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Studies on production techniques of some herb plants

I Effect of Agryl P17 mulching on herb yield and volatile oils of basil (*Ocimum basilicum* L.) and marjoram (*Origanum majorana* L.)

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Abstract. Agryl P17 fiber-mulching of cold-sensitive herbal plants, basil (*Ocimum basilicum* L.) and marjoram (*Origanum majorana* L.), were studied at three locations in Finland (1984—1985). The growing sites were Helsinki (60° 14′ N), Sahalahti (61° 28′ N), and Inari (69° 04′ N) for both species in 1984, and Helsinki for marjoram in 1985.

Agryl P17 mulching increased basil yield at all locations. The uncovered basil yielded approximately 54 kg/100 m² and when grown under the mulch, more than three fold, 191 kg/100 m². In the north (Inari), however, basil and marjoram did not give practically any yield. Marjoram did not benefit from mulching either in the south: the yield was 96 kg without and 80 kg/100 m² with mulching. The vegetation under the mulch was severely affected by fungus-diseases.

The volatile oil content in the dried basil herb ranged from 0.46 to 0.93 %. There were no significant differences in the total oil content whether basil was grown with or without Agryl P17. The oil content in marjoram ranged from 1.94 to 2.55 % the total content being significantly higher when grown under the cover.

Index words: basil, dill, fiber-cover, herb, mulch, volatile oil

Introduction

There is a lot experience in the efficiency of different mulching materials to protect the vegetable crops against low temperatures. Different fiber-covers have been used to achive earlier and larger yields in cool areas. For instance, Agryl P17 fiber has been used to protect strawberry, potato and vegetable plants like lettuce, cabbage, cucumber all of which have given earlier and larger yield when grown under the cover (HÅRDH 1982, GUTTORMSEN 1986, PESSALA 1986, SAMUELSEN 1986). The fiber is protected against uv-radiation degregation, and it is transparent to 75—80 % of the light and uv-radiation.

PESSALA (1986) has reported that the maximum temperatures are 10—15°C and the minimum temperatures 2.4—4.5°C higher under fiber-covers than in the open field. The

differences are smaller at night and on cloudy days than on sunny days. SCHALES and SHELDRAKE (1966) and BOHLIN (1977), among the others, have reported on higher humidity under cover. Weeds and plant diseases have caused problems in warm and humid conditions under the mulch.

There is a lack of knowledge on the effects of the vegetation covers used for herb plants. Therefore a study was carried out to determine the effect of mulching of two cold-sensitive species, basil and marjoram. Both the herb yield and content and composition of volatile oils was studied. The cultivation of these plants is most sensitive in the open field in the northern climate.

Materials and methods

Basil and marjoram were grown under fiber-cover and uncovered at three locations in Finland in 1984. The growing sites were Helsinki (60° 14′ N), Sahalahti (61° 28′ N) and Inari (69° 04 N). The research was also carried out with marjoram in 1985 in Helsinki. The vegetation was covered by Agryl P17 from transplanting till harvest. The plants were first grown in a greenhouse because this had, in the preliminary trials, proved superior to direct-sowing.

The basil plants were grown using commercial seeds which consisted of several chemotypes. Marjoram was of the French type in both years. The plants were grown 40—57 days in a greenhouse before transplanting outdoors to spacings of 20 × 25 centimeters. The soil received a moderate basic fertilization (0.9—0.4—1.4 kg NPK/100 m²), and the field was irrigated and hand-weeded when necessary. The herbs were harvested at the beginning of flowering and the amount of the fresh yield was measured.

The volatile oil analyses of the dried (at +35°C for 15 hours) herbs from Helsinki were carried out by the method of head space gas chromatography as described by HILTUNEN et al. (1985). Marjoram was analysed by this method in 1985, only. In addition, fresh marjoram samples from Sahalahti and Inari and basil from Sahalahti were determined by high resolution gas chromatographic — mass spectrometric method in 1984 (NYKÄNEN 1986).

The field trials were set up according to the method of completely randomized blocks with plots of 1.5 m² in 1984, and 3.8 m² in 1985. The data was statistically analysed by the analysis of variance (STEEL and TORRIE 1980).

