Výsledky pokusů u máku (*Papaver somniferum*) v ekologické a integrované pěstitelské technologii

Results of trials with poppy seed (*Papaver somniferum*) in organic and integrated production technology.

Perla Kuchtová[1] – Eva Plachká[2] – Miroslava Hájková[2] – Jan Kazda[3] – Petr Dvořák[1]

[1] Katedra rostlinné výroby FAPPZ – Česká zemědělská univerzita v Praze
[2]Výzkumný ústav olejnin Opava – OSEVA PRO s.r.o.
[3] Katedra ochrany rostlin FAPPZ – Česká zemědělská univerzita v Praze

ABSTRACT

The influence of organic and integrated management practices on poppy yield, pests and disease incidence was assessed in field trials in 2009. Crop management based on mineral fertilisers application and chemosynthetic pesticides treatment significantly increased the yield of poppy compared to organic crop protection and organic management of fertilization. Integrated crop protection decreased harmfulness of pests as rate of infectious diseases observed on capsules during harvest.

KEY WORDS poppy seed, seed treatment, yield, pests, diseases

INTRODUCTION

The significant advances made in crop management in the course of the last fifteen years have allowed cultivation of poppy seed in narrow rows without singling, but with mechanized harvesting and extensive use of pesticides. This has not, however, been sufficient to reach yield percentages higher to those of the early 20th century (Kuchtova et al., 2009). The occurrence of pests and diseases makes the organic growing of poppy seed more difficult.

In recent years, the economic importance of certain insects has increased in Central Bohemia. The *Stenocarus ruficornis* (Rotrekl, 2010) is well known to all growers of poppy seed. Adults of this species feeding on young leaves are capable of destroying a whole crop stand. In warm and dry spring conditions, there are no other protections available to farmers than insecticides.

With respect to insect pests causing damages in warm and dry years (Laštůvka, 2009) it was indicated that it is also difficult to protect poppy seed against the *Neoglocianus maculaalba* in the framework of integrated and conventional crop management as well as in organic farming. Treatment against capsule pests has become a standard practice of the poppy cultivation technology. The poppy seed is hypersensitive to infestation fungal diseases (*Pleospora calvescens, Helmintosporium papaveris, Peronospora arborescens, Sclerotinia sclerotiorum etc.*). It is therefore necessary to resort to fungicidal treatment. In the case of narrow row weeding, the slow initial development and formation of the crop cover make it difficult to reduce and maintain the occurrence of weeds at an acceptable level without the use of insecticide. This is the reason why organic poppy seed growers primarily use wide row weeding techniques on stands intended for their own consumption.

The use of agrochemicals sprays on large areas represents a short-sighted solution, especially in light of the increased demands of consumers with respect to “healthier” food products with no residues of pesticides, whose “cocktail” effect on the environment (including human body) is still unknown due to the lack of relevant information. A strong public pressure to reduce the consumption of pesticides and even prohibit the use of certain active substances is indeed growing. The threat or adoption of such drastic restrictions may ultimately lead to seeking environmentally friendly alternative methods and procedures. The objective of our work is to explore alternative plant protection techniques applicable to poppy cultivation in organic and integrated crop production systems.

MATERIALS AND METHODS

Field trials on poppy seed, variety Orfeus, were conducted (1) at two research stations of Czech university of Life Sciences (CULS) Prague in Uhříněves (Prague 10, CULS1) and in Červený Újezd (district Kladno, CULS2), (2) in the Oilseed Research Institute (ORI) of OSEVA Development and Research Ltd. In Opava and (3) on the land of organic farm Tachecí in Budyně nad Ohří (district Litoměřice, TACHECI).

Organic farm is located 165 m above sea level with 555 mm precipitation per year (340 mm of them fall in the vegetation period) and an average annual temperature 8.5°C. Soft soils were chosen for trials, soil type chernozem. Composted manure was used to previous crop.

Split plots arrangement of experiment was used. Each variant had 4 reps, except CULS1, where the lack of certified area enabled only 3 reps. Harvested surface of the parcel was 10 m^2.

Table 1 a: Variants of trial. Organic cultivation technology. Budyně nad Ohří 2009.

