# Organic Methods of Vegetation Management and Olive Insect Control

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## Abstract

**During this year the effect of treatments on two types of vegetation management of olive groves (organic production system and conventional system) clearly gave satisfactory results.**

**In an experimental orchard at FTRI the use of mulching straw effectively suppressed weed competition, conserved soil moisture for a long period of time and distinctly increased the productivity of olive trees compared with other treatments. A mulching treatment could replace in the future the use of herbicides (diuron and glyphosate) that have also shown good results in controlling weeds in a conventional production system.**

**To control the key pest of olive crops, alternatives which will provide minor risk to the farmers and the environment are developed. In an organic production system the efficacy of the bio-pesticide *Bacillus thuringiensis* (BT) to control olive moth (*Prays oleae*) was demonstrated.**

**No significant differences were seen between the numbers of olive pests in both cropping systems but after the treatment for controlling olive moth, densities of natural enemies was quite different. In organic production system where BT was used, the number of natural enemies was higher compared with those in conventional system where the broad-spectrum insecticide BI 58 (dimethoat) was applied.**

**Promising results are achieved to control olive fruit fly with natural products combined with cultural practices (early harvest of olive fruits). Bait treatments with protein hydrolysate + natural pyrethrum in organic production system and protein hydrolysate + BI 58 in conventional system have been shown to maintain the olive fruit fly infestation below the economic threshold levels compared with an untreated control.**

**New systems for weed management, the reduction of insect populations with pesticides allowed in organic agriculture, the development of new products, organic olives and oil for the export market are the impacts foreseen in this project.**

## Objectives

(1) To determine the effects of vegetation management on weed control and yield; and
(2) To determine the effects of microbial insecticides to control olive pests.

## IPM Constraints

Many different weed species, including grass, broadleaves, and shrub species, are present in olive orchards in Vlora. They pose a major problem for farmers. During the weed growth period, glyphosate, grazing and plowing can be used to control them. The roles of straw mulch in suppressing weeds and conserving soil moisture are validated.
The absence of alternatives to insecticides in controlling olive moth has left farmers with no option but to use insecticides. The study on a microbial product is expected to provide another option for the farmers in managing *P. oleae*. Results from these studies will be used to develop short and long term integrated management strategies based on different methods of weed and pest control and to reduce the cost of their control.

## Research methods

The experiment was carried out in Shamogjin, the Experimental Station of FTRI in Vlora. The soil of the experimental field was medium in texture and containing 1.34 % organic matter. Randomized complete block experiments were set up in two fields, an organic production system, and one using synthetic pesticides and fertilizers (conventional system). Each treatment plot contained 25 olive trees and was replicated five times. An olive tree row served as a buffer between replications. The area of each treatment was 240 $m^2$. The treatments were as following:
$T_1$ – Cover crop-mixed legume and rye for winter growth.
$T_2$ – Untreated control,
$T_3$ – Non-selective herbicide-glyphosate,
$T_4$ – Selective herbicide diuron,
$T_5$ – Grazing,
$T_6$ – Plowing,
$T_7$ – Straw mulch.

### Weed control

The entire experimental field was tilled in the autumn, except the untreated control plot.

The cover crop treatment was sown during October (2000) with rye and peas at 200 kg/ha and 150 kg/ha, respectively. Data were collected on the vegetative growth of plants from February until May. Grazing with sheep was done during March until May several times.
The non-selective herbicide Roundup (glyphosate 36 %) was applied on 15 May, when most of the weeds present were 15-20 cm higher at the rate 5 l/ha with knapsack sprayer calibrated to deliver 400 l/ha.
The selective herbicide TOTERBANE 50 F (diuron a.i = 600 g/l) was applied after plowing, during the first day of February, at the rate 4 l/ha with a knapsack sprayer calibrated to deliver 800 l/ha.
Plowing was done by tillage, between trees, usage a three wheeled tractor and by hand under the olive trees to the depth of 20 cm. Two hand plowings were done during spring to the depth of 20 cm.
Straw mulch was applied before weeds germinated using wheat straw during January
During January and June weeds were examined for each block. In each treatment two randomised samples were collected. The control points were 0.25 $m^2$ (the measurements 50 x 50). Weeds were classified into three groups: Grasses, broadleaf weeds and shrubs/trees.

