RESEARCHES REGARDING THE SOIL TILLAGE MACHINERY SYSTEMS FOR VINEYARDS

CERCETĂRI PRIVIND SISTEMELE DE MAŞINI PENTRU MECANIZAREA LUCRĂRILOR SOLULUI ÎN PLANTAŢIILE VITICOLE

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Abstract*. The experiments took place during the year 2009, in a Chaselas Dore variety vineyard, within the "Vasile Adamachi" experimental station and were aimed to establish the most adequate soil tillage system. The quality indices, average working speed and soil penetration resistance were evaluated, for five working variants. Interpretation of the experimental results allowed the establishment of most favorable variants for soil tillage, in accordance with the concept of sustainable agriculture and aiming to soil preservation.*
Key words: mechanization, soil tillage, technology

Rezumat*. Experienţele au fost desfăşurate în anul 2009, în plantaţia de viţă de vie cu soiul Chasselas dore din cadrul SDE „Vasile Adamachi" din Iaşi şi au vizat stabilirea sistemei de maşini pentru mecanizarea lucrărilor solului. Pentru aceasta s-au determinat indicii calitativi de lucru, viteza medie şi rezistenţa solului la penetrare pentru cinci variante tehnologice. În urma interpretării rezultatelor obţinute s-au stabilit variantele optime de tehnologii pentru mecanizarea lurărilor solului şi care corespund conceptului de agricultură sustenabilă, în principal pentru conservare solului.*
Cuvinte cheie: mecanizare, lucrările solului, tehnologie

INTRODUCTION

In the general context referring to the application of the sustainable agriculture concept and especially of soil conservation technologies in vineyards, several variants of soil tillage on the intervals between rows were experienced in 2009.

Four different non-conventional, conservative, tillage technologies were tested; a witness variant, using a classical tillage technology, was also taken into account.

The tested technologies included combined agricultural machinery and complex units, comprising sowing equipments, thus reducing both agricultural traffic and soil compaction.

Interpretation of experimental results allowed the selection of the best technological variant (in the terms of sustainable agriculture), assuring land protection and conservation

MATERIALS AND METHODS

The experiments took place in a vine plantation, Chasselas dore variety, established in 1985, with planting distances of 2.2 x 1.2 m and a density of 3787 plants/ha. The plantation is placed on a terrain with 8% slope, western - southwestern exposure and north - south rows orientation, along the contour lines. The prevailing soil is cambic chernozem, with a loamy clay texture and 20-24% humidity in the 0-40 cm depth layer.

Temporary soded with Facelia (*Phacelia tanacetifolia* L.) was applied to variants V4 and V3 because it prevents weed formation due to the quick development, the very dense foliage, the high biomass quantity and low requirements towards pedoclimatic factors.

This plant has a short growing season, emergence occurs in 8-10 days, it flowers 40-60 days after sowing, and the total flowering duration is about 50-60 days.

For all the five technological variants (table 1) the working quality indices were determined as a function of working speed; variant V1 was the witness variant, using the classical 2.25 m distance between the rows vineyard tillage machinery system (the PCV 1.8 cultivator plough, the DPV carried disc harrow and a cultivator equipped with arrow type active knives).

In variant $V_{2,}$ the CV 5 soil scarificator was used for basic soil tillage, while the vibrocoulter V.F 7 was used for total cultivation.

The CV 5 scarificator has a working width of 150 cm and is composed of a V-shaped rigid frame on which five chisel type active knives are mounted; the overall mass is 215 kg.

The VF 7 vibrocultivator consists of a frame, seven double-elastic supports on which the working devices (arrow with equal wings and roller) are mounted. The working depth is adjusted with the help of the supporting wheel; two hydraulic cylinders allow the adjustment of the working width.

