CAJA RURAL
PROVINCIAL DE ALMERIA

CLIMATE UNDER PLASTIC IN THE ALMERIA AREA.

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Abstract

The greenhouse industry is expanding rapidly in Southern European countries. Due to the favorable meteorological conditions, low cost unheated greenhouses can be used to cultivate crops from late summer through to the end of the spring season.

Very little information is available on the microclimate that exist under these simple plastic covered structures. The paper describes the wind, temperature and humidity fluctuationes, radiation and evaporation that characterizes the greenhouse enviroment in the Almeria area.

1.- Introduction

During the past 20 years the area of greenhouse structures in Spain has spread out along the Mediterranean Coast. The Campo de Dalías in Almería shows the biggest concentration. It is estimated that about 10.000 Hectars of greenhouses are located in this area.

Low cost structures made with pole timber and steel wires are used for raising plants from September through June. Summer months are too hot to provide an adequate environment for plant growth. Mild winters free of snowfall make it possible to utilize such kinds of simple greenhouses. A single layer of polyethylene is attached between two nets of galvanized steel wires and anchored to the ground. Rigid members have been partially substituted by tensile supports.

Next, the climate that exists under one of these greenhouses will be described. Data was recorded at the Estación Experimental Las Palmerillas, Caja Rural de Almeria, from October 1982 to September 1983. Temperatures were measured by R T D sensors, solar radiation was registered by two Eppleys black and white pyranometers, wind speed by a three cup anemometer and evaporation was measured daily on two standardized Class A evaporation tanks.

2.- Meteorological data

2.1 Wind

Wind is the first factor to be considered when analizing the Almeria climate. Virtually no crop con be grown without sometype of windbreak. Besides increasing temperature, greenhouses protect plants against wind damage.

Table I shows the monthly average and peak speed during the period October 1982-September 1983. Prevailing winds come from west-south west or east. Maximum speed recorded for thar period was 25 m/seg. Strong gusts are common in the area.

Table 1.Monthly average and peak wind speed.
October 1982-Septemner 1983.

MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AVERAGE SPEED	205,5	228,4	215,6	197,9	190,5	225,6	421,8	259,5	214,8	232,3	209,3	185,7
PEAK SPEED	20	24	22,7	18	17	25	22	19,1	16,2	15,8	16,8	18,1

AVERAGE SPEED - Km/day

PEAK SPEED - m/s.

2.2. Temperature

The air temperature inside an unheated greenhouse is higher during the day but similar to the outside temperature at night. Since there is very little air movement inside a greenhouse, the slow replacement of warm solar heated internal air by fresher external air is responsible for the day time increase of temperature. The mousetrap theory is the second possible factor that would explain the temperature rise. Very little data is available on the internal and external net radiation in the Almeria area. Research is being carried out on this subject, but it seems that in many cases the net radiation inside the greenhouse is less than outside. The so-called greenhouse effect needs to be better evaluated.

Figure 1 shows the average temperature fluctuation throughout the period October 1982-September 1983.