**Plant growth, phenology and yield**

Rate of vegetative growth Before each treatment, 200 shoots collected around olive tree canopies were analyzed to determine the progressive linear growth and mean vegetation growth. The measurements were made at the beginning of vegetative growth and two months later. Another measurement will be made at the cessation of vegetative growth.

Flowering and fruit set measurements Flower development was studied by analyzing 7000-8000 flowers from 10 trees/treatment distributed uniformly. The number of inflorescences and numbers of flowers/inflorescence were recorded. Two analyses were performed in July and September, counting the number of fruit set. The number of fruits and the yield for each treatment will be assessed again during the harvest period. Data about biometry of fruits, fruit weight, % of olive oil content in fruits, dry matter and the acidity of olive oil were collected and analyzed during the cultivation season.

Insect and disease control The organic field had five of the above treatments, excluding the two herbicide treatments. BT products were used to control olive moth, compared with a broad- spectrum insecticide BI 58 (dimethoate) widely used in Albania. Treatments were applied only once during the flowering stage. Larval populations were counted one week after treatment in the organic production system as well as in the conventional one. Before and after treatments, 400 inflorescences were analyzed for the presence of olive moth larvae.

Regarding olive fruit fly control, different bait treatments were tested, protein hydrolysate + natural pyrethrum in the organic production system and protein hydrolysate + BI 58 in the conventional system. Olive fruit fly treatments started after the first captures of adults, during the first days of July and were repeated every 15-20 days. An area of 0,5$m^2$ of olive canopy was sprayed. Copper fungicides were used to control the diseases in both cultivation systems. The first treatment was applied in June and the other one in September.

## Results

The dominant weeds in the experimental field were, among the grass species: *Poa sp.* (L.), *Cynodon dactylon* (Pers.), *Bromus sp.* (L.) , *Agrostis sp.* (L.); and *Koeleria gracilis* (L.); for broad leaved species: *Trifolium* sp. (L.), *Soncus sp.* (L.), *Xanthium spinosum* (L.) , *Heliotropium europaeum* (L.), *Arum italicum* (L.) and *Centaurea solstitialis* (L.); for shrubs: *Rubus ulmifolius* (Scot.) and *Dittrichia viscosa* (L.) W. Greuter.

Observations in January showed that were not significant differences between treatments and untreated control (Tables 1-4).

Considering total weeds our experiments indicated that all treatments were significantly different from the untreated control. The treatment with glyphosate provided adequate to excellent control of grasses broad leaves and shrubs (except *Arum italicum* (L.), which was resistant). Glyphosate belongs in the same statistical group with other treatments except control and grazing. Mulching has positive effects in terms of reducing weeds of different species. This practice consistently suppressed grass species growth and good results were also obtained in controlling broadleaf species and shrubs. But because wheat straw was infected with seeds of *Triticum* sp. (L.), *Phalaris* sp. *and Lolium* sp. (L.), which germinated during of spring, there were no significant differences.

Diuron applied after plowing controlled grass weeds and broadleaves well but failed to control the shrubs. Diuron is in the some statistical group with control and grazing, which were different from the other treatments.
Grazing was effective in controlling of some grass and broad leaves weeds species but not good effect against shrubs. This year, plowing provided good control and the differences are significant compared with untreated control and grazing.
Cover crop also showed good effect on weed control and belongs in the same group with grazing and diuron in broadleaf control.

