EIP-AGRI Focus Group

‘Pests and diseases of the olive tree’

Effect of crop intensification on pests and diseases

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1. Introduction

The levels of intensification of the olive grove cultivation are currently dependent on many factors ranging from farms with low density of plants per hectare, in dry and low or no mechanization, to plantations of hedge or high-density olive groves, usually irrigated and completely mechanized.

The purpose of this minipaper is to analyse how the intensification of the crop can affect the management of olive pests and diseases.

2. What is a superintensive olive grove?

The cultivation of the olive tree has undergone a great transformation in the last forty years, until reaching the high-density systems known nowadays. This process of intensification, mainly based on the increase in the number of trees per hectare, has been the consequence of technological and knowledge advances, mostly caused of the appearance of harvesting machinery, the use of irrigation, especially through irrigation drip techniques, and the knowledge generated relative to the management of tree canopy by specific pruning systems.

This intensification of the olive crop has occurred in several stages:

- First stage, since the 70s to the 90s: the advances resulted in the use of trees with only one trunk, and planting densities of about 400 trees per hectare.

- Second stage, at the end of the 90s: the employment of new varieties of low vigour and the starting of high-density plantation, aimed at the formation of a hedge and in which the harvest is done by specialized machinery with high work performance and low personnel requirements.

Either way, is evident that there has been an increase in terms of intensification of the crop, increased production, higher requirements in inputs, use of irrigation water, as compared to the "traditional" olive grove. However, the aim of this document and in accordance with the huge potential of the future high density olive groves, the term "intensification" or the references to "super intensive" olive groves will be made thinking of an olive grove that we can call "in hedge" or "high density (1.300> trees /ha)".

Some characteristics of this "high density" olive groves are:

- Use of low-vigour, highly productive varieties, adapted to the hedge cultivation system and quality oils.
- Plantation design based on the formation of a hedge, with 3-5 × 1-1.5 m planting pattern.
- Planting densities from 1,600 to 3,300 plants per hectare.
- Generalization of irrigation and soil management systems of minimum tillage or use of plant cover between lines.
- High initial investment in the plantation establishment.
- High requirement of inputs (as fertilizers for example).
- Use of specialized technical advice and service companies (mainly for harvesting and pruning).

Even today, according to some authors, is considered that the global surface of superintensive plantations can reach 500,000 hectares, representing over 4% of almost all 11.5 million hectares of olive groves throughout the planet. Other authors argue that there are approximately 100,000 hectares of high density or "hedge" olive groves in the world, mainly located in Spain (41,000 hectares), Portugal (14,000 hectares), Chile (12,000 hectares) and US (9,500 hectares.). A recent work of the department of agriculture of Andalusia calculates that there are about 55.000 hectares of olive groves in that community with between 600 and 2,000 plants per hectare.

3. Effects of crop intensification on the management of pests and diseases

3.1. Effects of crop intensification on olive pests

Overall, the olive crop intensification based on an increase in the number of plants per hectare and its distribution in the field, the increased use of certain inputs such as fertilizers, phytosanitary products and use of irrigation water, the modification of certain cultivation practices such as pruning and harvesting and the use of specific varieties, can lead to variations in the behaviour of pests and diseases, or at least to substantial changes in their management that should be taken into account.

However, on the other hand, the higher initial investment required and the specialized advice of this cultivation system, may cause some of the problems of pests and diseases to be diminished or better managed than in other systems that show less intensification. In this way, in general, in an intensive olive grove, modern methodologies and techniques are applied to calculate the needs of irrigation water, so that the water used is the minimum necessary to reach maximum production. In the same way, fertilization requirements are optimized, and is possible to adopt methodologies for pest and disease management that optimize the use of phytosanitary products. In the three types of inputs, a reduction in their use has a very favourable effect on the final income statement of the farm. All this is generally achieved with the use of new technologies and the advice of qualified technical personnel.

In this way, based in the cultivation practices in a high-density olive orchard, and differences respect the extensive one, we attempt to determine the effects in the most important pests and diseases of the crop.

