Greenhouse Films

Radiometric Characteristics and Agronomical Evaluation of Various Light Stabilisers

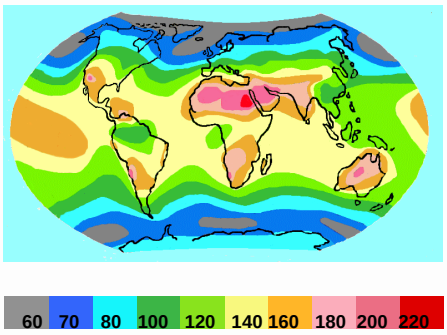
GABRIEL-CHEMIE GROUP

Greenhouse Films

Lifespan Expectation of a Greenhouse Film

A good UV stabilisation of a Greenhouse Film should enable that after desired lifetime at least 50% of initial tensile strength is present at the film. It has to be taken into account that each UV-stabilisation must be designed regarding to maximum possible annual sun radiation energy which is typical to geographic area of application.

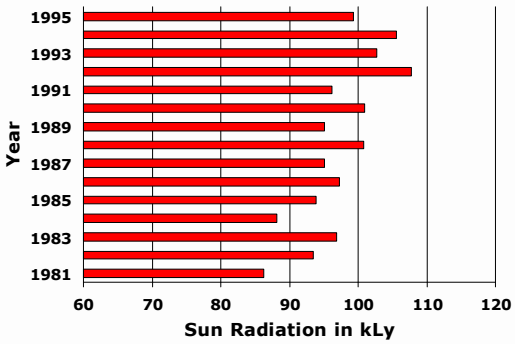
Global Radiation in kLy/Year



The annual sun radiation energy depends on meteorological conditions and can show absolutely different values according to place of the exposure. The sun radiation energy is usually expressed in kLy (Kilolangley) units. A conversion to other energy units is possible, the conversions in other units can be done as follows:

- *1 kLy = 1000 Ly Langley*
- *1 kLy = 4187,5 J/cm2 = 4,19 kJ/cm2*
- *1 kLy = 1,11632 Wh/cm2 = 11,63 kWh/m2*
- *1 hour of sunshine (average value) = 45 Ly (from 33 Ly to 77 Ly !)*

Annual Sun Radiation in Vienna/Austria



In the past, the yearly sun radiation energy in Central Europe was assumed with an average of 80 kLy per year. Latest measurements of the Austrian Central Meteorological Institute show that the annual sun radiation energy has risen due to climatic alterations to an average of approximately 100 kLy in Austria, even in some areas about 110 kLy. Diagram shows as an example the alteration of the sun radiation energy in Vienna/Austria relating to the year of measurement:

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A suitable UV-stabilisation of a Greenhouse Film must refer to geographical area(s) of exposure and their average sun radiation energy.

Over the last decades the amount of UV-B radiation, as measured by the NASA Satellite Nimbus 7, has significantly increased in many regions of the world (also in Europe). The UV-B radiation is the highest energy part of solar irradiation reaching the ground and this phenomenon is mainly attributed to the decrease of the ozone layer in the atmosphere. As a result this affects not only human health and crop growth, but also lifetime of plastic articles used outdoors. Gabriel-Chemie is therefore monitoring NASA global satellite data showing sun radiation energy all over the world and is taking this into consideration when recommending a light stabilisation.

UV-Stabilisation of Greenhouse Films:

Until the end of the 1970´s, the usual UV-stabilisation for greenhouse films was a combination of organic nickel compound (Ni-Quencher) with an UV-Absorber (1.Generation). Nowadays in some areas these formulations are still in use, but Ni-Quencher systems have experienced a considerable recession due to the fact that elementary nickel was found to be dangerous to the environment especially in case of inadequate disposal.

