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THE USE OF PLASTICS IN THE CONTROLLED CULTIVATION OF VEGETABLES V

by

M. Quaricato *
and
V. Ravelli **

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* UNIDO expert.

** Montedison Experimental Centre for the Uses of Plastics in Agriculture, Ravenna, Italy.

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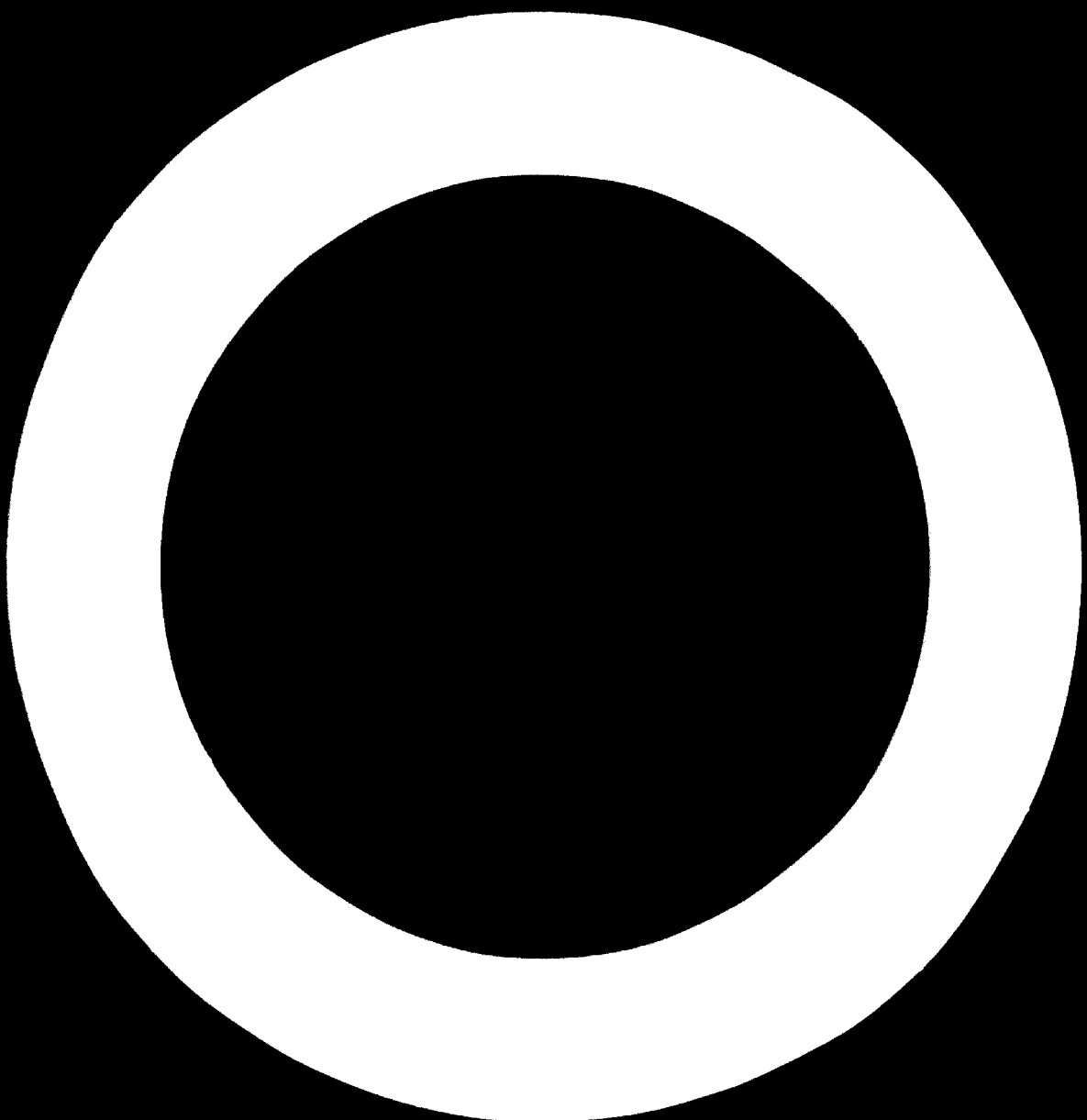


1. Introduction

1.1 More than two thousand years ago, the chrysanthemum was known and cultivated in China.

A thousand years later, it was brought to Japan by way of Korea and, under the name "Giku", it became the national flower.

