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OUTLOOK ON PROTECTED CULTIVATION IN THE MEDITERRANEAN REGION

W.O. BAUDOIN

Horticultural Crops Group. Crop and Grassland Service Plant Production and Protection Division FAO
Rome, Italy

Abstract: This introductory paper gives an overview of the evolution of greenhouse crop production the Mediterranean region during the last 15 years. Besides statistical data on area development, other aspects are covered with regard to crops, varieties, and productivity. Different technological subjects are also reviewed relating to greenhouse design, covering materials, ventilation, heating and cooling. Adequate cultivation practices in conjunction with coordinated climate control and the use of improved varieties are described as essential components of Integrated Vegetable Production and Protection Management (IPP), which includes Integrated Pest Management (IPM). The importance of quality is emphasized in the context of trade liberalization and increased competition on home and export markets. The threat of environmental pollution caused by the use of large amounts of PE is also mentioned. The paper concludes that the Mediterranean region has considerable potential for future expansion and improvement of greenhouse crop production. However, it is suggested that careful attention be paid in the selection of the most favorable sites.

INTRODUCTION

It has not been an easy task to summarize the different facets of such broad a subject, which relates to several specialized fields. I should therefore like to immediately thank the many colleagues who have assisted in compiling the information needed for this paper. When talking about the Mediterranean area, we restrict ourselves to those countries, which border upon the Mediterranean Sea. (Figure 1).

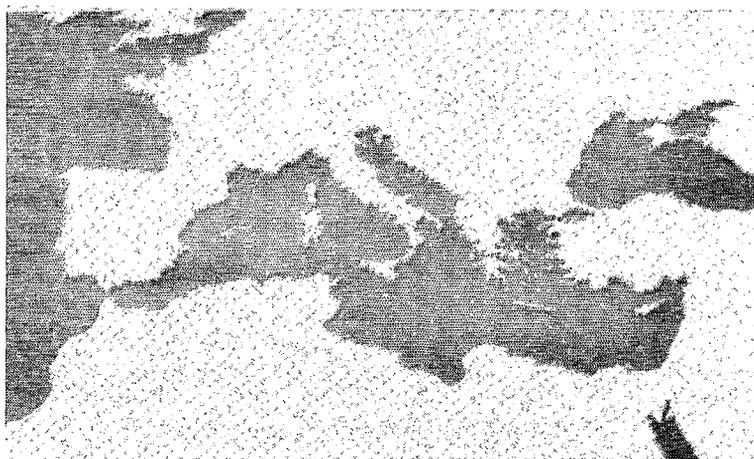


Figure 1. Mediterranean Sea

AREA DEVELOPMENT

In 1950 protected cultivation in the Mediterranean region was almost non-existent whereas it now covers some 396,000 hectares. In terms of global acreage, the use of plastic mulch is still largely predominant accounting for almost 50% of the total, greenhouses represent 26% and low tunnels 23%.

In the early 80s, the situation was quite different as can be seen from the information published in the FAO book on "Protected Cultivation in the Mediterranean Climate". In 1985, there were 66.000 hectares of greenhouses and 57.000 of low tunnels. By 1995 these figures had reached 103.000 and 91.000 respectively, which means an increase of 56 and 59% over a period of 10 years.

Several authors have documented that it was the oil crisis (1973) and the advent of polyethylene films which prompted the breakthrough of plasticulture in the Mediterranean region. Another important factor which boosted out-of-season production was the fact that with the raising standard of living local demand for fresh vegetables increased and people were prepared to pay higher prices (two dollars per kilo of tomato in March/April 1972 in Tunis). The prices have now dropped to US \$ 0.4-0.7 per hg for the same product during the same period.

TYPES OF COVERS

Plastic mulch

Plastic mulch is definitely the type of protection which has had a more rapid expansion with at present some 192 000 ha. Spain, France and Italy can account for 85% of the area covered with mulch.

The main reasons for using plastic mulch are:

- control of weeds;
- increase of soil temperature for earliness;
- soil moisture conservation and reduction of irrigation requirements;
- reduction of air humidity inside the greenhouse.