	Seed treatment	Sowing	2-4 leaves	20 cm	Hook buds		7 days	End of flowering
Var.	Diseases	*Stenocarus ruficornis*	*Stenocarus ruficornis*	Diseases	*Neoglocianus maculaalba*	Diseases	after 1.and 2. treatment	Pests Diseases
1	Eventus	Azadirachtin[1]	Spruzit	Polyversum		Polyversum	Spruzit	
2	Eventus	Azadirachtin[1]	Spruzit	Polyversum	Sodium silica glass	Polyversum	Spruzit	
3	Eventus	Azadirachtin[1]	Spruzit	Polyversum	Spruzit	Polyversum	Spruzit	
4	Eventus	Azadirachtin[1]	Spruzit	Polyversum	Spruzit	Polyversum	Spruzit	Spruzit
5	Eventus	Azadirachtin[1]	Spruzit	Polyversum		Polyversum	Spruzit	Polyversum
6	Check							

[1] *Azadirachtin pelleted, sowed at the same time with the seeds*

Table 1 b: Variants of trial. Integrated cultivation technology 2009. CULS, ORI.

	Seed treatment		2-4 leaves	20 cm	Hook buds		7 days
Var.	Diseases	Pests	*Stenocarus ruficornis*	Diseases	*Neoglocianus maculaalba*	Diseases	after 1.and 2. treatment
1	E-ventus[1]		Nurelle	Caramba			
2	E-ventus[1]	Chinook			Aqua Vitrin		Aqua Vitrin
3		Cruiser			Sodium silica glass		Sodium silica glass
4	Supresivit[2]		Biscaya		Azadirachtin + Greemax	Prosaro	
5	Polyversum[3]		Biscaya		oil		oil
6	*Check*						

[1] *E-ventus: elimination of pathogens from the surface of the seeds through an electronic seed treatment*
[2] *Polyversum: antifungal agent based on Pythium oligandrum approved for use in organic agriculture, registered for poppy crop during vegetation*
[3] *Supresivit: subsidiary soil agent based on Trichoderma harzianum, approved for use in organic agriculture*

Products of crop protection were tested in the trials on integrated and organic crop management (table 1 a, 1 b). On the area certified and controlled for organic farming the products registered for use in organic farming were tested only. On the others areas we observed the effect of both – native products and synthetic pesticides.

Seeds were treated according to the variants before sowing with E-Ventus, Cruiser, E-ventus in combination with Chinook, Chinook, Supresivit and Polyversum (table 1).

Table 2: Iterventions of growing technologies 2009. Localities: CULS1. CULS2, ORI, TACHECI.

Interventions	CULS1 Uhříněves	CULS2 Červený Újezd	ORI Kylešovice	TACHECI Budyně
Previous crop	peas and beans mixture	winter wheat	spring barley	winter wheat
Ploughing	19. 11. 2008	27. 10. 2008	end of October	end of October
Sowing soil preparation	1. - 4.4. 2009	1. 4. 2009	28. 3. 2009	7. 4. 2009
Sowing	5. 4. 2009 1.8 kg per ha	3. 4. 2009 1.8 kg per ha	8. 4. 2009 1.3 kg per ha	9. 4. 2010 1.8 kg per ha
Variety	Orfeus	Orfeus	Orfeus	Orfeus
Weed management	6.4. Merlin 750 WG 8.5. Lontrel weeding	4.4. Callisto 480 SC 5.5. Targa Super 5 EC	10.4. Merlin 15.5. Callisto+Starane 5.6. Trophy	weeding
Fertilization	14.5. Entec 26 40 kg N per ha	11. 5. Ammonium nitrate 30 kg N per ha	5.6. Ammonium nitrate 60 kg N per ha	Composted manure to preceding crop
Harvest	18.8. 2009	20.8.2009	19.8.2009	20.8.2009

In field trials, focus was placed on the factors relevant to the application of agro technical interventions in organic or integrated cultivation systems: plant health, pests occurrence, disease infestation. In advanced stages of vegetation number of plants, poppy numbers per plant, yield, etc. have been evaluated. Before mechanical harvest capsules were taken from 30 plants per repetition to determine the degree of infestation and analysis of the yield components.

Fertilization and weed management have been adapted to local conditions (table 2).