**Table 1. Average and percentage of total weed infestation relative to untreated Control (Each stem is considered a weed)**

| *Treatment* | *Average/m²* | *% of weeds* |
|---|---|---|
| Cover crop | 52.8 | 17.18 |
| Control | 307.2 | 100 |
| Glyphosate | 265.6 | 86.45 |
| Diuron | 93.2 | 30.33 |
| Grazing | 192.4 | 62.63 |
| Plowing | 212.4 | 69.14 |
| Straw mulch | 34.8 | 11.32 |

**Table 2. Average and percentage of grass weed infestation relative to untreated control (Each stem is considered a weed)**

| *Treatment* | *Average/m²* | *% of weeds* |
|---|---|---|
| Cover crop | 5.6 | 3.88 |
| Control | 144 | 100 |
| Glyphosate | 150 | 104.16 |
| Diuron | 26.4 | 18,33 |
| Grazing | 102.4 | 71.11 |
| Plowing | 126.4 | 87.77 |
| Straw mulch | 19.2 | 13.33 |

**Table 3. Average and percentage of shrub weed infestation relative to untreated control (Each stem is considered a weed)**

| *Treatment* | *Average/m²* | *% of weeds* |
|---|---|---|
| Cover crop | 0.8 | 3.84 |
| Control | 20.8 | 100 |
| Glyphosate | 2.8 | 13.46 |
| Diuron | 10 | 48.07 |
| Grazing | 12.8 | 61.53 |
| Plowing | 5.2 | 25 |
| Straw mulch | 2.8 | 13.46 |

**Table 4. Average and percentage of broad leaf weeds infestation relative to untreated control (Each stem is considered a weed)**

| *Treatment* | *Average/m²* | *% of weed* |
|---|---|---|
| Cover crop | 46.4 | 32.58 |
| Control | 142.4 | 100 |
| Glyphosate | 110.8 | 77.80 |
| Diuron | 56.8 | 39.88 |
| Grazing | 78.8 | 55.33 |
| Plowing | 82.8 | 58.14 |
| Straw mulch | 12.8 | 8.98 |

**Table 5. Effect of treatments on olive yield October 2000**

| Treatment | Mean Kg/plant | % relative to control=100 |
|---|---|---|
| Cover crop | 28.8 | 94 |
| Control | 30.7 | 100 |
| Glyphosate | 22.8 | 74 |
| Diuron | 28.4 | 92.5 |
| Grazing | 24.1 | 78.5 |
| Plowing | 35.5 | 115.6 |
| Straw mulch | 38.0 | 124 |

**Table 6. Effect of treatment on weight of olive fruits September 2000**

| Treatment | Mean of treatment | Mean of weight gr | % relative to control=100 |
|---|---|---|---|
| Cover crop | 230.3 | 2.3 | 109 |
| Control | 212.8 | 2.1 | 100 |
| Glyphosate | 229.0 | 2.3 | 109 |
| Diuron | 218.8 | 2.2 | 105 |
| Grazing | 216.9 | 2.2 | 105 |
| Plowing | 238.0 | 2.4 | 114 |
| Straw mulch | 272.0 | 2.7 | 128 |

**Olive fruit yield (Year 2000)**

The treatments applied during year 2000 have shown different effect on yield of olive trees. The results presented in Table 5 show that the olive trees in mulching and plowing treatments produced 24% and 15.6% higher yield than that on untreated control. Similar results were evident also for the mean weight of olive fruits (Table 6). In mulching and plowing treatments the weight was 28 and 14% higher respectively compared with the untreated control. Differences on the weight of fruits were observed between other treatments and untreated control, too. Regarding the biometry of fruits (Table 7) differences on D and d were evident in all treatments respect to the untreated control. Significantly higher those parameters were observed on mulching and diuron treatments.

**Chemical parameters of fruits**

The comparative effect of treatments on olive oil content (%) dry matter and olive oil acidity are shown in Tables 12, 13, 14. In general, all treatments have influenced on chemical parameters of fruits compared with the untreated control. The percentage of olive oil content on fruits and the dry matter were in general 2-5% higher. In mulching and diuron treatment the lowest values of olive oil acidity were observed. Cover crop, glyphosate and plowing treatments had similar values and lower than untreated control.

