative and quantitative comparison of them performances of cereals culture in Basilicata, relating the data obtained with those of traditional planting.
Moreover we verified the possibility to obtain production greater or comparable to that earned by traditional planting.

Materials and methods

The trials have been done by four different seeders: Laseminasodo, Gaspardo-Directa, Amazone AD 303 and Alpego ASI 300. The tests included:

- the estimated amount of technical parameters associated with the use of planters;
- evaluation of the regularity of longitudinal and transverse distribution of the seed;
- analysis of operational parameters for the harvest and quality of the final product.

The place of the investigation correspond to an hilly zone in Basilicata, on a soil with an inclination between 8 and 10%, whose granulometry and physical-chemical characteristics at time of the research are reported in the following tables.

Table 1. Granulometry components and physical-chemical characteristics

COMPONENTS	%	CHARACTERISTICS	VALUE
Coars sand	35,9	ph	8,5
Fine sand	23,9	CaCO3	12,0
Coars silt	5,4	Humidity	4,5
Fine silt	15,0	CO	1,0
Clay	19,8	O.S.	1,8

In order to obtain a direct comparison with traditional planting, which submitted the area over the last few years, and sod-seeding, subsequently we reported two tables (tab.3 and 4), containing all operations executed before and after the planting. In both cases it sowed the species *Triticum* durum, variety *simeto*.

Table 3. Cultivation operations executed by traditional tilling of soil

OPERATIONS	PERIOD	EMPLOIED MACHINE
Ploughing	August-September	Nardi trivomere 163 T QZ/A
First harrowing	26 September - 26 October	Gherardi DRS 7P
Second harrowing	27 October - 21 December	Gherardi DRS 7P
Planting	27 October - 21 December	Accord pneumatic DL 32
Manuring with Urea	Genuary	Leley 1250 6 q
Manuring with Niter	20 February-20 March	Leley 1250 6 q
Chemical weeding	April	Nobili J600 P
Harvesting	6 June-20 July	John Deere 1177AL
Straw Baling	July-August	Class roulant 68

Table 4. Cultivation operations executed by sod-seeding

OPERATIONS	PERIOD	EMPLOIED MACHINE
Harrowing	26 September- 26 October	Nardi trivomere 163 TQZ/A
Planting	27 October- 21 December	Amazone AD3 Super
Manuring with Urea	Genuary	Leley 1250 6 q
Manuring with Niter	20 February- 20 March	Leley 1250 6 q
Chemical weeding	April	Nobili J600 P
Harvesting	6 June-20 July	John Deere 1177AL
Straw Baling	July-August	Class roulant 68

In this summarizing scheme are enumerated the operations to follow before and after planting, by different cultivation techniques. It is clearly visible as in the direct planting it obtains a drastic reduction of operations previous planting. The harrow is the only processing necessary to place the seed to the correct depth and therefore allows the sprout from the seedling.

Table 5. Summarized description of cultivation operations with conventional planting and sod-seeding

CONVENTIONAL PLANTING	*SOD-SEEDING*
Ploughing *First harrowing* *Second harrowing* *Planting* *Manuring with Urea* *Manuring with Niter* *Chemical weeding* *Harvesting* *Straw Baling*	- *Harrowing* *Planting* *Manuring with Urea* *Manuring with Niter* *Chemical weeding* *Harvesting* *Straw Baling*

For each seeders have been reported the technical characteristics such as the number of lister discs, the effective working width, the weight etcetera. On the parcels of one hectare these machines have been submitted to the evaluation of some operational parameters (planting depth, operational capacity, fuel consumption of the tractor). The longitudinal distribution has been determined counting the seedlings outcropped on a line of 5 cm, obtaining this value 200 times. The data have been reunited in classes correspondent to the seeds newfound and calculated the frequency, expressed in percentage of each class on the totality of surveys. So it is possible to verify and quantify potential failed release of seed or to the contrary releases of an excessive number of them.

For the evaluation of the transverse distribution has been adopted the variation coefficient (CV), calculated analytically by the application of this equation (Sartori et al.1999):

$$CV = \sqrt{\frac{\sum \left(X_i - (X)^2\right)}{N-1}} \cdot \frac{100}{X}$$

where:
X = *arithmetic mean of the seed released by all unities (g)*
X_i = *quantity of seed released by each element adductor (g)*
N = *number of unities of planting evaluated.*

Consequently before the trials we estimated the quantity of seed released singularly by each adductor pipe, after some turns of the distributor. This trial was tested several times analysing the differences owing to the variation of the seed velocity in the hopper and the rotation velocity of roller distributor. Also the harvesting phase has been the subject of our study, estimating the operational capacity of harvester and the evaluation of unit productions.

Results

It has been reported the planting and harvesting results, in order to evaluate the size of the production obtained with the different cultivation techniques.
The first aspect analysed concerned the execution modalities of planting, as the depth, important because from it depends the good germination and the adequate development of seedlings. The values registered was practically similar for all machines with exception of the Laseminasodo which puts the seed to a lower depth, equal to 4 cm. This is due to the

characteristics of lister discs; being hay-cutters of lower weigh, the pressure applied on the soil is insufficient to guarantee high depth, which we obtained with the Gaspardo and Amazone, thanks to lister discs and in the Gaspardo to the compliance of the adductor organs.