RESULTS

In our experiment integrated crops produced the highest yield (0.947 t ha^{-1} in average of all variants in the integrated part of the experiment to 0.265 t ha^{-1} in average of all organic variants). The elimination of chemosynthetic pesticides or their compensation by more native products resulted in yield reductions (table 3, 4 a, b, c).

Table 3: Results of organic growing technology. TACHECI

Variant	1	2	3	4	5	6
Plant per m^2 (30.4. 2009, 4-6 young leaves)	80	130	63	70	72	91
Plant per m^2 (19. 8. 2009, harvest)	15	18	20	13	18	17
Plant per m^2 (%, percentage of survivors)	19	14	32	19	24	19
Interspace in crop stand (early growth)	69	70	59	70	66	70
Height of plant (cm, harvest)	110	108	111	113	110	112
Capsules infestation index (diseases)[1]	2.89	2.83	2.81	2.84	2.80	2.83
Percentage of capsules attacked by pests (%)	20.4	15.8	15.8	18.3	17.5	10.0
Yield (t per ha, 8% of monture, hand harvesting)	0.250	0.275	0.290	0.265	0.245	0.263
Percentage of yield to check variant (%)	95	105	110	101	93	100
Percentage of yield to average of all variants of the experiment (%, 0,947 t per ha = 100 %)	26	29	31	28	26	28
TSW (g, thousand grain weight)	0.471	0.469	0.472	0.473	0.473	0.477
Percentage of TSW to check variant (%)	99	98	99	99	99	100

[1] *Determining of the index: (n_1*1+ n_2*2+ n_3*3)/n, where n_1 = capsules with infestation 0-30 % of surface, n_2 = capsules with infestation 31-60 % of surface, n_3 = capsules with infestation 61-100 % of surface, n = the total number of observed capsules*

The differences between yields are even more evident when we realize that the harvest of organic experiment was carried out manually, while the integrated part of experimental fields were harvested mechanically.

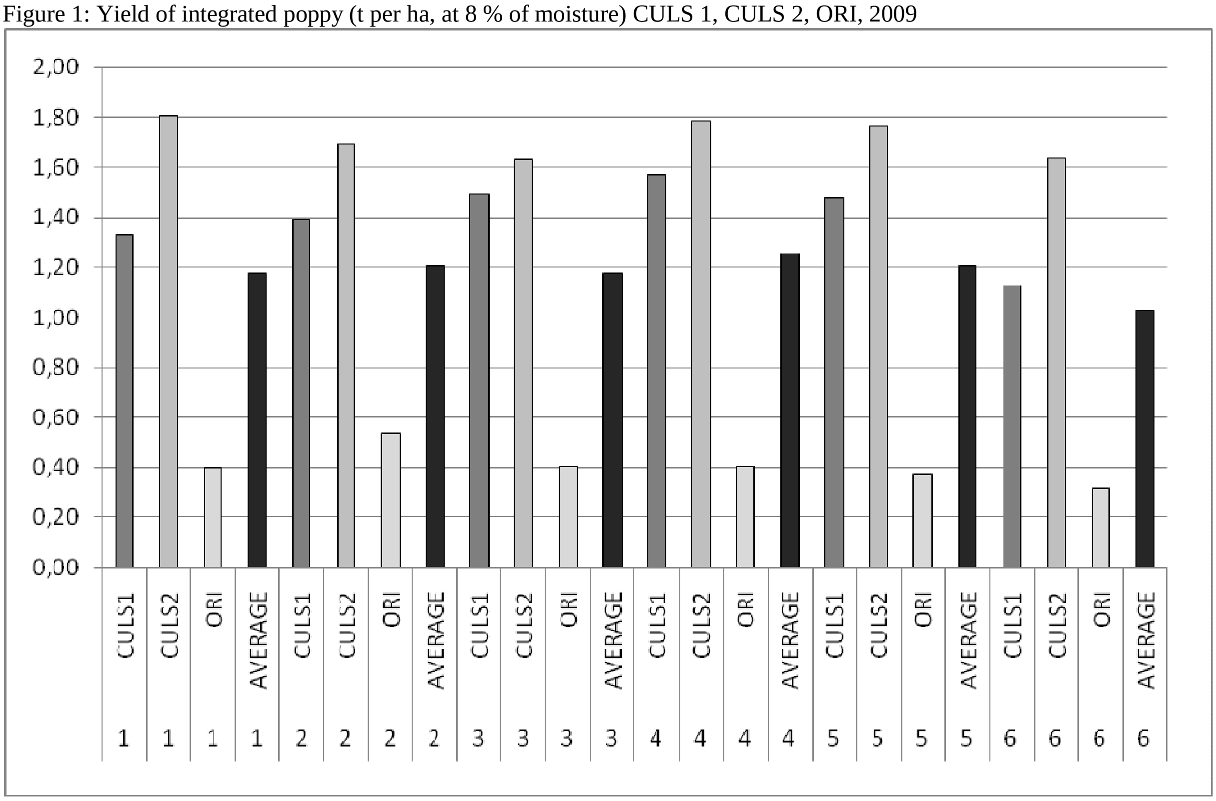
Table 4: Results of integrated growing technology. Average of sites CULS1. CULS2, ORI

