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RESPONSE OF *ORIGANUM* VULGARE L. TO DIFFERENT PLANT DENSITIES AND FIRST RESULTS OF MECHANICAL HARVEST

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SUMMARY - Tests for evaluating the agronomical response of *Origanum* to four plant densities were carried out from 1998 to 2001, on a local biotype of *Origanum* collected at Monreale (Palermo), in an area having the typical soil and climatic conditions of the Sicilian environment.
Data about plant biometric characteristics (height at different growth phases, number of branches per plant, fresh weight yield) and the proportions among inflorescences, leaves and stems were monitored. Moreover, essential oil analyses were carried out for each plant density.
The results showed that the plant density influenced the yield but not the plant height.
The best results were obtained in the second year, when the highest values of biometric characteristics were measured.
In 2000/2001 tests of mechanical harvest were carried out for each plant density, using a reaper-binder made by BCS. In the second year the machine was modified, in order to improve its working productivity and quality.

Key words: *Origanum, Biotype, Density, Mechanical harvest.*

INTRODUCTION

The World Health Organisation (WHO) defines as "medicinal plant" a plant containing essences, that can be used for therapeutic reasons or for chemical and pharmaceutical hemisynthesis. The medicinal value of *Origanum* plants depends on the content of active principles like thymol and/or carvacrol. There is an increasing interest in medicinal plants, because of their antioxidant, antimicrobial, aromatic, aperitif, digestive, antiseptic and expectorant properties.

The economical value of officinal plant derivates is also increasing because of the demand of the pharmaceutical industry.

In Italy there is the need to improve the quality of medicinal plant production, in order to compete with other countries.

In fact, the products imported from other countries have the disadvantages of customs delays and product deterioration and pollution during transport and storage.

Origanum is a species that can easily grow in Southern Italy, on hilly and mountain areas, not suitable for other crops. The need for high quality products and cheap raw materials suggests the development of growing methods aimed to decrease production costs without reducing the product quality. The creation of quality marks (DOC, DOP, etc.) and a closer connection between farmers and transformation industries could allow an "integrated" rural development and give a contribute in solving one of the main agricultural problems: the need for cultivating alternative crops, which could increase job possibilities and profit, especially in "marginal" hilly and mountain areas.

The aim of this work is to evaluate the bio-

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agronomical response of *Origanum* to four different plant densities and the possible reduction of production costs, through its mechanical harvest.

MATERIALS AND METHODS

Growing tests were carried out between 1998 and 2001 in the territory of Villalba (Caltanissetta), where *Origanum* is cultivated with high profitability.

The fields, located at 600 m above sea-level, have the typical soil characteristics of Sicilian inland hilly areas (clay soil texture with significant slope) (Fig. 1).

The main chemical and physical soil characteristics are shown in Table 1.

The experimental design was a randomised complete block with four replications.

Four different plant densities were compared in plots of 50 m^2:

- D1 0.20 x 1.00 m;
- D2 0.30 x 1.00 m;
- D3 0.40 x 1.00 m;
- D4 0.50 x 1.00 m.

The first fertilisation was carried out applying 100 kg ha^{-1} of P_2O_5 and 100 kg ha^{-1} of K_2O. During the three years the fields were not irrigated and a mechanical weed control was carried out.

In the first two years the crop was manually harvested cutting the plants at a height above the ground of approximately 0.10 m.

In the third year the crop was harvested using a BCS 622 reaper-binder, having 10 kW engine power and three forward speeds (Fig. 2). Two series of tests were carried out (test 1, test 2).

During the first series of tests the machine, designed for harvesting cereal and forage

Fig. 1 - *Origanum* test field at Villalba (Caltanissetta).

Tab. 1 - Main chemical and physical soil characteristics of Villalba (Caltanissetta) test fields.

Characteristics	Values
Sand	37%
Silt	29%
Clay	34%
Total Carbonates (De Astis)	5.87%
Active Carbonates (Drouneau)	3.60%
Organic matter	1.12%
Total Nitrogen (Kjeldal)	1.15%
Assimilable Phosphorus (Olsen)	28.0 p.p.m.
Assimilable Potassium (International method)	365 p.p.m.
pH (in water)	7.9

crops, was used without any modification. For the second series of tests the machine was modified to improve its working quality and efficiency, this last one being the ratio between the weight of the harvested crop and that of the total crop, expressed as percent.

The machine forward speed was reduced of about 10%, replacing its wheels (4.50-19) with two wheels having a lower diameter (5.00-15).