Plastic mulch is mainly used on strawberry, melon, watermelon, asparagus, tomato and cucumber. The most commonly used material is transparent, black or red/brown PE film. The utilisation of white film is becoming more common as it reduces soil temperature, particularly for summer cultivation, and provides for increased light reflection during the winter months. To combine the advantages of both black and white plastic mulch growers are adopting the co-extruded double layer black-white film. This film is also commonly used as walk-on film in the interrow spacing.

The thickness of film used varies from 30 to 80 microns. More recently, with the adoption of linear low density PE (LLDPE) the thickness has been reduced to 20-25 and even 12 micron.

Another application of transparent polyethylene film is for soil disinfection by solarisation. This technology is described in FAO's technical paper no 109.

Special gas-tight film with high heat transmission properties is used for soil treatment with methylbromide.

Low tunnels

Low tunnels are usually applied as a temporary protection to speed up plant growth in the early stages, but in some countries and on selected crops this protection remains throughout the growing cycle (lettuce, carrots). Over the years, farm machinery has been developed for automated mounting of hoops and plastic covers. The linear thermic polyethylene film of 30 to 80 micron thickness or 120 to 150 micron for pluriannual use is commonly adopted.

In 1995, low tunnels covered some 91.000 ha representing 23% of protected cultivation. Leading countries are Spain with 17.000 ha, Italy with 16.000 ha and Turkey with 15.000 ha, followed by Egypt, France, Algeria and Tunisia.

In the Mediterranean region, low tunnels are frequently used to cover strawberry, watermelon, tomato, cucumber, squash and asparagus.

Floating Mulch

Floating mulch is directly applied on top of the crop. Material used is either perforated either micro-perforated: 10 000 perforations per square metre, or macro-perforated: 200 to 400 persquare metre polyethylene film (LDPD 40-70 μ) or non-woven fabric (weighing 17g/m²), or a combination of both. The purpose is to protect the crop (potato, lettuce, cabbage, and cauliflower) against late frosts, gain in earliness, and defend against insect damage (aphids, caterpillars, etc.).

Greenhouses

Plastic and glass covered walk-in structures are considered greenhouses. The total area in 1991 was estimated at 103 395 hectares, with Spain and Italy on top of the list, with 28.500 and 24.300 hectares respectively, followed by Turkey with some 10.800 hectares.

The use of normal, long life or thermic PE of 180-200 micron still predominates, but there is a rapid evolution in this field, which will certainly be mentioned by several speakers. Co-extruded three-layer films are gaining in popularity due to the advantages they offer with regard to increased light transmissivity, better light quality (diffused light and photo-selective films) and better thermic properties.

For those who want to know the latest news about plastics, it is worthwhile mentioning that the next International Symposium on Plastics in Agriculture will take place in Israel from 9 to 15 March 1997.

Besides plastic covers, there are still also some 8 000 hectares of greenhouses covered with glass, mainly in France, Italy and Turkey as well as some old structures in Albania.

Finally, rigid plastic materials are still popular, chiefly in Italy with some 2 000 hectares (main material is PMMA: Polymethylmethacrylate), and also in Israel. Float glass is being adopted in southern France in view of its resistance to hail damage.

However, for some reason, perhaps economic, glass, which entails a long term investment, is expanding towards the south whereas the use of plastic covers, more commonly used in short term investments, is moving up to the north. The thermic properties of plastic film have improved over the years. Plastic film allows also to reduce the roof structure, thereby lowering the investment and increasing the luminosity inside the Greenhouse which is of critical importance to the northern regions particularly for autumn and winter crop production.

Disposal of plastic material

One of the main concerns at the end of this century is the management of waste material. Unfortunately in many production areas, the accumulation of plastic film is causing a threat to the environment. Most of the material is not yet biodegradable and disposal requires a special intervention which has its own cost.. Manufacturers are seriously preoccupied since the cost of disposal will soon have to be included in the sales price. Deplorably, plastic films are often dumped in isolated places. However this should no longer be permitted and other solutions are to be investigated depending on the country and the economic environment:

(i) Use of long life plastics in order to reduce the amount to be disposed. However several long-life plastic films are thicker. In this case, the real saving in the amount of plastic to be disposed, if considered by weight, might not be significantly less as compared to short life plastic.