At the beginning of the 1980´s HALS-Stabiliser (Hindered Amine Light Stabiliser) came on the market (2. Generation). These stabilisers are often proven to be more effective in preventing polymer degradation, due to heat and UV radiation.
Stabilising Greenhouse Films, we have to consider another important parameter: the influence of acid separating substances and sulphur containing or halogenated agricultural chemicals (as pesticides and insecticides or other agrochemicals). Therefore it was decided to study and develop a new generation of HALS-Stabiliser (3.Generation), which has less sensitivity to these chemicals and is performing better under difficult conditions. This new stabiliser is often combined with inhibitors which should neutralise the negative influences of chemicals as far as possible.

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World-wide there are following light stabiliser systems in use today (MAXITHEN® - terms):

1. Generation: MAXITHEN® HP 79141/105 UVAO
   conventional Ni-Quencher stabiliser + UV-absorber
   (yellow-green colouring characteristic of films)

2. Generation: MAXITHEN® HP 72630 UVAO
   conventional HALS-stabiliser + UV-absorber
   (no colouring characteristic of films - very good transparency)

3. Generation: MAXITHEN® HP 7A1140 UVAO
   MAXITHEN® HP 72910 UVAO
   new HALS-system with inhibitor system - less sensitive to pesticides (whitish colouring characteristic of films - diffused light radiation in Greenhouse Films).

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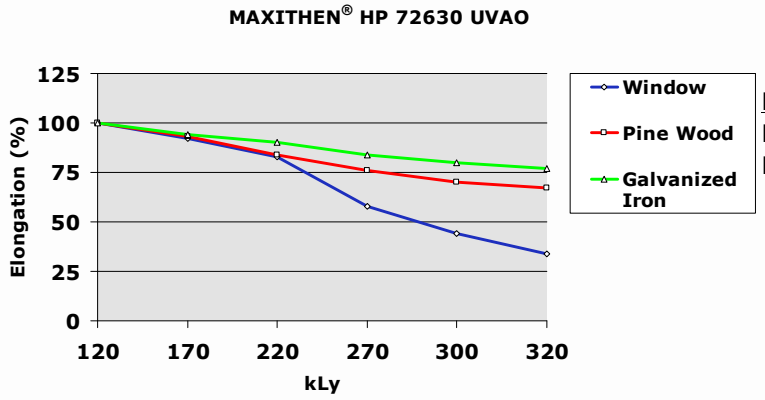
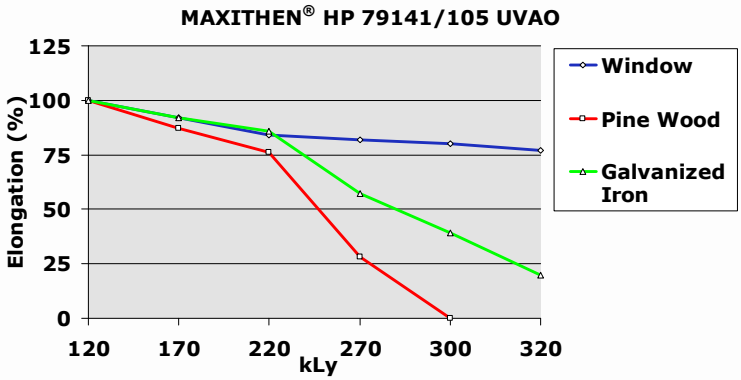
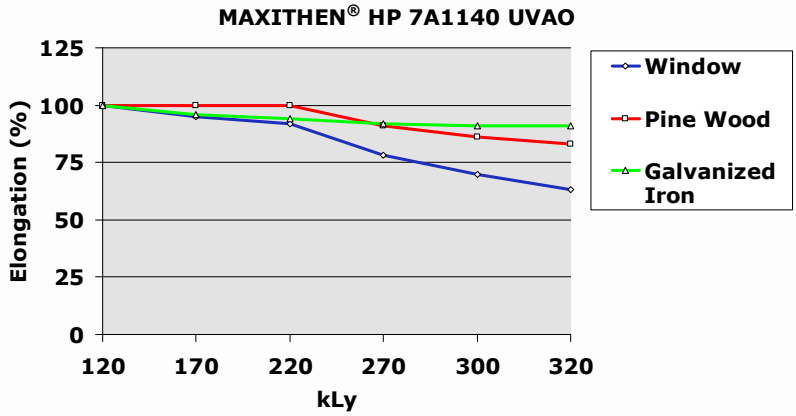
Greenhouse Film LDPE (200µ)
Influence of Pesticides on UV-Stabilisation