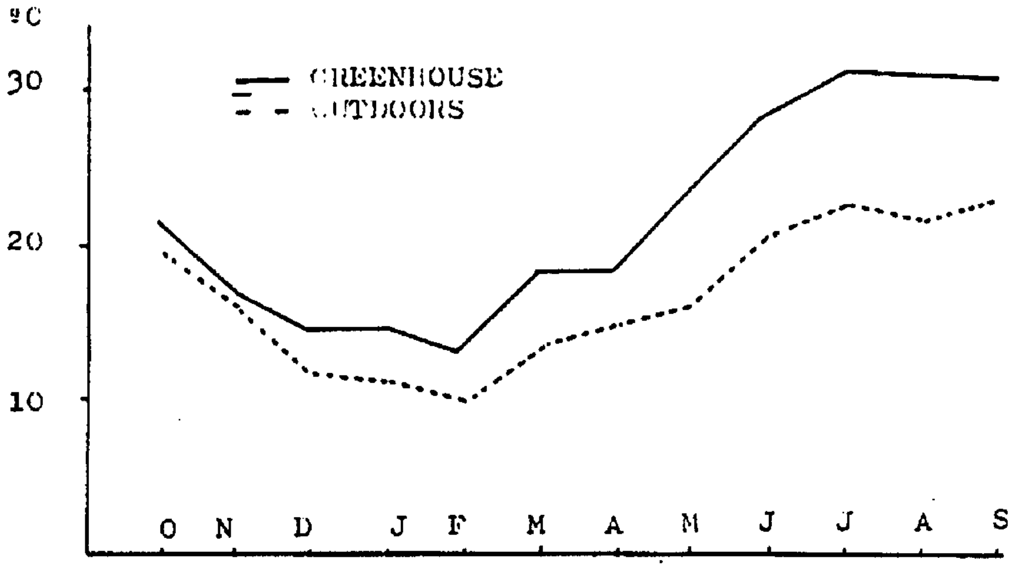

Fig. 1,- Greenhouse and autdoors temperature fluctuations. October 1982-September 1983.There [illegible] not any crop on the greenhouse from June to September.

Neither air nor soil temperature are the optimals for plant growth. During the coldest months growth is retarded, since average minimum temperatures are between 7 and 9 ºC. In February 1983 the lowest temperature of the year 2.8 ºC was recorded inside our greenhouses (Table 2).

On the other hand crops can also suffer from too much heat. Ventilation is needed even in December when maximum temperatures reach 30 ºC. Summer months are not suitable for growing plants under plastic. It is common to register more than 40 ºC from June to September. Temperatures of 40 ºC are frequently registered during the summer months.

Table 2.Greenhouse and outdoors maximum and minimum temperatures.Greenhouse without plants from June to September.

MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
GREENHOUSE MAX.AVERAGE	32,3	25,9	25,1	25,3	23	28,7	28,2	31,8	37,1	41,2	39,3	39,5
GREENHOUSE MIN.AVERAGE	15,0	12,0	9,1	8,7	7,5	10,5	12	15,9	20,3	22,6	23,4	23,5
OUTDOORS MAX.AVERAGE	22,9	18,6	14,4	14,1	12,7	17,5	19,1	20,8	25,4	28	28,7	27,4
OUTDOORS MIN.AVERAGE	16,4	13,8	9,7	8,6	7,3	9,9	10,8	12,0	16,7	18,1	17,8	19

Figure 2 shows the diurnal variation inside the greenhouse and outdoor air temperature and relative humidity during a sunny winter day. It can be seen that at night, indoor and open air temperatures run close together. In fact unheated greenhouse temperatures can be lower than the air outside. This is specially true on clear nights when most thermal radiation losses take place. Nighttime transpiration requires energy, which is partially released to the greenhouse air through condensation. As far as we know, no evaluation has been made in Almeria on the effect of nighttime transpiration and condensation on the internal temperature.