Figure 1. Hay-cutters in the Laseminasodo

Figure 2. Lister discs in the Gaspardo

Figure 3. Lister discs in the Amazone

Figure 4. Organs adductor

The operational capacity of seeders is on average 1,8ha/h, while for the Laseminasodo it is no lower of 1,3ha/h (tab.6). The most interesting results was those relative to regularity of the transverse and longitudinal distribution of the seed, expressed analytically by the Variation Coefficient (VC) and the mean emergency (tab. 7-8).

The first parameter, in the Amazone and Alpego, reached a value equal to 1,4%, very below of the maximum limit (2%) to express an optimal judgment for cereals and forages. For the other two seeders the VC, although more high, doesn't exceeded the maximum threshold.

The mean emergency was satisfying, varying between a minimum of 80 and a maximum of 90%. The values no lower are due not much to the characteristics of seeders as the lack in precipitations in the period subsequent to the planting and to the soil tenacity, that induced the prevarication of some seedlings over the other. This situation influenced on the results of the trials until the harvesting and, as it was simple to foresee, the production no lower were those obtained by the Alpego and the Laseminasodo, as showed in the table 9. With these machines the mean emergency were low, although whatever goods.

Comparing the entity of productions emerged that the production obtained by sod-seeding are not much lower to that obtained by the conventional planting. Further the trend of productions was very similar, in fact where the productiveness with the sod-seeding was lower, the same result it reached by the conventional techniques.

All machines highlight a high level of trustworthiness. During trials, in fact it doesn't verified breaks or other problems connected to the machine, such as to cause the stopping and consequently the increase of times necessary to the operation. The Gaspardo and Amazone provided the better results. The Laseminasodo resulted the seeders less valid because of some characteristics: in particular the lower weight and the presence of the hay-cutters instead the disks, prejudicing the placement of the seed to a greater depth, because it doesn't reaching a sufficient pressure on the soil. In some cases the hay-cutter was not up to pierce in the soil.

Table 6. Operational data of planting

Seeders	Depth of planting (m)	Working width (m)	Operational capacity (ha/h)	Fuel consumer (l/ha)
Laseminasodo	0,04	2,60	1,3	18
Directa-Gaspardo	0,07	3,00	1,8	20
Amazone AD 303	0,10	3,00	2,1	21
Alpego ASI 300	0,10	3,00	1,9	40

Table 7. Regularity of transverse distribution

Seeders	Dose of planting (q/ha)	Weight of 1000 seeds (g)	Velocity of advancing (Km/h)	Inclination machine (%)	Variation coefficient (%)
Laseminasodo	2,5	42,5	7,5	8-10	1,90
Directa-Gaspardo	2,20	45,7	7,5	8-10	1,84
Amazone AD 303	2,5	50,5	8	8-10	1,40
Alpego ASI 300	2,3	40	8	8-10	1,40

Table 8. Regularity of longitudinal distribution

Seeders	Number percentage of plants for segment										
	0	1	2	3	4	5	6	7	8	Medium number of plants	Mean emergency (%)
Laseminasodo	18	30	25	15	5,5	3	2	1	0,5	1,53	83
Directa-Gaspardo	19	32	26	15	5,9	1,5	0,5	0,1	0	1,65	90
Amazone AD 303	19	32	26	15	5,9	1,5	0,5	0,1	0	1,65	90
Alpego ASI 300	18	30	25	15	5,5	3	2	1	0,5	1,83	80

Table 9. Operational and qualitative data of harvesting

Seeders	Productions (q/ha)	Weight of grains (Kg/m^2)	Hectoliter weight (Kg/hl)	Working width (m)	Operational capacity (ha/h)	Production of conventional planting (q/ha)
Laseminasodo	15	0,25	83	4,80	1,15	22,5
Directa-Gaspardo	26	0,35	83	4,80	1,25	27
Amazone AD 303	31	0,44	83	4,80	2,2	32,5
Alpego ASI 300	25	0,30	83	4,80	1,3	27

Conclusions

The results emerged from our analysis confirmed that by the sod-seeding it is possible to guarantee:

- ✓ ecocompatibility, preserving the soil structure;
- ✓ energy saving, thanks to drastic reduction of the operations previous the planting;
- ✓ possibility to establish the period of operating, executing tilling when the soil presents the optimal conditions, avoiding damages to the structure and consequently
- ✓ interventions more timely.

The qualitative and quantitative satisfying standards can been reached on condition that is an optimal choice of the machine to employ, on the ground of the physical characteristics of the soil.In particular it is necessary an adequate choice of the lister discs that are the essential elements in order to a good apical emergency. The machine firms diverted their attention in this direction and recently are able to offer a wide set of operational organs on the ground of the operational conditions required.

The greater limit is the excessive cost of seeders, in fact the most part of firms resort to third party, because they haven't always the plot of land enough extended to let the gradual amortization. Besides we are unacquainted with the numbers of years that it is possible execute the sod-seeding without the conventional planting, because are insufficient the trials realized until today. Overstay the distrust of the owner for a practice still not much known, although it is spreading some decade ago.

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Each author contributed in that paper in same measure