To this end, consultations or surveys1 have been carried out to professionals and technicians, experts in the cultivation of olive groves in hedges or who work as researchers or experts in the olive grove in general. So, each of these technicians were duly consulted on the influence in pests and diseases of each olive cultivation practice.

Thus, the effect of the techniques on pests or diseases was estimated with a value scale since
-2 to 6:

Value	**Effect**
-2	lower incidence
0	No change
+2	Increased incidence
+4	High increase incidence
+6	Very high Increased incidence

Based on the results of these surveys the average has been calculated, the numerical and graphical results are reflected below

1 the quantitative consultation was carried out to seven olive technicians

farming practices	*Bactrocera oleae*	*Prays oleae*	*Saissetia oleae*	*Euzophera pinguis*	*Palpita vitrealis*	*Aceria oleae*	**total**
irrigation	1,33	0,67	1,33	0,67	3,00	2,33	**9,33**
fertilization	0,67	-0,67	1,00	0,67	3,67	3,00	**8,33**
plantation density	0,67	1,67	1,67	0,67	3,67	3,00	**11,33**
soil management	1,00	-0,33	0,00	0,00	0,00	0,00	**0,67**
harvest	-1,67	0,00	0,00	0,67	0,00	0,00	**-1,00**
pruning	0,00	0,00	-0,67	1,00	2,00	1,00	**3,33**
average	**0,33**	**0,22**	**0,56**	**0,61**	**2,06**	**1,56**	**5,33**

Table 1. Results of the survey on the practical effects of high-density olive cultivation on pests

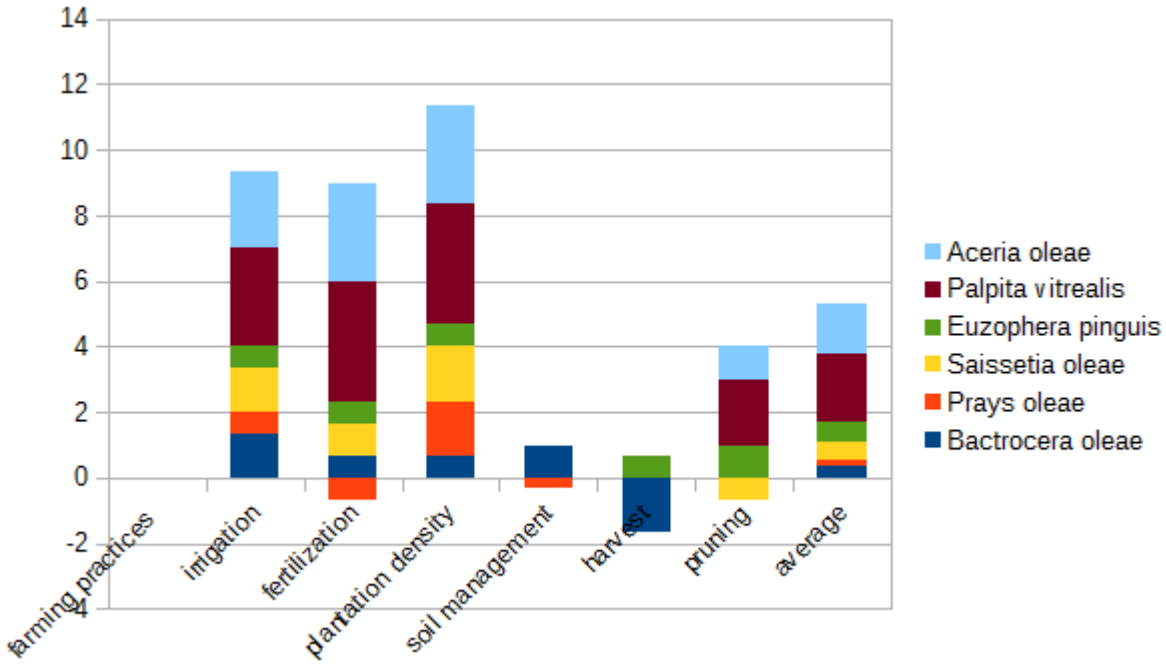

Figure 1. Results of the survey on the practical effects of high-density olive cultivation on pests