Results

Herb yield

The differences in daily temperatures were largest during bright days. The minimum temperatures were in an average 0—4°C higher and the maximum temperatures 5—5.8°C higher under the fiber than in the open field.

The growth period for basil was 98 days in southern Finland (Table 1). There were no differences in the growth and development of basil grown with or without the cover.

In the south the fresh basil yield was 191 kg under the cover and 54 kg/100 m² when grown uncovered. The yields were significant-

Table 1. Growth periods (days) of basil (1984) and marjoram (1984 and 1985) grown with and without Agryl P17 at three locations.

	BASIL/-84			MARJORAM			
	Helsinki	Sahalahti	Inari	Helsinki		Sahalahti	Inari
				-84	-85	-84	-84
No cover	97	98	106	106	89	126	106
Agryl P17	97	98	106	106	82	119	106
Sown	24.4	24.4	7.5	24.4	3.5	24.4	7.5
Planted	20.6	13.6	18.6	20.6	13.6	13.6	18.6

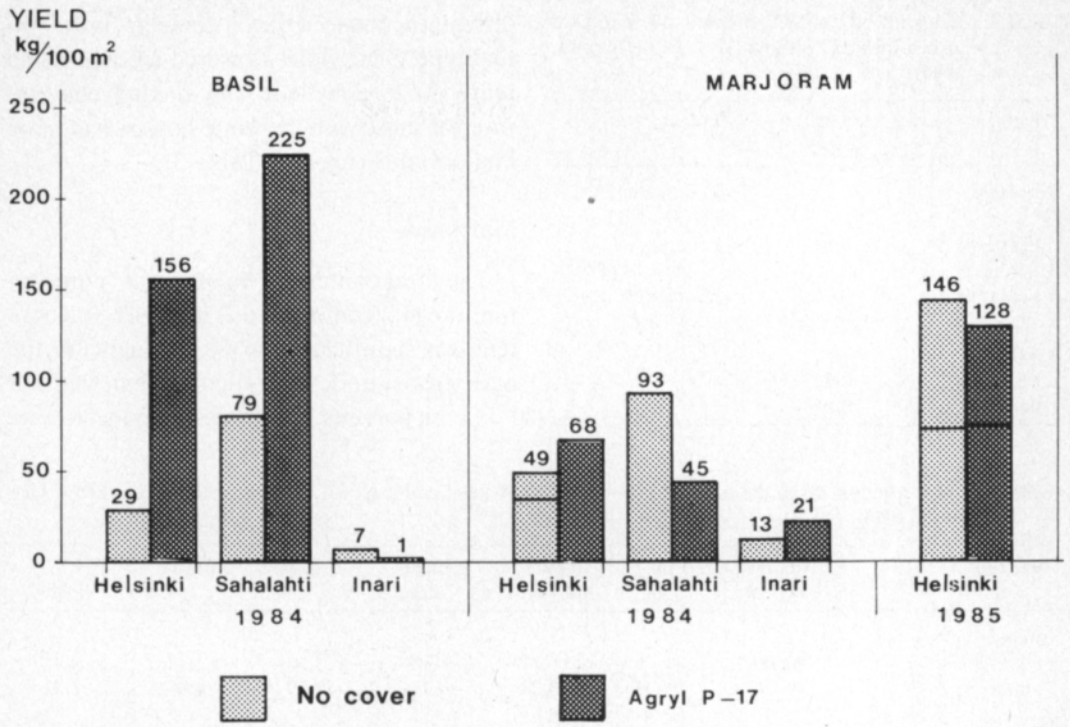

Fig. 1. The fresh herb yield of basil and marjoram grown with and without Agryl P17-cover at three locations (1984 and 1985). The stacked bars present the first and second yields.

ly larger under the cover both in Helsinki ($p < 0.001$) and in Sahalahti ($p < 0.001$) (Fig. 1). In the preliminary tests basil gave larger yield (210 kg/100 m²) in a greenhouse than out-of-doors. In the north basil did not give practically any yield at all.

The growing period for marjoram was 106—126 days in 1984, and 82—89 days by the first harvest in 1985 (Table 1). The development was approximately a week shorter under the cover than when grown uncovered.