In Japan, the chrysanthemum acquired symbolism as the flower of life and became part of fable and legend. Chrysanthemums were represented almost everywhere: on fans, screens, embroidered fabrics and even the crowns of the Mikado.

Chrysanthemums appear to have been introduced into Europe by way of France by a merchant in Marseilles towards the end of the eighteenth century. The plants arrived already as clones, rather than as spontaneous species.

From France, they spread throughout Europe.

1.2 The chrysanthemum belongs to the family Compositae, genus Chrysanthemum.

The genus is a rather rambling one, with more than 200 species.

It is probable (although their origin is too remote to permit of documented proof), that the forms cultivated today derive from the species Chrysanthemum and Chrysanthemum morrifolium Ram through hybridization and selection.

Towards the end of the nineteenth century in France, geneticists obtained the first seed plants and created the first varieties, but Britain was the European country which exercised the greatest influence on the evolution of the chrysanthemum, either through the import from China and Japan of new varieties, or through continuing research in hybridization and genetic improvement.

The new course in the development of chrysanthemum growing was decisively influenced by in-depth studies by American authors (1921) on the effect of light on this plant. By clarifying the growth and blooming mechanisms, these studies made possible the cultivation of chrysanthemums in all seasons of the year and laid the foundations for controlled cultivation, which began in 1962.

Controlled cultivation consists in photoperiodic stimulation at the time of blooming through a shortening of the natural day by cutting off of light from the plants by suitable methods. As far as we know, there are no relevant and precise statistics on patterns of chrysanthemum growing in the world, but thanks to its diversity of type, shape and colour, and owing above all to the possibilities afforded by controlled cultivation, this flower is among those most widely grown in the world.

It is certainly the most widely grown or marketed flower in Britain, Germany, the United States, Holland and Denmark.

In Italy, as in all Latin countries, the chrysanthemum has come to be looked upon very differently than it originally was, perhaps because it blooms naturally at the end of October (or the beginning of November), and is cultivated and sold almost exclusively for All Souls' Day. Only in recent years, owing particularly to the diversification of the flower through new clones, has the chrysanthemum started to be appreciated as a flower for decoration and, thus, to be cultivated throughout the year on a controlled basis.

In 1970, according to data from ISTAT, 607 hectares of chrysanthemums were grown in specialized cultivation and 173 hectares in non-specialized cultivation.

We do not know how many of these chrysanthemums were produced in controlled cultivation.

Taking into account the fact that the technique of programming is relatively recent, that it is only in the past few years that genetic research has produced shapes and colours of great beauty and that the long-lasting quality of the cut flower, even in summer, makes it sought-after throughout the year, we feel sure that this will be one of the flowers showing the greatest growth in demand and, hence, in cultivation in the near future. In addition, the use of plastics can even develop growing techniques for chrysanthemums further, improving their quality and reducing production costs.

At Mantua, near the Montedison Experimental Centre for the Uses of Plastics in Agriculture, a study of possible uses of plastics in the controlled cultivation of the chrysanthemum was started in 1971, and meaningful findings have been obtained.

2. Mulching and fertilizing irrigation

2.1 Whereas in horticulture, mulching is very widespread, and its positive aspects are universally recognized, in floriculture, it is still almost unknown and very little used.

To our knowledge, mulching has been used occasionally only on plantings of bulbs such as gladioli, tulips and freesias, but never on chrysanthemums.

2.2 The effects on the soil of black mulch can be summarized as follows:

(a) An average temperature in the mulched soil which is higher than that of bare soil except during the hours of very strong sunshine, when it is lower; in summary, a flatter temperature curve;

(b) A higher and more constant soil humidity than in the case of bare soil owing to the nearly total prevention of evaporation and the regulation of the flow of water, which is supplied only by irrigation using perforated tubes placed under the mulch;

(c) Preservation of the optimum soil structure achieved by working and, consequently, perfect circulation of oxygen and carbon dioxide at the roots;

(d) Greater microbial activity, resulting in better and more elevated nitrogen-formation, more accelerated transformation of organic matter, with a proportional increase in carbon dioxide, which, leaving the transplantation holes, will pass over the leaves, thereby making possible increased photosynthetic activity;

(e) More extensive root development of mulched plants than of those growing in bare soil, and shallower root systems;

(f) Excellent weed control.