Variant	1	2	3	4	5	6
Plant per m^2 (30.4. 2009, 4-6 young leaves)	78.7	154.0	116.0	97.3	85.3	98.0
Plant per m^2 (19. 8. 2009, harvest)	23.3	34.0	32.0	26.0	33.7	27.0
Plant per m^2 (%, percentage of survivors)	36	34	41	33	50	39
Interspaces in crop stand (early growth)	17.7	18.0	13.0	21.7	15.7	24.3
Height of plant (cm, harvest)	124	127	126	126	126	122
Capsules infestation index (diseases)[1]	2.14	2.01	2.22	2.13	2.19	2.17
Percentage of capsules attacked by pests (%)	10.40	6.25	8.90	8.20	5.40	8.75
Yield (t per ha, 8% of moisture)	1.178	1.208	1.175	1.254	1.205	1.028
Percentage of yield to check variant (%)	118	132	120	126	119	100
Percentage of yield to average of all variants of the experiment (%, 0,947 t per ha = 100 %)	124	128	124	133	127	108
TSW (g, thousand grain weight)	0.551	0.565	0.559	0.559	0.554	0.538
Percentage of TSW to check variant (%)	102	105	104	104	103	100

[1] *Determining of the index: (n_1*1+ n_2*2+ n_3*3)/n, where n_1 = capsules with infestation 0-30 % of surface, n_2 = capsules with infestation 31-60 % of surface, n_3 = capsules with infestation 61-100 % of surface, n = the total number of observed capsules*

In experimental organic cultivation the variants 2, 3 and 4 (tab 1 a) were the best ones with the yield of seeds 0.275, 0.290 and 0.265 t ha^{-1}, respectively (tab 3) compared to check untreated variant 6 (tab 3), which gave higher yield than variants 1 and 4 0.263 t ha^{-1} to 0.250 (variant 1) or 0.245 (variant 4).

Figure 1: Yield of integrated poppy (t per ha, at 8 % of moisture) CULS 1, CULS 2, ORI, 2009



Statistical analysis of results recorded by ANOVA (Tuckey HSD, at the 95,0 % confidence level, Statgraphics Plus) showed statistically significant differences between experimental sites as well as in agricultural technology. There were no significant differences between the variants from experimental sites. Differences in yield at different localities (CULS1, CULS2, ORI) can be seen in Figure 1.

Averaging of the results leveled the differences between the localities (Fig 1). In term of average yield, variants 4, 2 and 1 (Tab 1 b) were the best from of all with 1.254, 1.208 and 1.178 t ha-1, respectively. In addition, all selected strategies in integrated cultivation were better in relation to the untreated control, as opposed to organic poppy cultivation.

It was also interesting to compare the number of plants after emergence and at harvest, both within individual experimental sites, and between them according to the method of treatment. For organic variants, the percentage of survivors plants amounted from 15 (variant 1) to 20% (variant 3), while for the variants of integrated cultivation from 33 (variant 4) to 50% (variant 5, Tab 4).

Higher was also the rate of infestation by pests and disease in organic poppy cultivation (Tab 3, 4). Plants in integrated experiments were on average about 10-15 cm higher.