The marjoram yielded in an average 80 kg/100 m² when grown under Agryl P17, and 96 kg/100 m² when grown uncovered (Fig 1). The first harvest yielded significantly ($P < 0.05$) more than the second one. The later crops were severely affected by plant diseases (*Alternaria* sp. and *Botrytis cinerea*). The yields in Sahalahti in 1984 and in Helsinki in 1985 were significantly ($p < 0.01$) larger when marjoram was grown without the cover. In the preliminary tests carried out in a greenhouse the yield was 130 kg/100 m².

Volatile oil

Basil

The total content of volatile oil in basil herb ranged from 0.46 to 0.93 %. There were no significant differences in the amount of the main compounds whether the herb was grown with Agryl P17 or without it (Table 2). Only the content of 1,8-cineol was significantly ($p < 0.05$) higher when grown without mulching. The main components in the oil were methyl chavicol (estragol), linalool, β-caryophyllene, and unidentified component ×2.

The crop stand consisted of several fenotypes those with violet (1) or white (2) flowers being the major types. There were significant

Table 2. Essential oil content in two basil fenotypes grown with and without Agryl P17 (Helsinki, 1984).

Treatment	Oil %	F-value
No cover		Treatments F(1,3) = 0.33
Fenotype 1	0.89	Fenotypes F(1,6) = 14.68**
Fenotype 2	0.46	Interaction (1.6) = 3.37
Agryl P17		
Fenotype 1	0.93	
Fenotype 2	0.65	

differences between the oil contents of the two fenotypes. The violet-flowered fenotypes had more β-caryophyllene and methyl chavicol whereas those with the white flowers had more linalool and eugenol (Table 3).

Marjoram

The total content of volatile oils in marjoram ranged from 1.94 to 2.55 %. The oil content was significantly ($p < 0.05$) higher in the herb grown under Agryl-cover than without it in both harvests. The main components were

Table 3. Main components in the essential oil of basil fenotypes 1 and 2 grown with and without Agryl P17 (Helsinki, 1984).

Treatment	Methyl chavicol	Linalool	β-caryophyllene	Eugenol	×2	Borneol	1,8-cineol
No cover							
Fenotype 1	70.78	0	6.57	1.38	3.36	1.42	2.48
Fenotype 2	19.83	24.43	3.24	8.02	7.29	0.95	1.92
Agryl P17							
Fenotype 1	70.91	3.31	5.52	0.82	3.62	1.19	1.20
Fenotype 2	33.25	34.58	4.00	4.83	3.09	0.77	1.21
Treatment F(1,3)	0.82	0.81	5.20	1.32	0.63	0.58	16.89**
Fenotype F(1,6)	88.75***	257.05***	29.91**	6.01*	0.79	6.53*	1.29
Interact. F(1,6)	2.00	0.02	4.08	0.37	1.38	0.01	1.41

Table 4. Essential oil content and components in marjoram grown with and without Agryl P17 (Helsinki, 1985).

Component	NO COVER		AGRYL P17		F(1,3) Treatment (I+II)
	I Harvest August 1.	II Harvest Sept. 9.	I Harvest July 25	II Harvest Sept. 9.	
Oil content %	1.94	2.11	2.40	2.55	
Linalool	34.50	37.77	36.54	30.77	0.39
cis-Sabinene hydrate	12.63	13.15	12.18	10.96	0.34
Linalyl acetate	7.61	9.31	5.65	6.99	8.85
Sabinene	6.53	6.49	7.47	7.84	7.06
γ-terpinene	5.95	4.28	5.44	6.70	1.93
trans-Sabinene hydrate	4.49	3.60	4.17	3.59	1.31
α-terpinene	3.69	2.77	3.40	4.36	2.86
p-cymene	0.07	0	0.04	0	0.13
Terpinen -4-ol	2.71	2.41	2.36	2.93	0.25
α-pinene	2.44	2.11	2.75	2.99	3.39
β-caryophyllene	2.50	1.70	2.42	2.88	1.35
β-phellandrene	1.24	1.12	1.28	1.65	6.04
Terpinolene	1.32	1.05	1.22	1.60	3.45
Limonene	0.97	0.96	1.04	1.23	3.82
3-carene	0.77	0.85	0.31	0.51	16.99*
Myrsene	0.17	0.16	0.93	1.00	236.84***

Oil content/treatment: F(1,3) I harvest 22.88+, II harvest 14.72+.

linalool, cis-sabinene hydrate, linalyl acetate, sabinene, γ-terpinene and trans-sabinene hydrate. The six major compounds accounted for 75 % of the total oil content (Table 4). Except for the compounds 3-carene and myrsene, found only in traces, there were no significant differences between the 16 compounds studied whether grown with or without the cover.