(ii) Plastic films used in horticulture are mostly based on LDPE (low-density polyethylene, formed by a succession of carbon and hydrogen atoms) and are recyclable. Recycling into plastic film or other plastic items e.g. tools, pipes, watering cans and toys is possible. However one of the biggest constraints for recycling is the nature and percentage of contamination present in plastic waste. Furthermore, the higher the degradation of the film (e.g. UV degradation) the lower the quality of the recycled material. Plastic films for recycling need to be clean and free of pesticide residues.

(iii) Energy generation: Polyethelene film is a good source of energy. LDPE has a caloric value of 46 Mj/kg as compared to 44Mj/kg for oil. Eventually it could be used to generate electricity or to heat the greenhouses during winter. However the waste product may need to be sorted out and a special type of incinerator is required.

In some countries the same plastic film extruders have established a recycling unit to recycle the plastic films of it's customers. (e.g. Hyplast Belgium) .

CROPS

With the development of the greenhouse sector in the Mediterranean region, there was a progressive introduction of crop varieties, in response to market demand, which were not traditionally grown in the region,

Some interesting varieties include: Long shaped cucumbers, the midi cucumbers (25 cm), the blocky sweet peppers, traditionally produced in the Netherlands The muskmelon (Charentais type) from France, the Galia-type from Israel

Cherry cocktail and baby tomatoes from the USA and, more recently, the cluster or truss tomatoes from Italy as well as pear shaped (Roma type) tomatoes for the fresh market during winter time which are traditionally grown as summer tomato for processing.

As a result of trade liberalization, growers are also investigating diversification options to substitute the traditional solanaceae and cucurbitaceae with new crops such as asparagus, snow peas, baby carrots etc., as well as ornamental crops and fruits. However, vegetables remain largely predominant and, with the increasing demand for ready-for-use mixed salad, there is an emerging market for all types of leafy vegetables such as batavia lettuce, corn lettuce, diverse chicory vegetables, rocket-type salads, etc.

Varieties

Besides continuous adaptation of varieties for multiple disease resistance, there are other criteria, which have prompted the growers to look for new varieties:

- prolonged shelf life of tomatoes to allow for distant shipping, linked to the “rin”- gene (e.g. Hybrids Daniella, Argenta, Madrilla, Felicia and others).

However, the consumers rapidly realized that these tomatoes were less tasty and therefore the price dropped, creating new openings for better tasting, mid-life tomatoes and, more recently, the truss tomatoes (e.g. Pachino-H from Sicily).

- The production of Galia-type melon expanded as a consequence of vitescence in the muskmelon, and for the same reason, the Vauclusian-type (Delton variety and other similar varieties are now gaining in popularity in the international market).

Yields

Crop yields are continuously increasing. For example, ten years ago, good tomato yields reached 8-12 kg/m² (between November and June) in unheated greenhouses, whereas now in 1995, yields of 25-30 kg/m² in heated greenhouses are common, which means an increase of 100%. It is astonishing to learn that tomato yields of up to 60 to 65 kg/m² are being obtained with a single crop in the Netherlands spread over a harvesting period of 9 months, corresponding to an 11 month growing cycle in the greenhouse. With tomatoes the potential yield level can even reach 80 to 85 kg/m² in one long cycle. This is a clear indication of the tremendous yield potential of vegetable crop species.

Cropping pattern

In the past, growers adopted short growing cycles, aiming at two crops a year, e.g. tomato crop up to 6-8 trusses followed by a one wave yield of muskmelon, or a cucumber crop followed by a tomato crop.

The tendency, at least for tomato, is that growers favor a long growing cycle with up to 20-30 trusses, with the adoption of special plant training systems (twin rows and “v” cropping of tomato, or horizontal trellising and pruning on two branches) to take full advantage of the space available in the greenhouse.