Pesticides/Insecticides applied:
Permethrin (Cl) every month
Metham-Sodium (S) every semester

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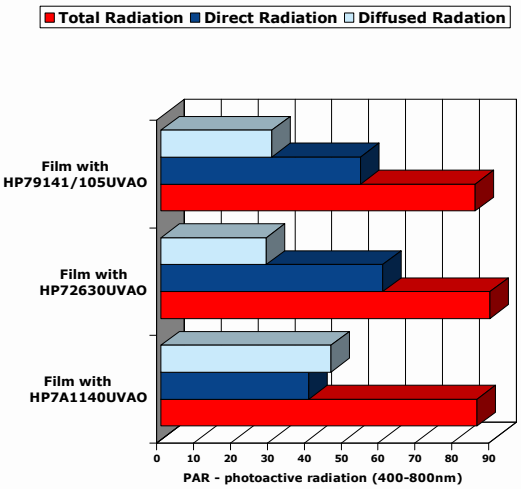

Influence of UV-Stabiliser Systems on Light Transmission of Greenhouse Films

Whereas total radiation of all films is quite the same, the comparison between direct and diffused radiation shows a big difference: in particular the film with the stabiliser system of 3. Generation transmits the radiation by diffusing it inside greenhouse areas. Therefore also the plants which are situated in shadow areas receive enough light.

Field Tests with Stabiliser Systems of 3. Generation:

In order to evaluate the agricultural behaviour of films using the new stabiliser, a new type of field test was set up:
Data of the film:
Polymer: LDPE
Wall thickness: 180µ
Stabilisation: each film with about 9% Stabiliser-MB

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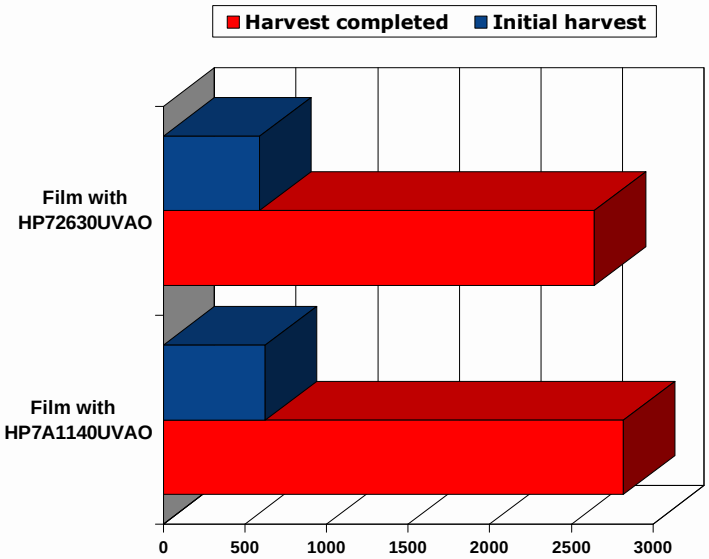
Exposure:
Location: Italy/Tuscany
Agrochemical: treated with Pesticides (Metham-sodium) every semester and with Insecticides (Permethrin) every month
Evaluation: Plant results were recorded at field tests from 24th February until 15th April 1997.

The field tests were done both for vegetable, as cucumber and tomato, and for flower crop cultivation, as statice and safflower.