DISCUSSION

Lower yields of the variants in organic experiment can be attributed to particularly strong pressure from the adults of *Stenocarus ruficornis* during germination, when the depletion of plants. Granular Azadirachtin applied to the lines during sowing, did not bring the desired effect. Azadirachtin, gradually releasing the granules, killed many soil macro-organisms (probably microorganisms also), as has been observed, but did not directly affect the *Stenocarus ruficornis*. In the same year, the same pest destroyed the similar trial with organic poppy growing at Uhříněves (CULS1). In a panic response to the growing damage on the experimental plots in Budyně (TACHECÍ) being used row spraying of Spruzit (Tab 1), non-selective product based on natural pyrethrum authorized for use in organic agriculture. (Unfortunately, the Spruzit is unstable and its effect does not last long, as can be monitored during its use in the later stages of growth against pests of capsules, namely against *Neoglocianus maculaalba*.) The compensation effect has been observed, but it could not compensate for loss of income, combined with the failure of plant surface and strong pressure from pests of capsules and plant diseases (namely *Pleospora calvescens*, *Helmintosporium papaveris*, *Peronospora arborescens*) during vegetation. *Botrytis cinerea, Sclerotia sclerotiorum*, mosaic diseases and bacteriosis were also observed. For this state of affairs is not surprising fact higher rate of infestation of organic poppy capsules. The surprise is that was anything harvested. If it is possible to talk about a successful strategy, the variants were the best, where treatment was used against pests of capsules (variants 2, 3 and 4, Tab 1).

In contrast with organic variants, seed treatment (Chinook, Cruiser) and spraying with chemical agents (Nurelle, Biscaya) showed greater effect and less loss of plants in the early stages of culture. The paradox is that good yields were recorded for "green" versions of the integrated poppy growing, where biological agents with fungicidal effect in combination with chemistry were used (variants 4, 5, Tab 2). It was also good combination of electronically and chemically (Chinook) treated seeds, in which during the vegetation water glass (Aqua vitrin) was used for protection against pests and diseases only.

In Opava results were marked by erratic emergence, mainly due to dry in the spring of 2009, which has been almost a month. (This was also the reason for the ineffectiveness of the Merlin and the need of corrective.)

CONCLUSION

Based on our results, it would appear that the poppy cultivation in organic farming is impossible, but it is not. Sure, on the large areas. Poppy cannot grow organically everywhere.

The difficulties are mainly related to poppy cultivation in warm areas, where to begin to occur to a greater extent of thermophilic pests. With climate change and weather patterns diseases pressure change and sometimes increased. The solution is to cultivate poppy seed in the higher, cooler areas.

Weed management is special issue in organic poppy growing, difficult because hand-operated weeding requiring. The only possibility for success is to adapt to farm conditions, trying to modify crop rotation, use unusual methods of weed management (mulching), and use resistant varieties and test the products of crop protection registered for use in organic farming.

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REFERENCES

KUCHTOVÁ, P. – KAZDA, J. - CIHLÁŘ, P., PLACHKÁ, E., HÁJKOVÁ, M., HAVEL, J., DVOŘÁK, P., ŠUPOVÁ, E.: Vliv vybraných přípravků a jejich kombinací na výnos máku (*Papaver somniferum*, L.) In: Prosperující olejniny. 2009, 10.12.2009 ČZU v Praze, 82 – 103 pp

MOTTL, V. Mák – pěstování a ekonomika. In: 9. makový občasník. Praha. Únor 2010. Sborník odborných seminářů. ČZU v Praze, Katedra rostlinné výroby FAPPZ, s.14 – 19

HAVEL, J. – RICHTER, R. – LOŠÁK, T. – BARANYK, P. – ZEHNÁLEK, P. – ZELENÝ, V. – MARKYTÁN, P. Mák setý, ozimý, jarní forma. In: Olejniny. 1. vydání, ProfiPres, Praha 2010, s. 81 – 112

LAŠTŮVKA, Z. Climate Change and Its Possible Influence on teh Ocurrence and Importance of Insect Pests. Pant P/rotect. Sci. Vol. 45, 2009, Special Issue: s. 53 – 62

ROTREKL, J. Krytonosec kořenový (*Stenocarus ruficornis*) na máku a možnosti ochrany. 2010, Výzkumný ústav pícninářský s.r.o. Troubsko, s. 1 - 8 Dostupné z: http://www.vupt.cz/dokumenty/rot_06_10.pdf