2.3 Taking into account the optimum conditions for chrysanthemum cultivation, growing requirements and the ideal environment, on the one hand, and the effects of mulching, on the other, the authors immediately began to use this practice, even in controlled chrysanthemum cultivation.

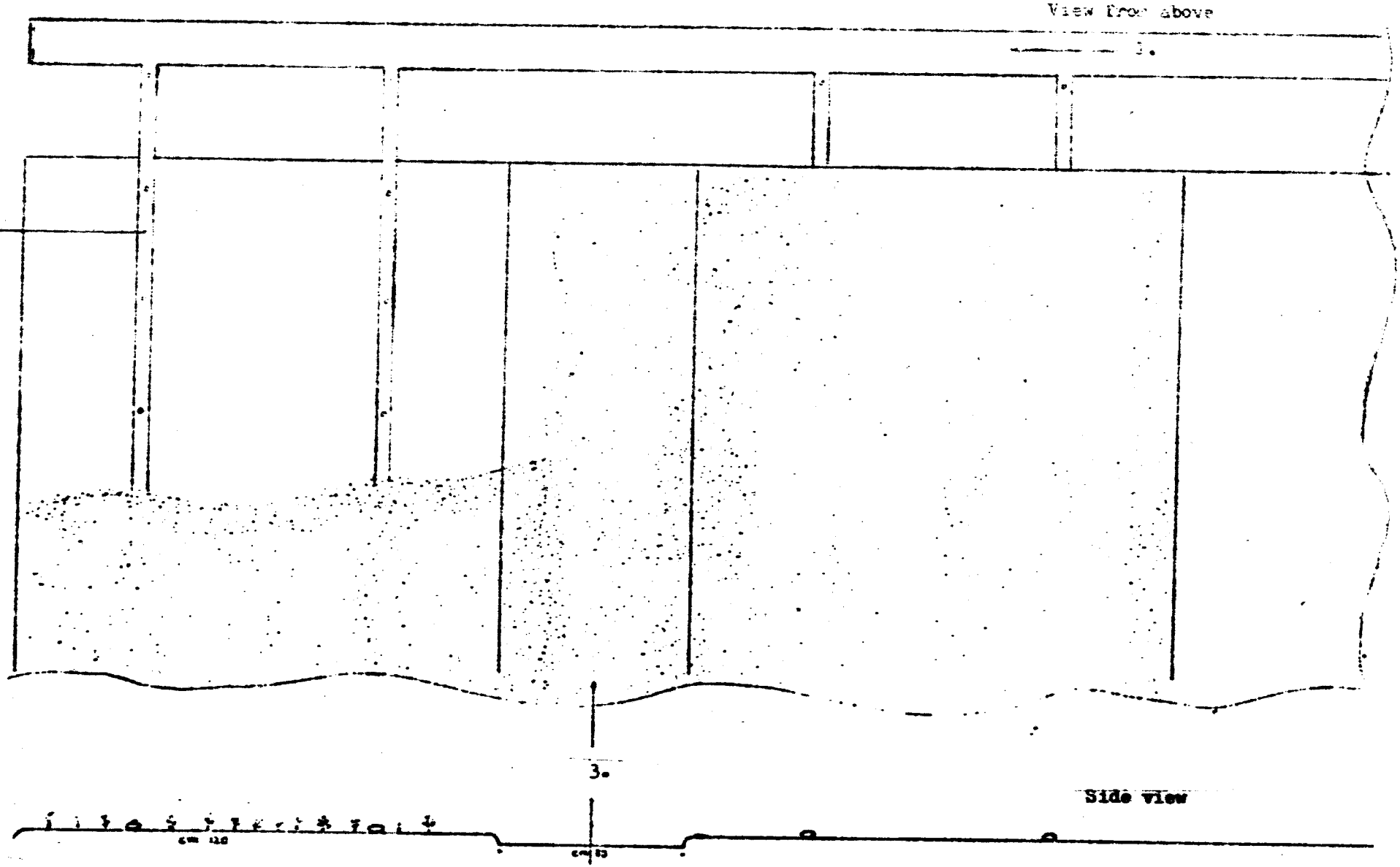
Once the beds, 1.20 m wide, with paths 50 cm wide between them were prepared, black polyethylene film 0.05 to 0.07 mm thick was spread out, with full mulching of the paths as well (in this way preventing the development of weeds and the formation of mud as a result of irrigation).

