

Atlas Weather-Ometer[®]

Agricultural Films Duration under Accelerated and Natural Weathering

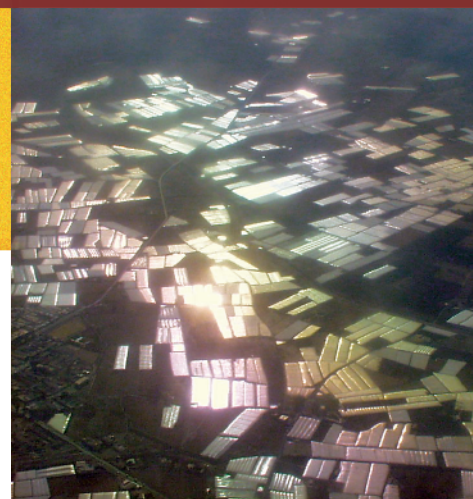
Background In 1976, the total surface area covered with greenhouse films worldwide was approximately 600 km². In 1990, the corresponding surface area surpassed 2200 km² and reached 7230 km² in 2002. The impressive development in the use of greenhouses can best be visualized by looking at southern Europe (Spain/Almería). This is considered the biggest concentration of greenhouses in the world and a reference for the greenhouse industry in the Mediterranean countries. Low-density polyethylene homopolymer (LDPE) and ethylene-vinyl acetate copolymers (EVA) are the most common plastic materials used for greenhouse cover films.

Requirements The service lifetime required for greenhouse cover films depends heavily on the country, especially the tradition in the country. Service life varies from one agricultural season (i. e. six to nine months) to several years in some cases. In Almería (6657 MJ/m²/year of radiant exposure; 1 kLy = 41,868 MJ/m² @295–3000 nm), commercial films are guaranteed for two agricultural seasons (21 months, two years minus one summer, equivalent to a radiant exposure of 10885 MJ/m²) or three seasons (33 months, three years minus one summer, equivalent to 17585 MJ/m²) and their real lifetime is strongly dependent on the heavy use of pesticides which destroy the photostabilisers.

Test Method/Procedures The European Standard EN 13206:2001 classifies agricultural plastic films in six categories (N, A, B, C, D, E) according to their exposure in a xenon-arc accelerated weathering test. Some test conditions (irradiance, water spray, black panel temperature, relative humidity and metal sample backing) are recommended, but the use of pesticides is not included in the test. For this study, the strong influence of pesticides on the lifetime of agricultural films, in both laboratory accelerated and natural weathering tests, is described.

Laboratory Accelerated Weathering Tests were performed in an Atlas Ci4000 Xenon-arc Weather-Ometer[®] according to ISO 4892-2:1994. The samples have been exposed to 0.35 W/(m²nm) at 340 nm, black panel temperature of 65° C, chamber temperature of 30° C and relative humidity at 65%. The 2-hour weathering cycle (18 minutes water spray, 102 minutes of dry period) used for the test is characterised by continuous radiation.

Natural Weathering Tests were performed according to ISO 877:1994, method A. The test rack was south facing at 5° from horizontal. The location was Móstoles (near Madrid/Spain), latitude 40° 19' 29" N, longitude 3° 51' 49" W, altitude 661 meters, climate Mediterranean subtropical/dry summer (Cs), 6070 MJ/m²/year of average radiant exposure. Every 1000 hours in the Weather-Ometer[®] and every three months of natural exposure, the test was stopped in order to treat the samples with pesticides.



Aerial View of Almería Greenhouses

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Criteria for Lifetime Description Tensile measurements were carried out according to ISO 527-3:1995/Cor.2:2001. The value of residual elongation at break to 50% of the non-weathered sample is used to describe the lifetime.

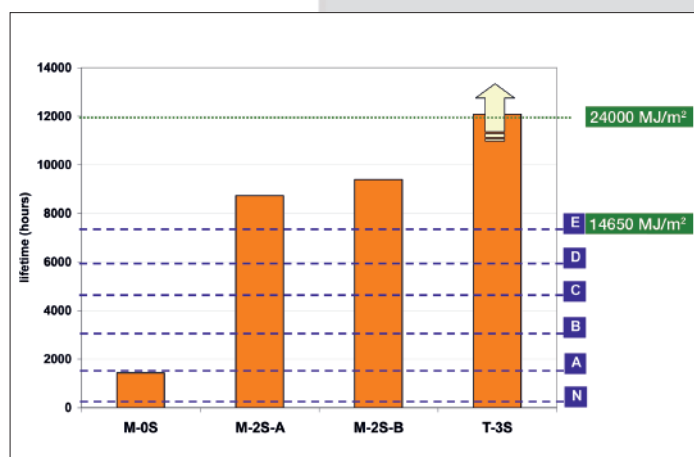
Sample Material Four films, three which are a good representation of the real films used currently in the Mediterranean countries, and one as a reference, were studied. The samples were produced by extrusion and film blowing.

Results In order to find the best correlation between accelerated weathering and natural weathering at defined, controlled conditions as well as weathering in real-use conditions, a statistical study of the duration in real-use conditions of the four films studied has been done. The average lifetime of the 2-seasons films is 23 months (12560 MJ/m² approx.) and that of the 3-seasons film is 35 months (19260 MJ/m² approx.), as shown below.

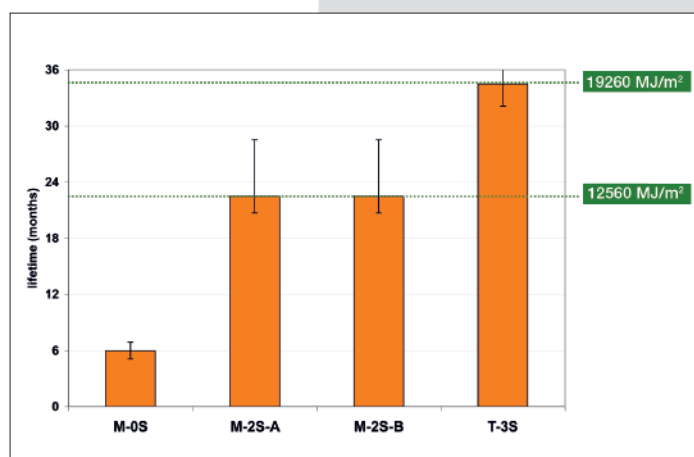
Conclusions When the EN 13206:2001 accelerated weathering test without pesticides is applied to real 2 and 3-seasons films used in Mediterranean countries, all of them largely exceed the duration of class E (the highest one) and no differences can be seen between them until 12000 hours of test.

The most frequently used pesticides, when combined with metam-sodium (soil desinfectant), cause the strongest detrimental effect on lifetime in the accelerated weathering test. When the EN 13206:2001 accelerated weathering test in a Ci4000, including a treatment with metam-sodium and permethrine (leaf pesticide), is applied to the same films, it approaches the lifetimes of the 2-seasons films to those defined in the EN and differentiates them from the 3-seasons film. However, all of them should be classified as E films, according to the standard.

The Ci4000 Weather-Ometer® allows running accelerated weathering tests of agricultural plastic films including pesticide treatment in controlled, reproducible conditions and with good correlation to natural weathering tests.



Lifetime of the films were studied under accelerated weathering conditions in a Ci4000 Weather-Ometer® according to EN 13206:2001 with pesticide treatment P2 (metam-sodium + permethrine).



Lifetime of the films studied in conditions of real use in greenhouses.