Table 1

Mechanization of soil tillage technologies in the vineyard plantation

Technology Variants	Aggregates used	Soil tillage	Traffic (no.crossings)
V_1 (witness)	SV 445 + PCV 1,8 SV 445 + DPV 1,5 SV 445 + PCV (Knives arrow)	Autumn ploughing Spring soil loosening Cultivation works	5
V_2	Aster 45 +CV 5 Aster 45 + V.F 7	Soil scarifier Cultivation works	4
V_3	Aster 45 + DL 1300 Aster 45 + DLV 1500	Fall soil tillage Sowing Facelia	2
V_4	Aster 45+ DPV 1,5 Aster 45 + DLV1500	Spring disc harrow work Sowing Facelia	2
V_5	Aster 45+ PCVM 1,8 cu Aster 45+ DL 1300 (Claw raising)	Fall soil loosening Cultivation works	3

In variants V3 and V4 the complex unit DLV 1500 was used for soded

The vertical rotor mill (DL-1300) can be used either as a stand alone machine, for germinative bed preparation after ploughing, or aggregated with the Vitigreen (DLV-1500) sowing machine, in order to prepare the germinative bed and soded.

The complex unit composed of mill and sowing machine requires 30-45 hp tractors, with the working devices being powered by the tractor's PTO at a speed of 540 rpm.

The working depth of the vertical rotor mill is adjusted via the Packer type roller. The Vitigreen sowing machine consists of a hopper with a capacity of 250 liters and nine distributors; its total weight is 110 kg.

The devices used for the evaluation of quality working are: furrow depth measurement dipstick, with 1 cm accuracy, simple metric frame, metric frame with a 50 mm mesh, electronic balance, timer, paper bags for collection of samples and electronic static penetrometer (Penetrologger type).

The quality indices were evaluated using the following relationships:

The average working depth (a_m) is calculated the relationship

$$a_m = \frac{\sum_{i=1}^{i=n} a_i}{n} \text{ cm}$$

where: a_i are the values of the working depths, measured with the dipstick; n - number of measurements (20 measurements on 100 m travel distance)

The **soil break-up degree** (G_{ms}) was computed using the relation

$$G_{ms} = \frac{\sum_{i=1}^{i=n} \frac{M_{sci}}{M_{sti}}}{n} \cdot 100,\%,$$

where: M_{sci} is the weighted mass of soil with clods having the dimension lower than the 5 cm conventional dimension; M_{sti} – overall mass of soil., n - number of measurements (samples taken), which must be at least three. ,

The soil samples are weighted with an accuracy of 10 grams and are drawn using the square metric frame (with one square meter area), on the working depth, in at least three random positions located on the diagonal plot.

Soil loosening degree (G_{as}) was computed with the relation

$$G_{as} = \frac{\sum_{i=1}^{i=n} \frac{h_i}{a_i}}{n} \cdot 100,\%,$$

where: h_i is the height of tillage soil with respect to the until aged soil (cm) a_i - working depth (cm), n - number of measurements taken (at least 10, along 100 m).

Plant mass coverage with soil (G_{av}) was determined with the relationship

$$G_{av} = \frac{\sum_{i=1}^{i=n} \frac{M_{vai}}{M_{vti}}}{n} \cdot 100,\%,$$

where: M_{vai} is weighted mass of plants covered with soil; M_{vti} – overall weighted mass of plants material, n - number of measurements taken (at least 3.)

The plant samples are weighed with 1 g accuracy and are collected (before and after ploughing) over one square meter surface, using the metric frame; there should be at least three repetitions, diagonally placed on the lot.

RESULTS AND DISCUSSIONS

The main results obtained in during the experimental researches are presented in table 2, being as follows:

The average working depth (a_m) has the minimum value of 3 cm for variant V3 and a maximum value 35 cm for V_2 variant. The maximum deviation from the imposed working depth was 1.6 cm for variant V_1 and was due to the downward forces acting upon the plough's active organs.

Soil break-up degree (G_{ms}) varies depending on the technology used, soil humidity and working speed of the unit.

Taking into account that the agro technical requirements impose a soil break-up degree of at least 90%, we concluded that the best option is V_3, which achieved a value of 98.76% for this index. Variants V_4 and V_5 led to relatively close results, with 85.93% and respectively 85.83%.