**Table 7. Data about fruit biometry, October 2000**

| Treatments | Mean of treatment | | % relative to control=100 | |
|---|---|---|---|---|
| | D | d | D | d |
| Cover crop | 2.06 | 1.5 | 114 | 107 |
| Control | 1.8 | 1.4 | 100 | 100 |
| Glyphosate | 2.05 | 1.55 | 113 | 110 |
| Diuron | 2.1 | 1.6 | 116 | 114 |
| Grazing | 2 | 1.5 | 111 | 107 |
| Plowing | 2 | 1.5 | 111 | 107 |
| Straw mulch | 2.4 | 1.6 | 133 | 114 |

**Table 8. Effect of treatments on olive oil accumulation, October 2000**

| Treatment | Mean of treatment | % relative to control=100 |
|---|---|---|
| Cover crop | 19.2 | 103 |
| Control | 18.6 | 100 |
| Glyphosate | 19.5 | 105 |
| Diuron | 19.2 | 103 |
| Grazing | 18.9 | 102 |
| Plowing | 19.2 | 103 |
| Straw mulch | 19.6 | 105 |

**Table 9. Effect of treatments on dry matter, October 2000**

| Treatment | Mean of treatment | % relative to control=100 |
|---|---|---|
| Cover crop | 49.3 | 99.6 |
| Control | 49.5 | 100 |
| Glyphosate | 50.7 | 102.4 |
| Diuron | 50.2 | 101.4 |
| Grazing | 49.6 | 100 |
| Plowing | 50.3 | 101.6 |
| Straw mulch | 51.1 | 103.2 |

**Table 10. Effect of treatments on olive oil acidity, October 2000**

| Treatment | Mean of treatment | % relative to control=100 |
|---|---|---|
| Cover crop | 0.5 | 71 |
| Control | 0.7 | 100 |
| Glyphosate | 0.5 | 71 |
| Diuron | 0.4 | 57 |
| Grazing | 0.6 | 86 |
| Plowing | 0.5 | 71 |
| Straw mulch | 0.4 | 57 |

**Vegetative growth of plants on cover crop and grazing treatments**

The assessment of plant density / $m^2$ and dynamics of vegetative growth was done from February until May. As shown in Table 11, the density of vegetation on cover crops was 600 plants/$m^2$, where the presence of the peas was 8-10%. On grazing treatment on 26 February, the number of plant density was 730 plants/$m^2$. During the period of vegetation, grazing with sheep reduced the number of plants about 50% (26 May) and maintained plants at a very low height, compared with cover crop treatment (Tab 12). Table 15. Mean vegetative growth on cm in cover crop and grazing treatment, Shamogjin 2001

**Table 11. Mean vegetative growth on cm in cover crop and grazing treatment, Shamogjin 2001.**

| Treatment | No of plant | Plant height cm | | | |
|---|---|---|---|---|---|
| | | 26 February | 26 March | 26 April | 26 May |
| **Cover crop** | 600 | 26.8 | 41.4 | 67.4 | 89.7 |
| **Grazing** | 600 | 27.2 | 18.6 | 10.9 | 6.4 |

**Table 12. Number of plants/m$^2$ on cover crop and grazing treatment, Shamogjin 2001**

| Date of observation | Cover crop Plant/m$^2$ | | | Grazing Plant/m$^2$ | | |
|---|---|---|---|---|---|---|
| | Rye | Peas | Total | Rye | Peas | Total |
| 26 February | 551 | 48 | 599 | 730 | - | 730 |
| 26 March | 537 | 49 | 586 | 495 | - | 495 |
| 26 April | 531 | 49 | 580 | 377 | - | 377 |
| 26 May | 531 | 50 | 581 | 383 | - | 383 |

**Vegetative growth**

Vegetative growth was assessed during the most intensive vegetative growth period (May). Results indicated that were significant differences on linear vegetative growth of shoots in all treatments relative to the untreated control (Tab.13 ). The total linear vegetative growth of shoots were higher in the plowing and cover crop treatments. The other treatments produced positive effects on vegetative growth too, but no significant differences were observed on mulching treatments compared with herbicides treatments. For this experiment the measurements of December will be needed to draw a definitive conclusion.