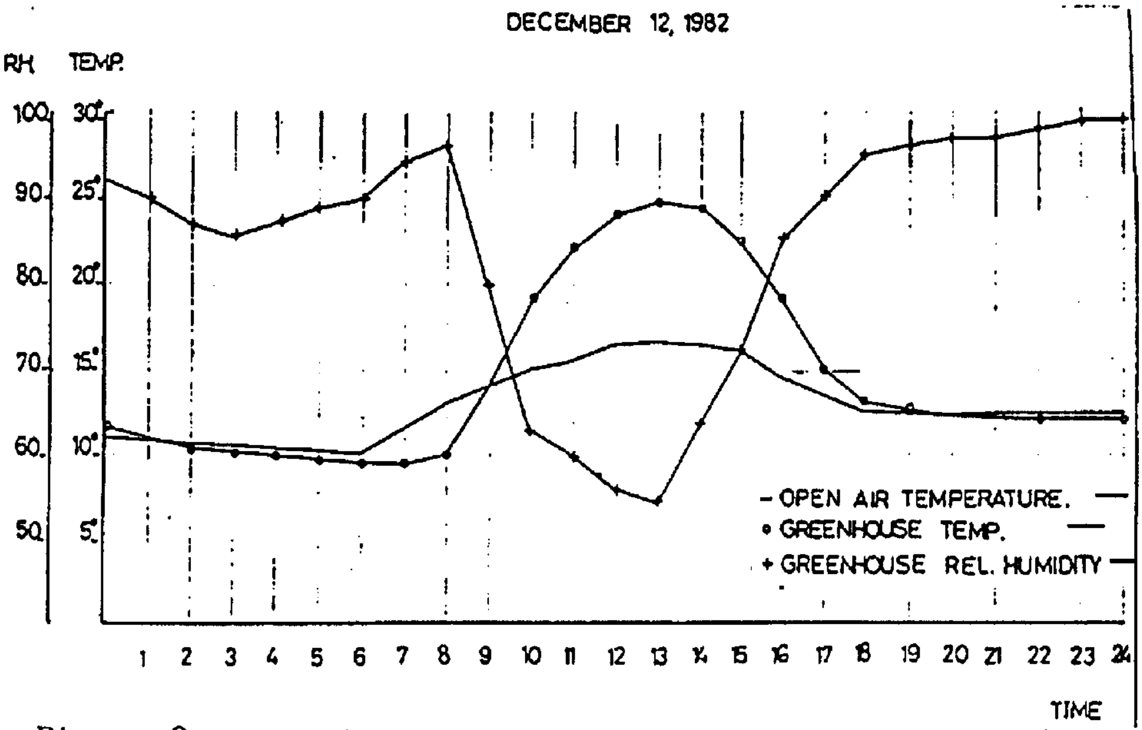
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Figure 2. Temperature and relative humidity fluctuations on a sunny winter day.

That a better ventilation is needed can be seen in figure 3. Where the climatic variation on a spring day is represented. High temperatures can cause crop stress while relative humidity decreases to a undesirable levels, affecting not only crops but working conditions.