To carry out the irrigation and fertilizing irrigation, an installation was set up with perforated tubes under the mulch (figure 1). From the main line in PVC, 120 mm in diameter, two branches were led off for each plot. The perforated tubes in polyethylene 0.25 mm thick and 40 mm in diameter, with two holes 1.5 mm in diameter on opposite sides at 30 cm intervals were inserted at the branches. For the planting, small cross-cuts were made in the mulch at set distances and the rooted cuttings were inserted in a shallow planting, with the surrounding soil gently firmed around it.

Unmulched plots of the same size, with the same number of plants per square metre and irrigated by ordinary mist-spray irrigation lines served for comparison.

For between two and four days (depending on the season of transplating, especially during the months of greatest sun exposure), the cuttings transplanted into the mulched plots were mist-sprayed two or three times a day to prevent overheating of the black mulching film from causing burns which would inhibit rooting. On the mulched plots, one fertilizing irrigation was carried out a week by dissolving the dose of fertilizer in the irrigation water. On the unmulched plots an equal dose of the same granular fertilizer was spread before irrigation.

DIAGRAM OF THE FERTILIZING IRRIGATION LAYOUT FOR USE IN THE CONTROLLED GROWING OF CHRYSANTHEMUM



1. Main PVC conduit, ϕ 120 mm, with branches
2. Perforated PE pipe, ϕ 60 mm, with 1.5-mm perforations every 30 cm
3. [illegible] between flower beds

As a result of many tests at different times on around 20 varieties, the following conclusions were drawn.

Mulching and fertilizing irrigation bring about the following:

(a) A higher level of vegetative growth, making it possible to shorten the long-day period by an average of three to five days or, with an equal length of long-day cycle, longer stem length;

(b) A stronger stem, bearing, in the small-flowered cultivated types with disbudding of the central bud, a larger number of flowers per stem, and in the large-flowered cultivated types with disbudding of all buds except for the central one, flowers of larger diameter with a smaller number of second-quality flowers per square metre;

- Less need for anti-cryptogamic treatments (the plant no longer being sprayed after rooting) and greater efficacity of control of Septoria chrysanthemella and Cladosporium.

  In the mulched plots, even in the varieties most susceptible to these diseases, the leaves at the base of the stem remained healthy at the time of cutting.

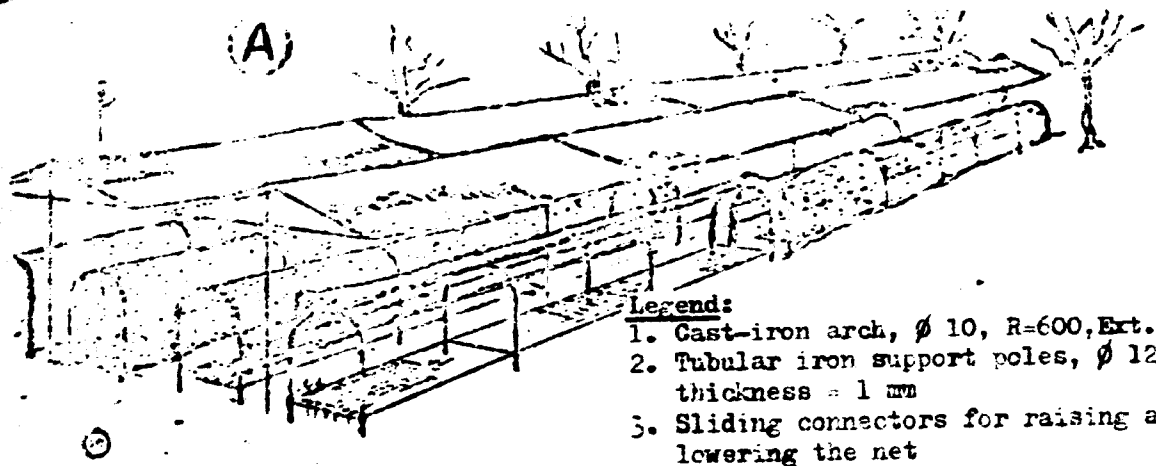
- Full weed control with the use of less labour (approximately 70 hours per thousand square metres). The unmulched plots, by contrast, required two or three weedings during the growing cycle. The weedings, which must be carried out by hand owing to the very small spaces between the plants (12 x 12 cm or 15 x 12 cm), as careful and conscientious as they may be, always cause damage to the small plants' delicate and shallow root systems. This is why, at the end, a smaller number of stems is gathered per square metre, with a larger number of rejects.