**Table 13. Linear Vegetative Growth of Shoots, Shamogjin, May 2001**

| Treatments | No of shoots observed | Vegetative growth Total cm | Mean of veg. growth cm | % relative to control= 100 |
|---|---|---|---|---|
| Cover crop | 200 | 4040 | 20.2 | 145 |
| Control | 200 | 2783 | 13.9 | 100 |
| Glyphosate | 200 | 3709 | 18.5 | 133 |
| Diuron | 200 | 3541 | 17.7 | 127 |
| Grazing | 200 | 3234 | 16.2 | 116 |
| Plowing | 200 | 4040 | 20.2 | 145 |
| Straw mulch | 200 | 3578 | 17.9 | 129 |

**Flowering, fruit set and harvest yield**

In this experiment, the floral differentiation has been observed during April. Regarding flower development the mean number of flowers/inflorescence exhibited high differences among the treatments. The highest number of flowers was obtained on mulching and plowing treatments. The other treatments have more less the same value but the differences were clear compared with untreated control (Tab 14) Due to the technology applied, during the fruit set stages, a high number of fruits were observed. Data collection on 1 July demonstrated than in the mulching treatment, the fruit set was twice that in the untreated control. Good results were also obtained in the diuron treatment. On the other side there were no significant differences in fruit set between other treatments, but compared with the untreated control the values in those treatments were much higher.

To show the effect of the treatment on the real level and consumption of nitrogen the foliar nutritional analyzes were done three times on a sample of 500 olive leaves collected from each treatment. The analyses will continue until December and the final results will be available next year.

Fruit counting at harvest time and yield weight of each treatment will be needed to draw a definitive conclusion.

**Table 14. Effect of Treatments on Flowering and Fruit – Set, Shamogjin 2001**

| Treatment | Flowering Stage | | | | Fruit – Set | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 01 July | | 10 Sept | | |
| | Nr. of Inflor | Nr. of Flowers | Mean of Flowers/ Inflor. | % control= 100 | Nr. Fruits | % | Nr. Fruits | % | % control= 100 |
| Cover Crops | 2339 | 29325 | 12.2 | 122 | 1411 | 4.8 | 1263 | 4.3 | 148 |
| Untreated | 2475 | 24824 | 10.0 | 100 | 1432 | 5.7 | 733 | 2.9 | 100 |
| Glyphosate | 2220 | 26644 | 12.2 | 122 | 1604 | 6.0 | 1013 | 3.8 | 131 |
| Diuron | 2157 | 24971 | 11.6 | 116 | 1737 | 6.9 | 1131 | 4.5 | 155 |
| Grazing | 1753 | 20618 | 11.8 | 118 | 1721 | 8.3 | 1028 | 5.0 | 172 |
| Plowing | 2291 | 30390 | 13.3 | 133 | 2172 | 7.1 | 1244 | 4.1 | 141 |
| Mulching | 2622 | 39452 | 15.0 | 150 | 4535 | 11.5 | 2343 | 5.9 | 203 |

**Insect and disease control**

Data presented in Table 19 revealed that the insecticide treatments gave good control of olive fruit moth. The larval mortality indicated a non-significant difference between BT and Rogor (B 58). BT produced a mortality rate of 79.95 %, compared with 89.48 % for Rogor, both different from the untreated control. In the field trials the direct effect of Rogor and BT on non-target arthropods was compared. Parasitoids, predators and other arthropods were collected on 0.5 m linen clothes placed beneath the trees treated with insecticides. Fig. 1 shows the mean numbers of beneficial and economically indifferent arthropods found after the treatments. The analyses indicated that there are no significant differences in the number of those arthropods on the trees treated with BT and on untreated trees. In the plots treated with Rogor (BI 58) the number of arthropods were quite different and much lower respect to other treatments.