Table 2

Influence of speed on some soil tillage quality working indices

Variants	Average working speed *Km/h*	Quality indices			
		a_m *(cm)*	G_{ms} %	G_{as} %	G_{av} %
V_1	3,63	20	79,23	24,9	95,06
V_2	4,14	35	77,23	26,8	78,93
V_3	1,95	3	98,76	25,3	84,43
V_4	6,27	10	85,93	23,2	93,60
V_5	6,61	15	85,83	21,2	88,10

In terms of soil loosening **degree** (G_{as}), the experimental results for all the working variants were comprised between 21.2 and 26.8%, these being acceptable values from an agro technical point of view..

The best value when referring to **plant mass coverage with soil** (G_{av}) was recorded for variant V_1 (95.06%), while the lowest value was recorded for variant V_2 (78.93%).

Due to the 2.25 m distance between the rows, the displacement of the tillage units is always performed on the same ruts, thus resulting in a higher soil compaction on the tracks of the tractor wheel. In order to evaluate this effect, the penetration resistance was measured a week after the completion of the maintenance works (during the growing season); the average values of this index are presented for soil layers comprised zero and 40 cm depth. Compaction of soil is influenced both by the substrate upon which the working organs act and soil humidity.

The maximum value (1.06 MPa) was recorded for variant V_1, being still within the limits imposed by the requirements referring to normal growth and development of plant roots.

The values of penetration resistance that were recorded for the other technological variants are significantly lower, namely 0.42 MPa for variant V_3 and 0.56 MPa for variant V_2.

The requirements imposed by the sustainable agriculture concept are relatively easily met by the proposed soil maintenance technologies when the firm has adequate machinery systems.

In choosing the optimal soil maintenance system, soil erosion control should also be taken into account, as well as the risk of land and environment pollution and degradation, the final goal being to achieve an economically efficient production.

Table 3

Variation in penetration resistance as a function of depth

Variants	**Depth** (cm)	**Penetration resistance**			**Average** (MPa)	
		R_1	**R_2**	**R_3**	**repeat**	**variants**
V_1	0-10	0,84	0,89	1,09	0,94	**1,06**
	10-20	1,04	0,89	1,27	1,06	
	20-30	0,73	1,08	1,35	1,05	
	30-40	1,04	1,17	1,46	1,22	
V_2	0-10	0,31	0,19	0,28	0,26	**0,56**
	10-20	0,40	0,57	0,40	0,45	
	20-30	0,89	0,71	0,59	0,73	
	30-40	0,53	0,80	1,10	0,81	
V_3	0-10	0,35	0,43	0,24	0,34	**0,42**
	10-20	0,50	0,30	0,63	0,47	
	20-30	0,43	0,50	0,33	0,42	
	30-40	0,49	0,41	0,50	0,46	
V_4	0-10	0,32	0,25	0,33	0,30	**0,63**
	10-20	1,00	0,91	1,10	1,00	
	20-30	0,67	0,60	0,49	0,58	
	30-40	0,78	0,64	0,61	0,67	
V_5	0-10	0,43	0,58	0,65	0,55	**0.92**
	10-20	1,04	1,32	0,97	1,11	
	20-30	0,85	1,34	1,02	1,07	
	30-40	1,08	0,96	0,90	0,98	

CONCLUSIONS

1. Following to the developed experiments and interpretation of obtained data, the best technological options for mechanization in vineyards with a 2.25 m distance between rows was established.

2. When considering the criteria of reduction of both soil maintenance works and energy consumption, the use of unconventional systems, conservative tillage, highlighted that the best technological variants were, in order, V_3 followed by V_4 and V_5, which are mechanized tillage technologies regarded as alternatives to conventional technology.

3. When it is necessary to apply ploughing using the mouldboard plow 1.8 PCV, variant V_3 (or V_4) should be considered, using this equipment to perform autumn soil tillage (instead of using the disk harrow or the vertical rotor mill).

4. Application of variant V_1 requires generally higher costs per unit of surface due to the higher number of operations during the growing season (high fuel consumption), coupled with lower values of the quality indices taken into account.

5. V_3 and V_4 variants are more favorable than the other ones because a single pass (in spring) with the complex unit consisting of the DL 1300 vertical rotor mill 1300 and the 1500 Vitigreen sowing machine leads to soded with facelia of the space between rows, thus making useless other additional operations and facilitating the access of equipments in rainy periods.

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