In general, we can state that the use of irrigation, increased fertilization, and the absence of tillage could favour the incidence of *Bactrocera oleae*, given that the fruits are more turgid and attractive for the pest and no-till can prevent the possible death of pupae that are found in the ground. Additionally, the intensive olive grove, with fully machined harvest, has the possibility of an early and quick harvest, which in practice is an escape route of this pest, avoiding the possibility of of larvae pest or fungal pathogens development in the fruit.

On the other hand, as in other farming systems, the choice of the variety can exert great influence on the behaviour of the pest. Thus, varieties with smaller fruits or more greenish coloration are less attractive for laying eggs, so plantations of varieties such as arbequina would be less sensitive to fly than plantations with

other varieties considered more sensitive such as, gordal, manzanilla or hojiblanca etc., that are not suitable for high density systems.

Regarding *Prays oleae*, it can be considered that the increase of flowering and production and a correct monitoring of the pest, can compensate possible increases of population levels. In principle, with an adequate management of the crop, there should not be differences regarding the incidence of the pest between a traditional or high-density model. In any case, it would be interesting to study if a higher level of inflorescences or fruits per m3 of tree canopy in the case of the high-density olive plantations would allow a different management of this pest compared to an olive tree with a lower volume of canopy per hectare. In general, most of of the respondents consider that there are no differences in this pest.

In the case of *Saissetia oleae*, higher levels of fertilization and irrigation can cause a greater vigour of the plant and greater predisposition to the attack of the pest, also favoured by a greater vegetative density and lack of aeration.

Euzophera pinguis is one of the pests that can see its potential damage diminished given that in the high-density olive grove there is no damage to the trunk or main branches by pruning or harvesting.

Palpita vitrealis has been one of the important phytosanitary concerns in high density olive groves due to its appearance in the first months or years of life of the plantation and its effects on the buds and young shoots of the plant that are decisive in the formation of the hedge plantation. At present, the change in the systems of formation of the hedge used in the olive grove of high density, where the existence of a dominant apical bud is not so important, the plague has lost importance.

Aceria oleae is possibly one of the pests that being considered secondary for a traditional olive grove, it can become a phytosanitary problem in the case of a high-density olive grove if not properly managed. An excess of fertilization and irrigation, together with a greater availability of young sprouting and leaf mass, may favour the development of this pest that also has few authorized plant protection products.

On the other hand, in case *Palpita unionalis* problems may occur, since an excessive use of plant protection products based on pyrethroids may increase the incidence of *Aceria oleae*.

Regarding the type of pest, on average, *Palpita unionalis* and *Aceria oleae* would be the most influenced by the high-density system, while *Euzophera pinguis*, *Prays oleae* and *Bactrocera oleae* are the pests less affected by the intensification of the crop.

To summarize, the increase in the number of plants per hectare, the use of irrigation and the higher doses of fertilizers, ensure, in that order, the incidence of pests in a high-density olive grove compared to the "traditional" one.

3.2. Effects of crop intensification on olive diseases

farming practices	*Verticillium dahliae*	*Venturia oleaginea*	*Pseudomonas savastanoi pv. savastanoi*	*Pseudocercospora cladosporioides*	*Colletotrichum spp.*	total
irrigation	2,67	1,67	0,00	1,67	1,00	**7,00**
fertilization	2,67	1,67	0,67	1,67	1,00	**7,67**
plantation density	2,00	3,33	1,67	3,33	2,67	**13,00**
soil management	0,00	0,33	0,00	0,67	0,00	**1,00**
harvest	0,67	0,00	4,33	0,00	0,00	**5,00**
pruning	1,67	-0,33	3,33	-0,33	0,33	**4,67**
average	**1,61**	**1,11**	**1,67**	**1,17**	**0,83**	**6,39**