The cutting height was lowered reducing the thickness of the support slide of the cutting bar (Fig. 3).

It was possible to reduce the bunch size modifying the binding mechanism, in order to bind the bunch at a height similar to that of the manual binding.

The binding height of the bunch was lowered lifting the base of the conveyor.

The average plant height and the main biometric parameters were measured on a 30 m^2 test area.

The proportions among inflorescences, leaves and stems (as percentage of the total dry weight) were also computed.

For each test 300 g of dry product were distilled by the means of a steam flow; the resulting quantities were statistically expressed as the percentage ratio between oil volume and sample dry weight.

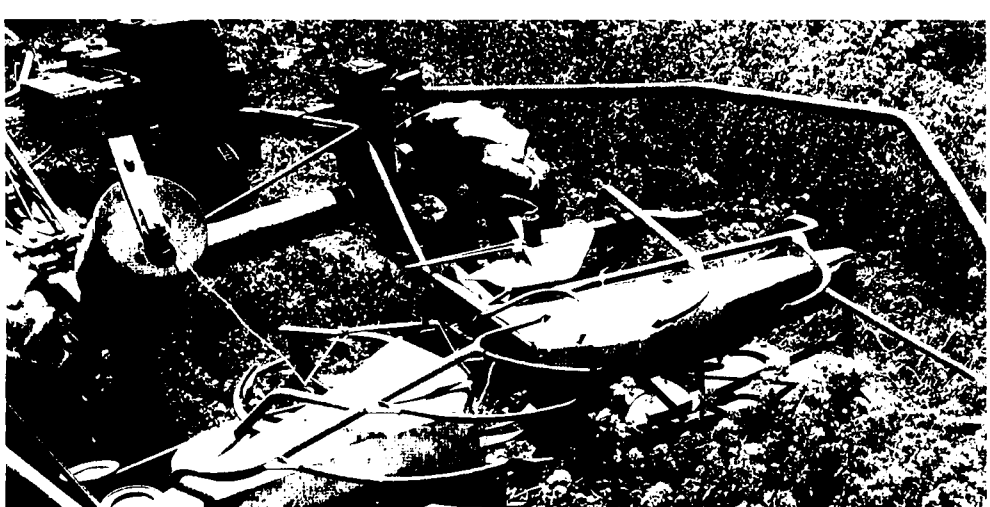

Fig. 2 - Modified BCS 622 reaper-binder used during the tests.

Fig. 3 - Cutting bar, binding unit and conveyor of the modified reaper-binder.

The time of the harvest operations was measured for each plant density, using both the unmodified machine and the modified one, in order to compute the working capacity and productivity. The machine working quality, that is the length, the average weight and the binding height of the bunch, was also measured. The results were compared with those of the manual harvest, which was carried out by an operator using a sickle.

The temperatures and rainfall during the testing periods are shown in Figure 4.

Rainfall was scarce and always lower than 500 mm, of which more than 55% were concentrated in October, November and December. Winter and spring periods were the most dry ones.

The temperatures recorded are typical of the testing region; values below 0 °C were recorded only in the last decade of January and in the first decade of February of the first year.

During the three years of research, between May and June, a strong south-east wind increased the temperature up to 40 °C.

RESULTS

The fresh weight yield was positively influenced by the plant density.

The height differences among the plants were not significant: plant heights ranged from 0.35 m, (D4 density) to 0.37 m (D3 density). The average proportions of inflorescences, leaves and stems (as a percentage of the total dry weight) were 34.8%, 23.3% and 41.9% respectively. The highest content of essential oils (3.16% of the sample dry weight)