- With tubes installed under the mulch, the weekly fertilization required for the crop is facilitated to the utmost and calls for a very small amount of labour.

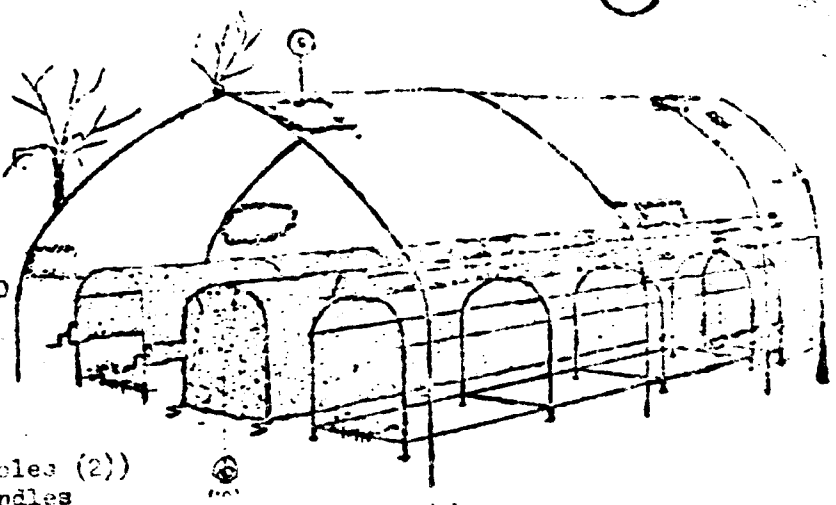
These results show that the use of black polyethylene mulch on chrysanthemums is economical and deserves to be used and to become more widespread.

2.4 In practice, when the distances between plants corresponds to the mesh of the net supporting the stems, it is inserted into a framework of 10 mm wire and superimposed on the mulch. (Figure No. 2A, side view, 4 and 8). In the centre of the mesh, a cross-cut is made with a special bayonette. When the planting distances are different from the net mesh, perforations are marked on the mulch at the desired intervals using a specially prepared nailed wooden board, and the same procedure as described above is followed thereafter.

(A)



(B)