**Table 15. Effects of BT and BI 58 on olive moth larval populations (Anthophagous generation) (Shamogjin, Vlore 2001)**

| Product | Active ingredient | Dose | Observation before treatment 11.05.01 | | Observation after treatment 18.05.01 | | % mortality |
|---|---|---|---|---|---|---|---|
| | | | A | B | A | B | |
| Dipel PM | BT (16000u l/mg) | 0.1 % | 9.5 | 1 | 2 | 3 | 79.95 % |
| (BI 58) | Dimethoate | 0.2 % | 9.5 | 1 | 1 | 1 | 89.48 % |
| Untreated plots | - | - | 9.5 | 1 | 14.75 | 8 | - |

Note – A. Number of larvae / 100 flowers
B. Number of pupae / 100 flowers

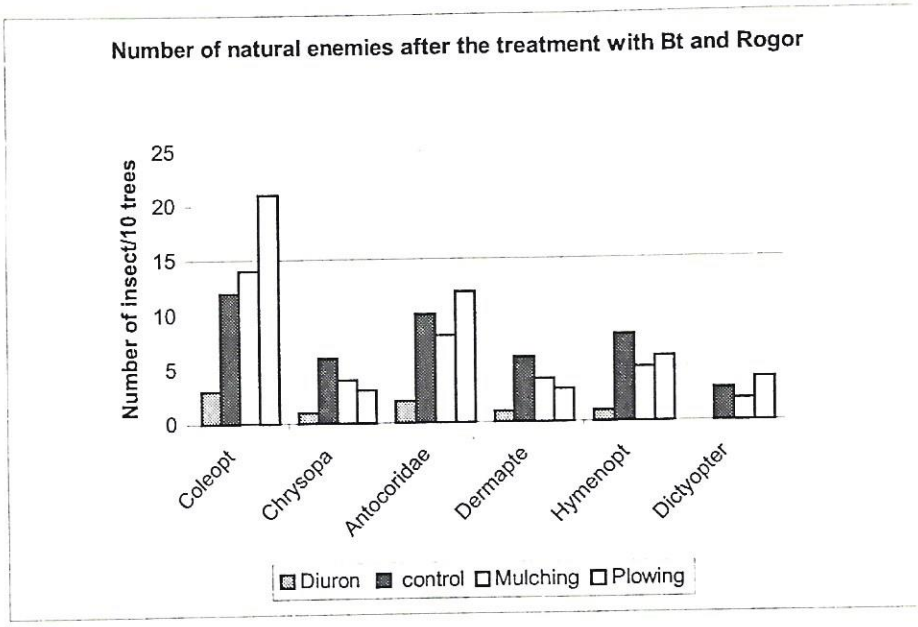


**Fig. 1. Effects of pesticide treatments used against olive moth towards natural enemies and innocuous insects.**

The comparative effect of bait sprays with natural pyrethrum and Rogor against olive fruit fly are shown in Fig. 2. To control olive fruit fly, seven treatments were made in the organic production system and four treatments in the conventional production system. During the period of cultivation no apparent differences were observed between the different bait control programs. The level of infestation remained low and below the economic thresholds level compared with the untreated control. Harvesting of olive fruits during the first decade of October prevented a high level of infestation normally starting after this period; in this way further bait treatments were made unnecessary.