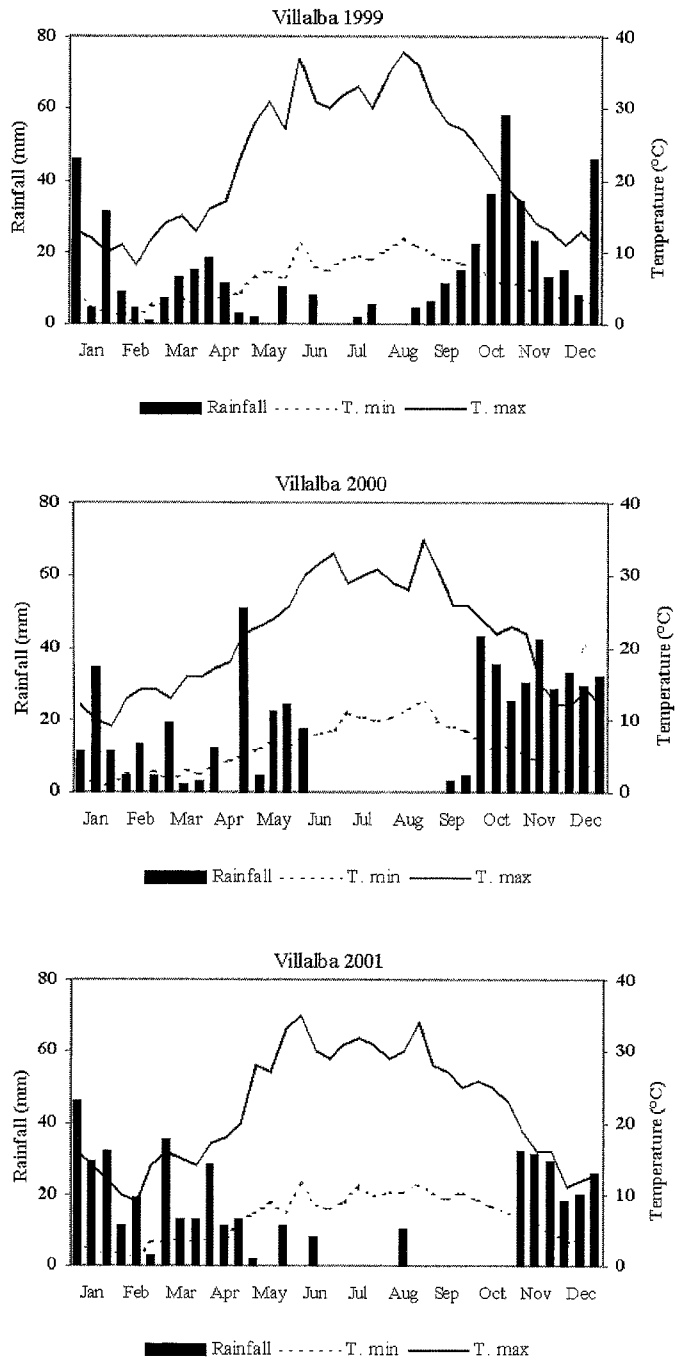

Fig. 4 – Rainfall and temperatures during the testing periods.

Tab. 2 - Main biometric and productive characteristics of *Origanum* "Monrealese" biotype.

Variables	Fresh weight yield (kg ha^{-1})	Plant components (%)			Essential oil content (%)	Plant average height (m)	Inflorescence height (m)	Plant diameter (m)	Plant branches (n)
		Inflorescences	Leaves	Stems					
Year									
1998/1999	3500b	45.6a	22.2b	32.2b	2.80	0.38b	0.15ab	0.35	180
1999/2000	13885a	35.2ab	23.2b	41.6a	2.65	0.41a	0.16a	0.57	220
2000/2001	12500ab	31.0b	29.2a	39.8ab	2.92	0.39ab	0.14b	0.53	192
Plant density									
D1	10000a	35.0ab	22.7a	42.3ab	3.16	0.36	0.14	0.49	231
D2	9500ab	31.3b	24.5ab	44.2a	3.1	0.36	0.14	0.49	228
D3	8000b	36.5a	22.3a	41.2ab	2.81	0.37	0.14	0.52	210
D4	8500b	36.4a	23.7b	39.9b	2.73	0.35	0.14	0.46	191

The values followed by the same letter are not significantly different for $P \leq 0,05$. (Test of Student Newmann Keuls - SNK).

was found for D1 density, the lowest value (2.73%) for D4 density.

From the first to the third year a decreasing percentage of inflorescences and leaves and an increasing percentage of stems were recorded. The highest production was obtained in the second year, when the highest values of average height, plant diameter and branches number were recorded (Tab. 2).

The efficiency of the mechanical harvest in test 2 (94%) was 3% higher than that recorded in test 1 and slightly lower than that of manual harvest (99.5%) (Tab. 3). In fact, the lower forward speed of the modified machine reduced by 2-3% the product losses on the fields, caused by some crop clogging between the cutting bar and the binding unit. Moreover, the lower height of the cutting bar above the ground allowed that only the 4-6% of the product was left on the fields.

The working capacity and productivity were slightly lower in test 2 than in test 1, of 10% and 6.5% respectively, because of the 10% reduction of the forward speed.