Discussion

Both basil and marjoram reached larger yields when grown in a greenhouse than in the field. Outdoors the effect of Agryl P17 was mainly in increasing the herb yield of basil and the volatile oil content in marjoram herb. The fiber increased also the rate of development of marjoram. The basil types, instead, developed at different rates and no destinct differences were found whether grown with or without the mulching. The differences between the two major basil fenotypes were considerable. Thus a pressure should be placed on herb plant breeding in purpose to receive varieties with high essential oil content.

The fiber did not increase the average amount of the volatile oils in the dry basil herb. NYKÄNEN (1986), instead, states that the oil content in fresh basil was significantly higher when grown under Agryl P17. Specifically the amounts of methyl chavicol and eugenol were higher. The differences in the results are partly due to the analysing methods and heterogenious materials. The composition of oil may have changed also during the drying process, and the results on dry herb supposingly resemble that of a typical commercial herb.

Using Agryl P17 increased the amount of volatile oils in marjoram. This phenomenon was also found in fresh herb (NYKÄNEN 1986). These results confirm with those of HÅRDH and HÅRDH (1972) and HÅRDH (1978), who found higher oil content in marjoram grown in a greenhouse than outdoors. On the contrary, HÅRDH (1978) also states that the total amounts of aromatic compounds of marjoram are often higher under the field conditions than in warmer conditions, in greenhouse.

The marketable marjoram yield did not increase and the benefit of the mulching was found in the amount of the oil, only. The warm and humid conditions under the fiber led to disease infection. This phenomenon was earlier reported by many scientists.

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SELOSTUS

Eräiden maustekasvien viljelyteknisiä kokeita.

I Harsokatteen vaikutus basilikan ja meiramin satoon ja haihtuvaan öljyyn.

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Agryl P17 harsokatteen käyttökelpoisuutta tutkittiin vuosina 1984 ja 1985 kylmänarkojen maustekasvien, basilikan (*Ocimum basilicum* L.) ja meiramin (*Origanum majorana* L.), viljelyssä. Kenttäkokeet tehtiin ensimmäisenä koevuonna kolmella paikkakunnalla: Helsingissä (60° 14′ N), Sahalahdella (61° 28′ N) ja Inarissa (69° 04′). Toisena vuonna meiramikoe toistettiin Helsingissä, yliopiston puutarhatieteen laitoksella. Haihtuvien öljyjen pitoisuus määritettiin head space-menetelmällä kaasukromatografisesti.

Harsokatteen käyttö lisäsi basilikasatoa. Ilman katetta viljeltäessä tuore yrttisato oli keskimäärin 54 kg/100 m² ja katteen alla yli kolmekertainen, 191 kg/100 m². Pohjoisimmalla paikkakunnalla, Inarissa, ei saatu juuri lainkaan satoa kummastakaan lajista. Meirami ei hyötynyt katteesta eteläisemmilläkään koepaikoilla. Tuore yrttisato oli 96 kg kattamattomalla ja 80 kg/100 m² katetulla alueella. Harsokatteen alla meiramikasvusto oli saastunut pahoin sienitauteihin.

Haihtuvan öljyn määrä kuivatussa basilikassa oli 0.46—0.93 %. Kate ei vaikuttanut öljypitoisuuteen. Meiramin haihtuvan öljyn määrä oli 1.94—2.55 %. Harsokatteen alla öljyn määrä oli merkitsevästi suurempi kuin ilman katetta viljeltäessä.

Vuorokauden minimilämpötilat olivat katteen alla 0—4°C korkeammat ja maksimilämpötilat 5—5.8°C korkeammat kuin taivasalla.