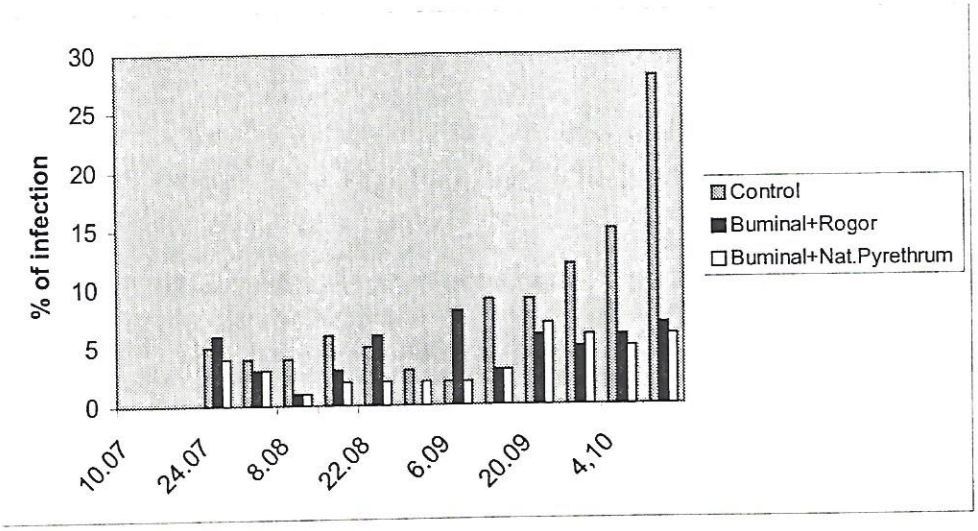


**Fig. 2. Effect of bait-treatments on olive fruit fly control**

Due to the tolerance of Frantoi cultivar to olive leaf spot disease there were no infection from this disease in the experimental area. But, during the period of cultivation a high level of infection from cercospora disease was observed. For that reason, two treatments with copper hydroxide products were done to reduce the infection of this disease.

## Impact

In general, the results indicated that mulching and cover crop application can effectively minimize weed density in olive groves and can promote significantly higher yield. Since straw mulch is abundant and cheap, farmers can use it to obtain greater profits from olive crop cultivation. Application of the non-selective herbicide glyphosate showed good efficacy in weed control in the olive orchard. Use of the selective herbicide diuron reduced the amount of weed germination in olive orchard. Results from these studies allowed to incorporate new practices into the integrated management strategy of weed control for a short and long term.

BT was identified as a product with an acceptable efficacy for olive moth control under field conditions. The bio-pesticide can be considered useful for farmers in the control of one of the key pest on olive crops. It has been shown too that the bait treatment with natural pyrethrum can be viable alternative to chemical insecticide use for controlling of olive fruit fly in organic olive groves. As results the market quality of their olive production will be greatly enhanced by their low insecticide residue level.

## Networking Activities

Participation in two workshops (in Dhermi and Elbasan districts) and in one field day in Vlora with olive growers, extension officers, olive specialists, etc. In those meetings the new techniques of weed control were explained and the possibilities of using new alternatives to control olive moth and olive fruit fly were discussed and demonstrated.
Two papers describing results of IPM CRSP studies on vegetation management and olive pest management in organic groves were presented at the Iterreg II Italy-Albania Workshop, held on September 11-12, at Tirana and Vlora.
In collaboration with Organic Agriculture Association, a brochure was prepared for the management of organic olive groves.

## Project highlights

Straw mulch, which is abundant and cheap, can be used by the farmers to control with efficacy the weed and to increase the olive production, too.
The study identified low impact products for potential use against the key pests of olive crop. Such compounds are very much of interest as they have low toxicity. BT and natural pyrethrum products are a potential alternative to insecticides for managing the olive moth and olive fruit fly, respectively.
In general the technology applied in this study may be practiced in other areas were olive is intensively cultivated.

# Effect of Pruning on Olive Production, Infestation by Black Scale and the Incidence of Olive Knot and Timing of Copper Sprays to Control Leaf Spot and Olive Knot

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## Abstract

**Three levels of pruning severity (non pruned, lightly pruned and heavily pruned) were tested. On heavily pruned treatment the olive trees have a good linear vegetative growth and the number of fruit produced is much higher compared with the non pruned and lightly pruning treatments. On the other side water sensitive papers attached to branches have demonstrated that spray penetration can be improved in trees with more open canopies.**

**Another experiment was carried out applying treatments with copper fungicides every month (October-May) to determine the best moment of spraying to control leaf spot and olive knot. The results of this year show that the treatments during spring (March, April) and autumn (October, November) are more protective. The control strategies developed were sufficient to effectively manage the leaf spot disease.**
**This project will allow greater implementation of a non-chemical tactic and organically-acceptable products into olive IPM.**