In test 1, using the unmodified machine, the bunches, in spite of being shorter, had an average weight (2.58 kg) much higher than that required by the market (0.25 kg) and a higher binding height (0.25 m) with respect to that of the manually harvested ones (0.15 m) (Fg. 5). These problems were partially

Tab. 3 - Working capacity, productivity and efficiency of mechanical and manual harvest.

Test	Working capacity (ha h^{-1} operator)	Working productivity (kg h^{-1} operator)	Harvest efficiency (%)	Product losses (%)	
				On the fields	Not harvested*
Mechanical harvest Test 1	0.2000	2.275	91	3.0	6.0
Test 2	0.1810	2.127	94	2.0	4.0
Manual harvest	0.0016	20	99.5	0.5	0.0

*below the minimum height of the cutting bar.

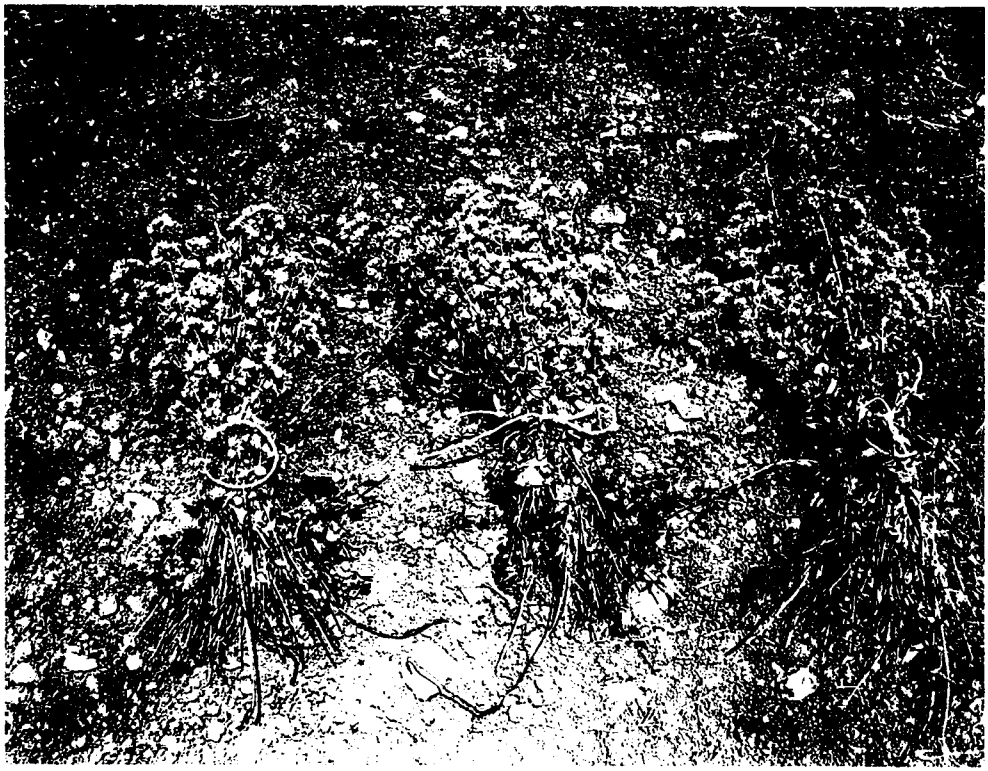

Fig. 5 - *Origanum* bunches required by the market.

solved using the modified machine, as the results of test 2 show (Tab. 4).

Further modifications of the machine will be made, in order to improve its working quality. The machine will then be tested during the next harvest, to evaluate whether the working quality could reach the quality achieved harvesting manually.

DISCUSSION AND CONCLUSIONS

Origanum "Monrealese" biotype showed high suitability to the soil and climatic test conditions and, at the same time, a relatively high yield.

The yield was positively correlated with the plant density. However, the highest con-

Tab. 4 - Working quality of mechanical harvest (tests 1 and 2) and manual one.

Test	Cutting height (m)	Bunches per ha (n)	Bunch average weight (kg)	Bunch binding height (m)
Mechanical harvest				
Test 1	0.15	4.409	2.58	0.25
Test 2	0.12	7.731	1.52	0.19
Manual harvest	0.10	50.000	0.25	0.15

tent of essential oils was recorded for lower plant densities.

The highest fresh weight recorded during the second year was due to higher values of plant diameter and branch number.

After modifying the machine a 3% higher harvest efficiency was recorded and bunches having weight and binding height similar to those required by the market were obtained.

The tests show that the production of fresh and/or dry *Origanum* and of its essential oils could play a major role to improve the economy of "marginal" areas of inland Sicily.

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