Agronomical Evaluation of UV-Stabiliser Systems



1. Cucumber Cultivation *(Cucumis Sativus)*

Cumulative Production per Plant (g)

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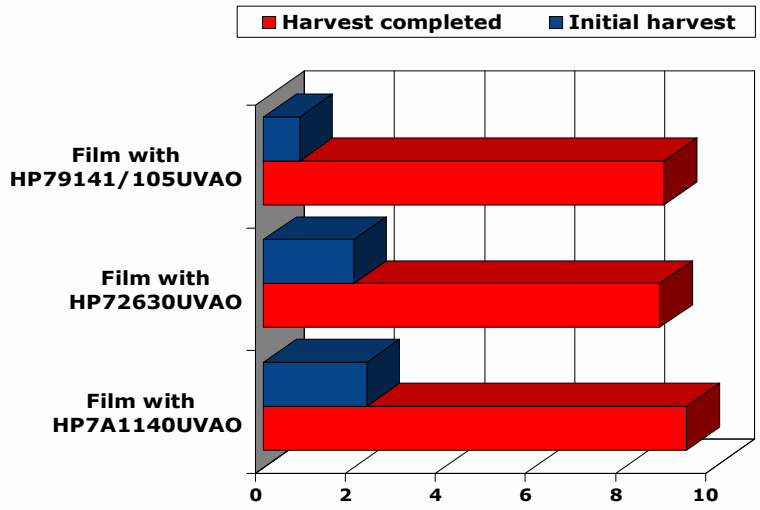
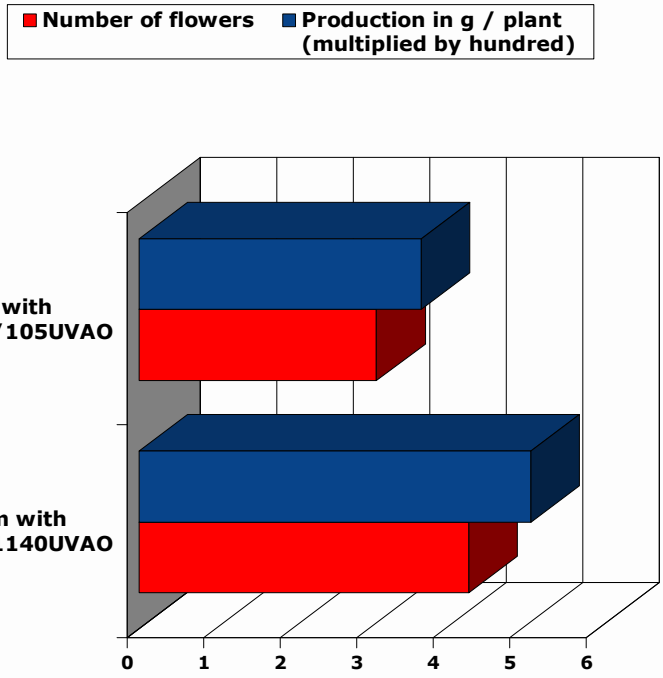


Number of flowers

Whereas it is difficult to find any difference between the stabiliser systems of 1. and 2. Generation, the difference to the film stabilised with MAXITHEN® HP 7A1140 UVAO is remarkable, in particular regarding the initial harvest.



2. Tomato Cultivation:
Initial Results (First Blooming)

The number of flowers as well as the weight per plant is higher, when the film is stabilised with MAXITHEN® HP 7A1140 UVAO.