Table 2. Results of the survey on the practical effects of high-density olive cultivation on diseases

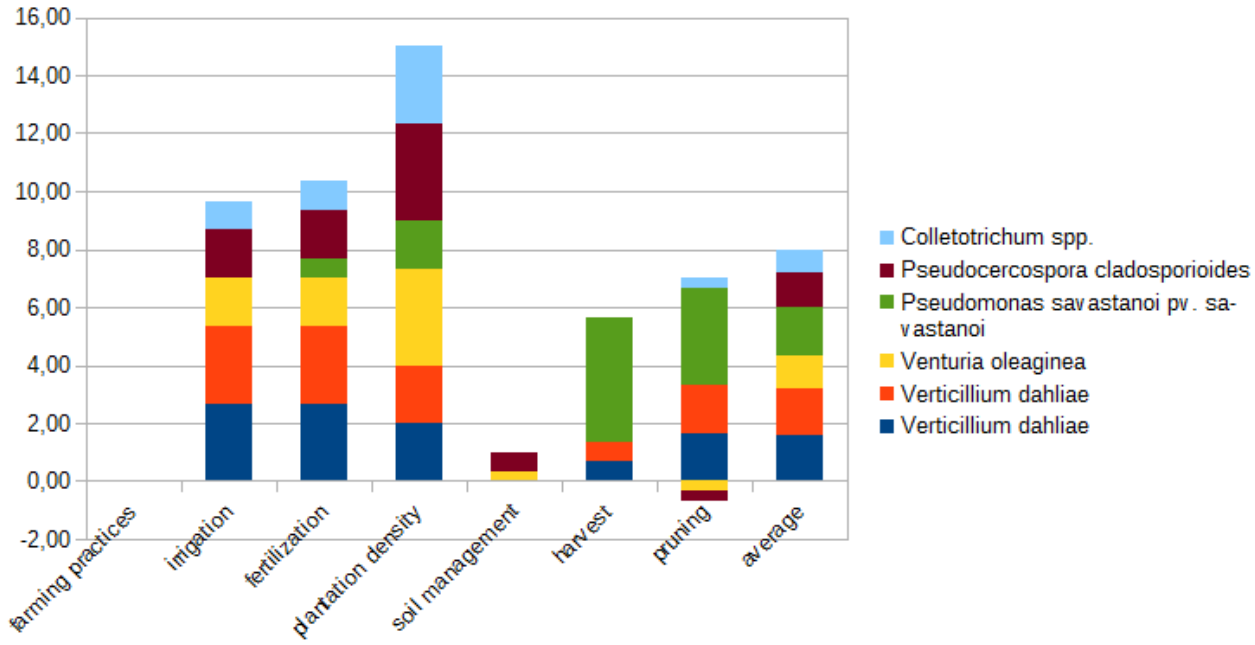

Figure 2. Results of the survey on the practical effects of high-density olive cultivation on diseases

With regard to diseases, *Verticillium dahliae* could increase its incidence if proper management of irrigation and fertilization is not carried out, since conditions of high soil moisture and excess nitrogenous fertilization may favour the disease (Barranco D. et al. 2008). On the other hand, the dispersion effect caused by the fall of leaves to the soil of infected trees is known (Jiménez Díaz, R. M., 2008).

However, the high initial investment required for a high-density plantation, makes the farmer to acquire plant of quality with guarantee of being pathogen-free. Also, the fact that some of the varieties used in this system such as Arbequina that present a certain tolerance to the pathogen (Barranco D. et al, 2008) allows of some margin to handle the disease. This joined with the selection of pathogen-free soils for its establishment may will facilitate its management.