High quality seedling production providing for rooted transplants in rockwool blocks, or other substrates according to availability, is becoming widespread.

Greenhouse occupation index

The greenhouse occupation index represents the number of days per year the greenhouse is effectively occupied. Through better greenhouse design, cultivation practices and technology, the greenhouse occupation index has moved from 0.50-0.60 of 15 years ago, to 0.88-0.90 of today, which is getting close to the current prevailing index of 0.92 and 0.95 of Belgium and the Netherlands.

Greenhouse crop index

Represents the number of successive crops per year cultivated in the greenhouses. This value is coming down, in view of better climate control, particularly ventilation and cooling, to allow for a longer growing season. From a previous average of two it is now being reduced to 1.5 and in some cases to one. In fact, as a consequence of better crop management and improved varieties, growers tend to maintain a single crop over an extended period, which may reach 8 to 10 months.

TECHNOLOGY DEVELOPMENT

Greenhouse design

Protected cultivation in the Mediterranean was initiated by small growers, mainly in Crete, Greece and Spain, who designed simple artisanal structures to extend the growing season or to gain earliness. However, these low cost simple structures had gradually to be abandoned due to poor climate control, which was responsible for poor quality products and low yields. Subsequently, industrial round-arched monospan tunnel type greenhouses of 5 to 9 metres width became very popular since film fixing was relatively easy. Growers gradually adopted multispan greenhouses of 20-25 m width to reduce border effects and to improve ventilation with side and ridge openings. The height of the greenhouses at gable increased from 2-3 m to 4-4.5 m and is still going up, gutter height increased from 2 m to 2.8m

Covering Materials

Research continues in this field, and the plastic industry is always proposing new materials with better mechanical resistance or improved thermic properties more appropriate light transmission (more attention is given to the quality of the light in terms of diffused light and PAR light)

I will not go into details as I realize that several authors will cover this subject in this document much better than I could.

Fertigation

The application of liquid fertilizer has expanded rapidly in conjunction with micro-irrigation. The equipment used varies from simple Venturi type fertilizer injectors and hydraulic pumps to more sophisticated computer-controlled nutrient injection and distribution systems.

To save on fertilizer applications some countries have adopted the recycling of drainage water (up to 30% of fertilizers can be reused) However, the principle remains the same and allows to customize the plant nutrient applications to the plant requirements at different growth stages and to save on fertilizer applications.

Fertigation is also being used as a means to have an impact on the quality of the produce. The composition and total salt content of the nutritive solution highly affects the quality and taste of tomatoes.

Hydroponics and Substrate cultivation

In certain circumstances, where soil or water problems prevail (soil-borne diseases or salinity problems), substrate or hydroponic culture has been adopted. Of particular interest in this field is the use of polyurethane mats (PUR) which do not pose the problem of disposal and can be re-used for a period of 10 years. While PU and rockwool are commonly employed in the north, Mediterranean countries tend to use other locally available substrates such as coarse sand in Spain and Tunisia, pozzolana in France and Italy, perlite in Greece and Morocco.

CLIMATE CONTROL

From simple tunnels without ventilation, growers have realized that even in the mild Mediterranean environment, climate control is a must for sustained production and high quality produce.

However, in almost all cases, climate control is not yet practiced as a coordinated approach of different parameters, but is still operated as an independent intervention with regard to certain threshold levels without linking them one to another.

Typical examples are:

Ventilation based on temperature, without taking into consideration light and humidity in the greenhouses. However, the higher the light level the higher may be the optimum and maximum temperature in the greenhouse; excessive ventilation may cause saturation deficit thereby reducing stomatic activity and plant growth.

Heating up to a minimum night temperature level, without taking into account diurnal light and temperature levels.

Ventilation

Considerable progress has been made during recent years in conjunction with new greenhouse designs, allowing for side and roof top ventilation. Total greenhouse openings are calculated as a percentage of the floor area to allow for a sufficient number of air renewals per unit of time.