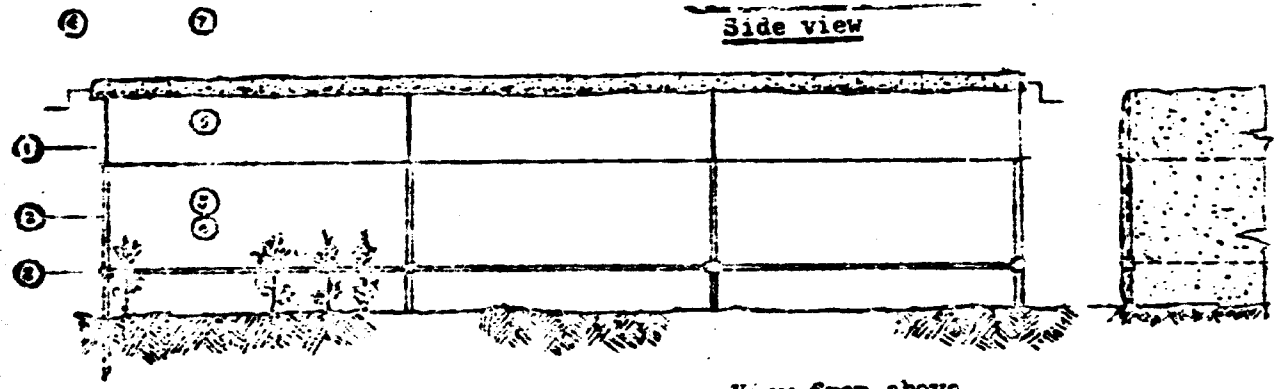


Legend:

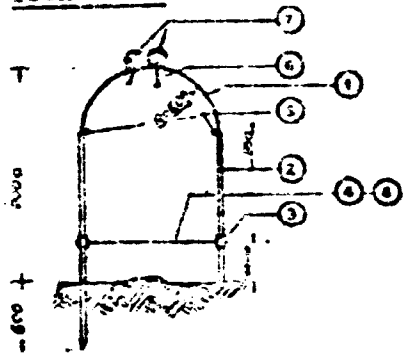
1. Cast-iron arch, ø 10, R=600, Ext.=2400
2. Tubular iron support poles, ø 12, thickness = 1 mm
3. Sliding connectors for raising and lowering the net
4. Frame, ø 10, for supporting the net
5. Iron cross-pieces, ø 10 (welded to poles (2))
6. Iron roller, ø 10, terminating in handles
7. Black polyethylene covers, 0.10-0.15, connected by PVC clips to (5)
8. Moplen mesh net, 80/100, for support of flowers, connected by PVC clips to (4)
9. Moplen-80 net, 3600 interstices/dm^2 (shading factor: 30 per cent)
10. Fixed black polyethylene end-pieces, 0.10-0.15 mm

ALL METAL PARTS MUST BE GALVANIZED

Side view



Front view



View from above

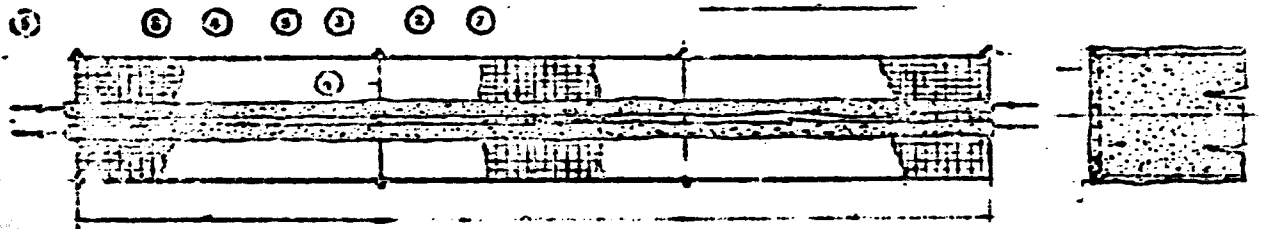


Figure 2

		MONTEDISON S.p.A.	
	Photoperiodic control structures for the controlled growing of chr		MF 4039

3. The net for supporting the stems

3.1 In traditional cultivation, reeds or small canes, to which the plants were tied during the growing period, were used as props. This practice was later altered; strong wooden stakes were driven into the ground along the rows of young plants (every 5 or 6 m), and two strong wires were fixed to these. The flower-bearing stems were then tied to the wires.

This practice obviously entailed an enormous expenditure of labour. Furthermore, the plants had to be spaced in such a way that the gardener could pass between the rows, resulting in a decrease in yield per square metre.

3.2 The introduction of new varieties and of the technique of controlled cultivation made it necessary to cultivate the plots with a high degree of planting density, but this no longer enabled the gardener to pass between the rows. It then became preferable to use a light-gauge wire net with meshes measuring 15 x 15 cm mounted on small frameworks, usually wooden, as supports. This system, which is technically very feasible, is still widely used, but we are of the opinion that it is economically too costly.

It is much more convenient to use an extruded polypropylene net. This is strong, cheap and light-weight and is found on the market in widths ranging from 35 cm to 320 cm, with meshes of various sizes.