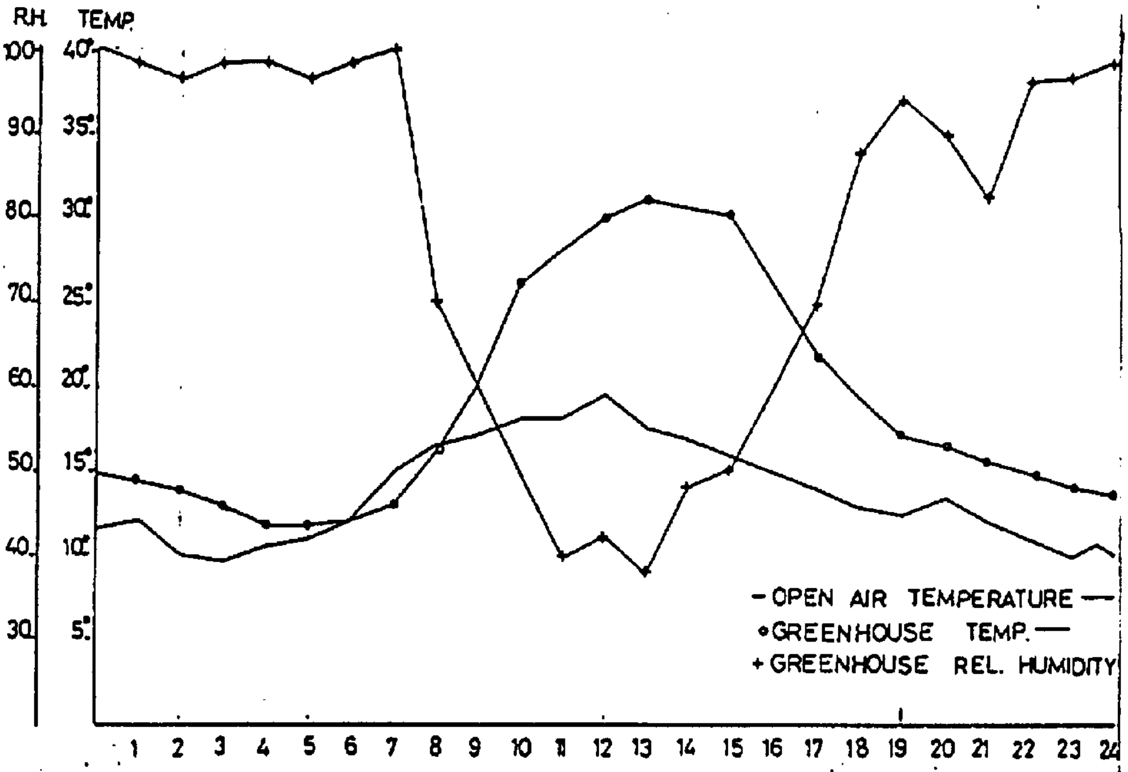

Figure 3.Temperature and relative humidity fluctuation on a spring day.

2.3._Solar_radiation

Monthly average radiation is given in figure 4. Transmissivity may change from month to month due to dust accumulation on the cover and to the changing angle of incidence of solar rays along the year.

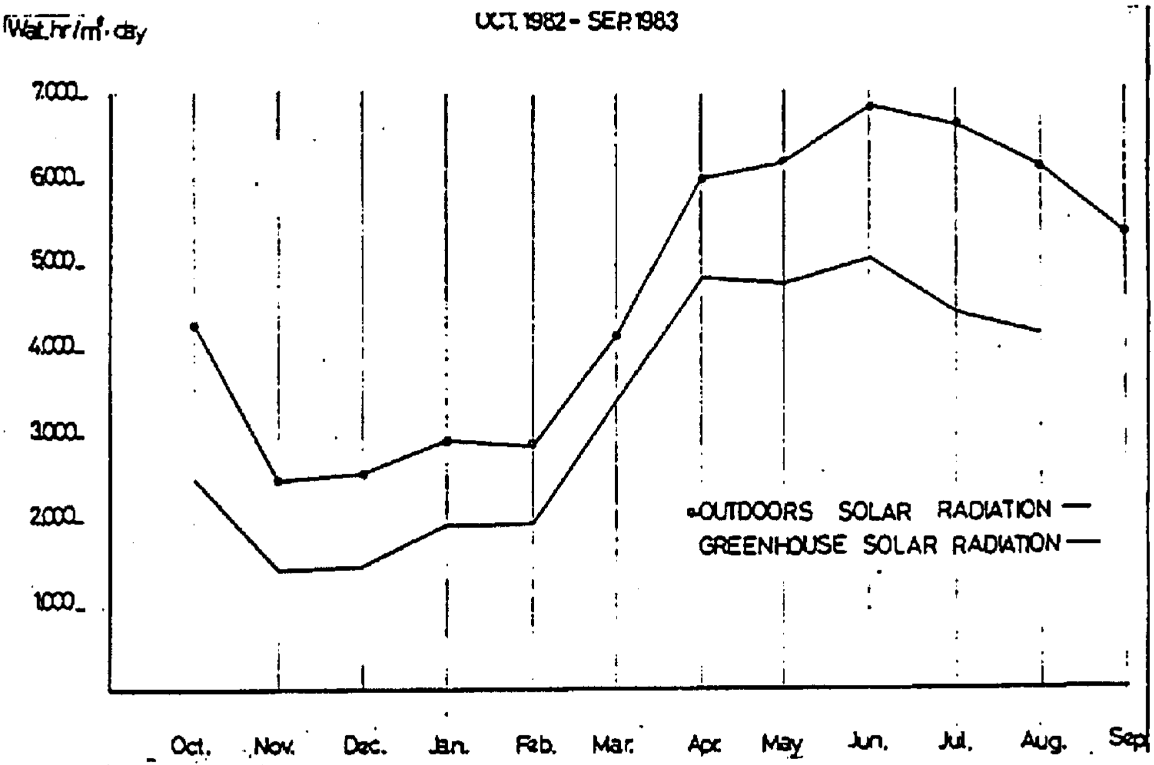

Figure 4.