Some agree that *Venturia oleaginea* and *Pseudocercospora cladosporioides* are two diseases that are going to be accentuated in the case of high density olive groves, mainly due to the existence of a hedge that gives rise to a greater volume of plant that if not properly managed may present problems of aeration and to an increase of the humidity in the foliage, which can hinder the control of the disease, especially in areas prone

to olive leaf spot. This fact, however, can be managed through a correct choice of the variety, if suited for intensive plantation, given that there are significant differences in susceptibility to the disease among olive germplasm. This could also be said of *Colletotrichum* spp.

Pseudomonas savastanoi pv. savastanoi is an olive pathogen, which in specific cases can generate greater problems in a high-density olive grove. This is due to the fact that the bacterium needs wounds to penetrate the plant and infect healthy trees. Special attention must therefore be given to mechanized harvesting and monitor the presence of the disease to avoid its dispersion within the plantation by the wounds that can be caused by the harvesting or mechanical pruning machinery.

In summary, and as in the case of pests, the increase in the number of plants per hectare and the formation of the hedge, the greater fertilization and the use of irrigation may favour the development of diseases. On the other hand, in intensive mechanization at pruning and harvest can also increase the risk of developing certain diseases.

4. What are the main challenges in the management of pests and diseases of the intensive olive groves?

Certainly, the high-density olive grove faces important challenges in the phytosanitary management of the crop, which must always be attempted with a sustainability component in mind.

In this way, advances must be made solutions to manage pests and diseases should be environment-friendly and social and consumer demands.

We cannot forget either the effect that climate change will impact on agriculture in general and on olive trees in particular and that will introduce a new variable in the pests and diseases management.

From these general approaches, the management of pests and diseases in the high-density olive grove must face the following challenges:

• Anticipate the effect that climate change will have on the behaviour of pests and diseases in the high-density olive groves and on the possible appearance or expansion of new phytosanitary problems.

• Advance in management systems based on validated, safe and reliable monitoring and tracking procedures for pests and diseases that provide enough information for decision making. In that sense, we must advance in the knowledge of integrated pest control techniques designed and adapted for the intensive olive crop.

• Make a commitment to the use of new technologies that allow a more efficient and intelligent management of pests and diseases, with the main objective of reducing their incidence on the crop with the use of the best control techniques.

• Advance in pest management systems based on less dependence on the use of phytosanitary products and more importantly other management techniques such as biotechnological or cultural, and where the improvement of agricultural biodiversity as a key element for crop sustainability should play an important role.

5. Research gaps and knowledge Needs for the improving management of pests and diseases of the intensive olive groves

Listed the challenges in the management of pests and diseases of the high-density olive grove, it is easy to identify what are the research and development needs in that area.

To know how climate change can affect the behaviour of pests and diseases of the olive grove, its distribution, its degree of effect in productivity or quality of fruit or oil and which can be the escape routes or management strategies in this new scenario.

Advancing systems for monitoring pests and diseases, supported by new technologies such as the internet of things or artificial intelligence that may enable new tools for better decision making.

Learn how new thresholds of available treatments depending on the cultivation system that allow using the appropriate tools depending on the level of pest and other productive or economic variables of the crop.

Develop new phytosanitary tools for the management of pests and diseases, based on biotechnology or cultural techniques that reduce the dependence on the use of synthetic plant protection products. In that line, it is very important to know the role that biodiversity can play to enhance biological control of olive pests.

5. Ideas for Operational Groups

The operational groups can play a very important role to test in the field advances in the management of the intensive olive grove that increase their sustainability. in that sense, fieldwork related to the following subjects are very important:

- Development of new methodologies for monitoring pests and diseases
- Establishment of treatment thresholds for intensive culture systems
- Use of new technologies that improve the monitoring of pests and the crop itself
- Application of new techniques based on big data and artificial intelligence for help in decision making
- Increase of the agricultural and biological diversity of farms as an element for the improvement of sustainability and its effect on the management of pests and diseases

6. References

Barranco D. et al. 2008 *El Cultivo del Olivo* . Jiménez Díaz, R.M. 2008. *Impactos potenciales del cambio climático sobre las enfermedades de los cultivos. Phytoma España 203: 64-69*