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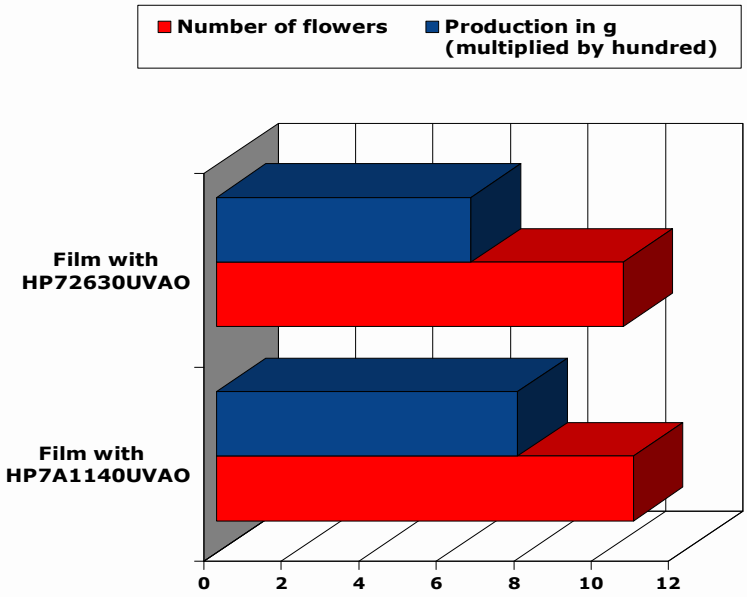
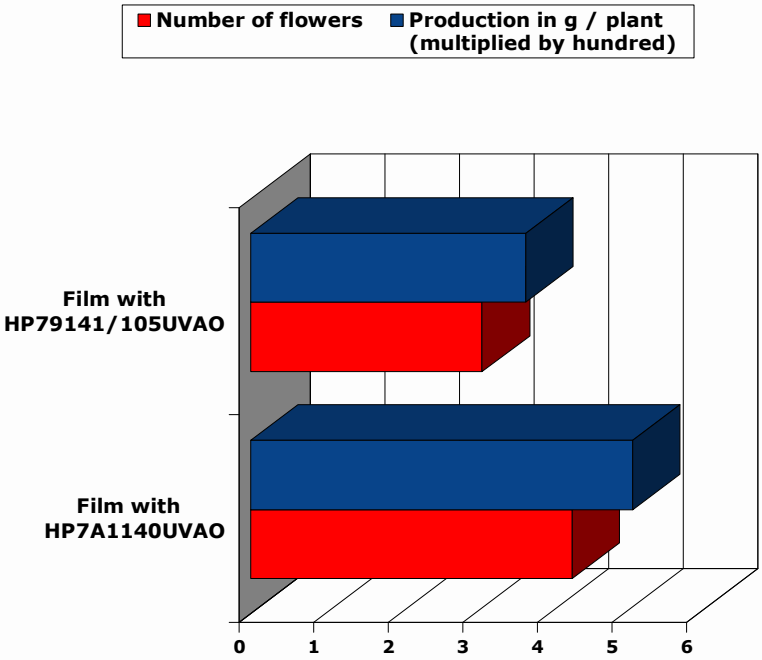


3. Statice Cultivation
(Limonium Sinatum)
Total per Plant

Especially the number of flowers is higher when MAXITHEN® HP 7A1140 UVAO is in use. This is very important in such a cultivation.



4. Safflower Cultivation
(Cartamum Tincturius)
Height in cm

If MAXITHEN® HP 7A1140 UVAO is used in the film, the plants grow remarkably higher.

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Important Criteria for the Light Stabilisation of Greenhouse Films

The lifetime of Greenhouse Films is definitely influenced by the kind and quality of used polymers. Once evaluated polymer-formulations should remain unchanged.

Gabriel-Chemie adapts the light stabilisation of a Greenhouse Film depending upon the desired lifespan expectation and according to geographical area of application in co-operation with the customer (e.g.: Central Europe - 100 kLy/year).

An indication about the wall thickness (Micron) of required monolayer film, respective of individual layer in case of co-extruded film as well as indications about applied agrochemicals, in particular knowledge about applied pesticides and insecticides - possibly based upon sulphur or halogenated compounds or acid separating substances - are prerequisite to us to provide optimum recommendations to the customer.

Gabriel-Chemie has extensive experience in the area of the stabilisation of Greenhouse Films and is a competent partner in this field of application.

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