In the province of Almeria, rainfall is scarce and unevenly distributed. Natural vegetation is poor and dust is carried along the wind and deposited on top of the greenhouse plastic. An increase of 14% in solar radiation transmissivity was measured on August 1983 after washing the greenhouse cover with a garden hose.

Most greenhouses in Almeria are flat or slightly sloped (less than 10º). In many cases the ridge axis is east to west oriented to combat the prevailing winds. During winter, the angle of incidence of solar radiation on a flat surface is such that a lot of radiation is reflected (Table 3) changing the roof slope increases the transmittance, but the number or strength of structural members needs to be increased too.

Table 3.- Angle of incidence and P.E. transmissivity on a flat surface at noon.

	DEC-15	JAN-15	FEB-15	MAR-15	APR-15	MAY-15
Angle of incidence	60	58	50	40	28	18
Transmiss.	0'82	0'82	0'84	0'87	0'88	0'90

2.4. Evaporation

Water is the limiting factor in the Almeria area. An accurate estimate of the water consumption is extremely important to the growers. Table 4 gives the monthly average of greenhouse and outdoors evaporation measured in a standardized class A evaporation tank.

Table 4. Average evaporation on a class A tank.
October 1982-September 1983.
m.m./day.

MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
GREENHOUSE AVERAGE	2,17	1,04	0,79	1,0	1,02	2,78	3,51	3,6	4,35	5,16	4,70	4,46
OUTDOORS AVERAGE	3,2	1,52	1,81	2,02	2,06	3,67	5,73	6,17	7,31	8,65	7,28	6,81

Sand mulching called "enarenado" is extensively used in Almería mainly to help to control the salt accumulation and reduce soil evaporation. Methods of calculating evapotranspiration had to be calibrated in situ because of the specific meteorological conditions.

Experimental data on water consumption is available. Castilla (1984). As an example, a well watered tomato crop grown from October 15 to May 15 will need 313.6 mm. on average.

Good correlation has been found between class A tank evaporàtion and solar radiation. This information will soon be published.

3. Conclusions

Low cost high tensile structures are very appropriate to the Mediterranean climate. Today, traditional greenhouses cannot compete economically with this kind of protection.

-Local growers have the expertise to repair their greenhouses when required. Materials are readily available in the area

- Greenhouses are effective wind breaks. Also day time temperatures are increased compared to the outside air. This is specially interesting during the coldest months.

- Nightime temperatures inside are similar to nightime temperatures outside. Thermal inversion takes place on clear nights when radiation losses are abundant. Some heating would be desirable in the winter but so far it has proved to be uneconomical.

- In most cases, natural ventilation during the day is not enough to lower the temperatures to the most convenient levels. In our opinion, the development of more efficient natural ventilation systems has top priority to improve the growing conditions.

- Solar radiation average transmissivity can be enhanced just by washing the covers. A dusty cover reduces solar radiation at the canopy level which could be favorable during warm periods. Flat roofed greenhouses have not good transmissivity in the winter due to the high angle of solar incidence.

- Since the plastic film is punctured to be attached to the supporting members, rain gets into the greenhouse through those holes. This leads to the development of fungal diseases if there is a period of rainy weather in the area. Considerable losses occurred in 1978 due to this.

- In the future the expansion of low cost greenhouses is expected to continue in those areas where the climate is favorable. The Technology that is being used in traditional greenhouses is not suitable for those simpler structures. Appropriate solution have to be developped to solve our specific problems here, keeping in mind that low cost unsophisticated structures require unsophisticated technology

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