The height of modern greenhouses is being increased and only ridge ventilation is applied according to the height of the greenhouse (e.g. 25% for gable height of 3-3.2 m; 18 to 20% for 4 m and 14-16% for 4.5m). Ventilation openings are calculated to optimise the chimney effect and allow for the desired ventilation rate. However, there is still scope for improvement with regard to the automation of the system in order to link ventilation activation to the temperature or humidity conditions prevailing inside the greenhouse.

Heating

In 1980 there were almost no heated greenhouses in the Mediterranean region; simple heating devices were used essentially for frost protection. Nowadays heating has become fundamental for temperature and humidity control, both essential for sustained production of high quality. Unfortunately, the limiting factor is often the cost of the energy source (gas, petrol, and coal) and the low efficiency of the burners. There is considerable scope for improvement in both the heater technology and the source of energy.

Cooling

Under most conditions, shading and pad cooling systems have proven to be inefficient or uneconomical. In recent years the adiabatic cooling systems, based on the use of high pressure foggers, seem to have a better future. It is being used to extend the growing season during the warmer months of late spring and summer. However, technological improvements are still required to reduce the cost and to avoid clogging of the system.

Quality of Diversification

Very soon, if it is not already the case, the target markets, especially those for export of Mediterranean grown vegetables, will be saturated. It is anticipated that quality will make the difference, as consumers will become more and more demanding.

Quality criteria will not only refer to shape and color, but taste will also be decisive. Strict control over pesticide residues will also be an essential requirement. Some parameters are however difficult to quantify and qualify and their appraisal requires specialized training, methodology and equipment. At the Technical University of Munich, under the guidance of Prof. Dr W.H. Schnitzler, standards, technology and working methodology are being investigated with

a view to establishing guidelines for the appraisal and control of quality parameters of vegetable commodities.

Consumers will look for named and labeled tomatoes and not just for any tomato. Some countries and companies already know the rules of this game. e.g. Tunisia with its trademark PERLA, certifying constant grading, quality and taste (average prices for quality certified tomatoes have gone up over the last four years from 0.7 dollars per kg to 1.15 dollar per kg).

INTEGRATED VEGETABLE PRODUCTION AND PROTECTION MANAGEMENT (IPP)

The green revolution placed a lot of emphasis on the intensive use of agricultural inputs and on the need to combat any possible pest or disease with extensive use of pesticides.

Over the last five years, the use of pesticides has come down from 16kg of a.m./ha/year to 10-12 kg as a consequence of progress in Integrated Pest Management (IPM). Environmentally conscious growers' associations have been established who respect strict rules with regard to the selective use or zero use of pesticides (MBT in Belgium, Migro Sano in Switzerland).

However, additional progress can still be made in further reducing the use of pesticides by placing more emphasis on other non-chemical means of controlling the occurrence of pests and diseases, *inter alia*, starting with disease resistant varieties and seeking all the advantages of better climate control and cultivation practices.

FAO is conducting a survey on the current know-how in the field of IPP under greenhouses in the Mediterranean countries and Dr Papisolomontos will present a paper in this volume on the methodology used for data recording which should lead to a computerized information exchange system.

CONCLUSION

The future development perspective of protected cultivation in the Mediterranean region looks promising in view of the environmental advantages, as compared to more northern regions. However, the success of greenhouse production in the Mediterranean region will greatly depend on the quick response of growers to new technological progress and consumer requirements. Indeed, in an open market competition, efficiency, progress and quality will be fundamental for the survival of this type of industry. Special attention will have to be paid to the adaptation of new species and varieties, reduction in pesticide use, high standards of quality and grading. Within the countries, comparative advantages should be sought by identifying the most suitable pedo-climatic zones with the most favorable growing conditions for protected cultivation (well-drained light soils, 200 cal/day, average temperature of the coldest month above 70 C, 1100-1500 sunshine hours during the six winter months. From a technological point of view the adoption of low-cost energy saving heating systems will play an essential role in the economic viability of winter crop production in the Mediterranean region.

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