Near the Experimental Centre for the Uses of Plastics in Agriculture at Mantua, a net 120 cm wide with meshes measuring 10 x 8 cm, having 12 meshes in the width, have been adopted. The net is fixed with PVC clips to small frames made of 10 mm wire. These frames can be made to slide along the upright members of the structures prepared for the photoperiodic control, and can be raised as the plants grow (figure 2, legend: 3, 4, 8). Since the net is inexpensive (only 0.80 lire per flower), the meshes are cut to facilitate gathering. This makes possible greater speed of gathering, and there is no risk of ruining the leaves in removing the cut stems from the meshes themselves.

4. Short-day treatment

4.1 All flowers of course pass through two entirely distinct phases, namely the vegetative and flower-bud-formation phases. In the chrysanthemum, these two phases are determined by the length of the day, when all the other conditions required for vegetative development, i.e. temperature, light intensity, supply of nutrient elements, soil moisture, etc., are given. The chrysanthemum is a short-day plant, for it flowers only if the day is shorter than a given length, with flowering retarded or simply suppressed if the day is long.

Hence, shortening the day induces blooming.

The borderline between inducement and non-inducement length constitutes the critical length, or "critical photoperiod), which for the chrysanthemum is around 13 or 14 hours.

However, it does not suffice to say that there must be a short day; it is also essential that the night should be long and uninterrupted because stimulation, even briefly, from artificial light during the night inhibits the blooming of these plants.

4.2 In order to achieve a long night, the plots of chrysanthemums were covered with black awnings in such a way that the light intensity in the enclosures did not exceed 3 to 5 lux (moonlight). By using plastics, the matter was simplified and costs reduced.

In this connexion, the use of black polyethylene film 0.10-0.15 mm thick has been made standard. These awnings are spread in the afternoon between 5 and 6 o'clock and taken up between 8 and 9 o'clock on the following morning.

The use of black polyethylene awnings to cover chrysanthemums has shown some disadvantages in southern countries during the months of greatest sun exposure for the following reasons:

(a) Formation of a high level of humidity under the black awnings, leading to ease of attack by cryptogams in the most sensitive varieties;

(b) Overheating in the enclosures, leading to the formation of poor-quality flower buds in the varieties most sensitive to high temperatures.

As regards point (a), the problem can be easily solved by complete mulching of the ground, thus preventing evaporation.

As regards point (b), a 30 per cent shading net can be placed over the shelter during the photoperiod; by reducing the radiant energy, this makes possible an adequate decrease in the temperature in the shelters.

The shading net, woven from polypropylene filament, has additional important advantages, namely:

- Elimination of the danger of hail damage;
- Better rooting of the young plants;
- Elimination of the disadvantage of fading of flower colour owing to excess light and temperature in the case of summer-flowering chrysanthemums.

4.3 Near the Montedison Experimental Centre for the Uses of Plastics in Agriculture at Mantua, we have been studying the most suitable structures for achieving the photoperiod in controlled cultivation of chrysanthemums in various locations:

(a) Outdoor cultivation with transplanting from 10 May to 10 July, resulting in flowering from 15 August to 10 October (figure 2A);

(b) Cultivation in cold tunnels with transplanting for the second growing stage (10-20 July) and production of flowers for All Souls' Day (figure 2B);

(c) Cultivation in hothouses with artificial lighting for other times of year (figure 3).

4.3 (a) The type of cultivation mentioned in point (a), with transplantings from 10 May to 10 July, requires suitable equipment for the photoperiodic control and for supporting the shading net (figure 2A).

The structure for photoperiodic control consists of a series of poles made of 12-mm iron tubing, which are joined in pairs by small 10-mm wire arches. The distance between poles, at the base, is 1.30 m, and the height at the summit of the small arches is 2 m. A black polyethylene awning, 5.5[illegible] m wide, fixed with suitable clips to the summits of the small arches, is used.

All along the length of the two edges of the awning, two 10-mm bars of the type used for reinforcing concrete are fixed with PVC clips. The ends of these are shaped into crank-type handles so that they can be turned to roll up the black polyethylene awning to the summits of the small arches.

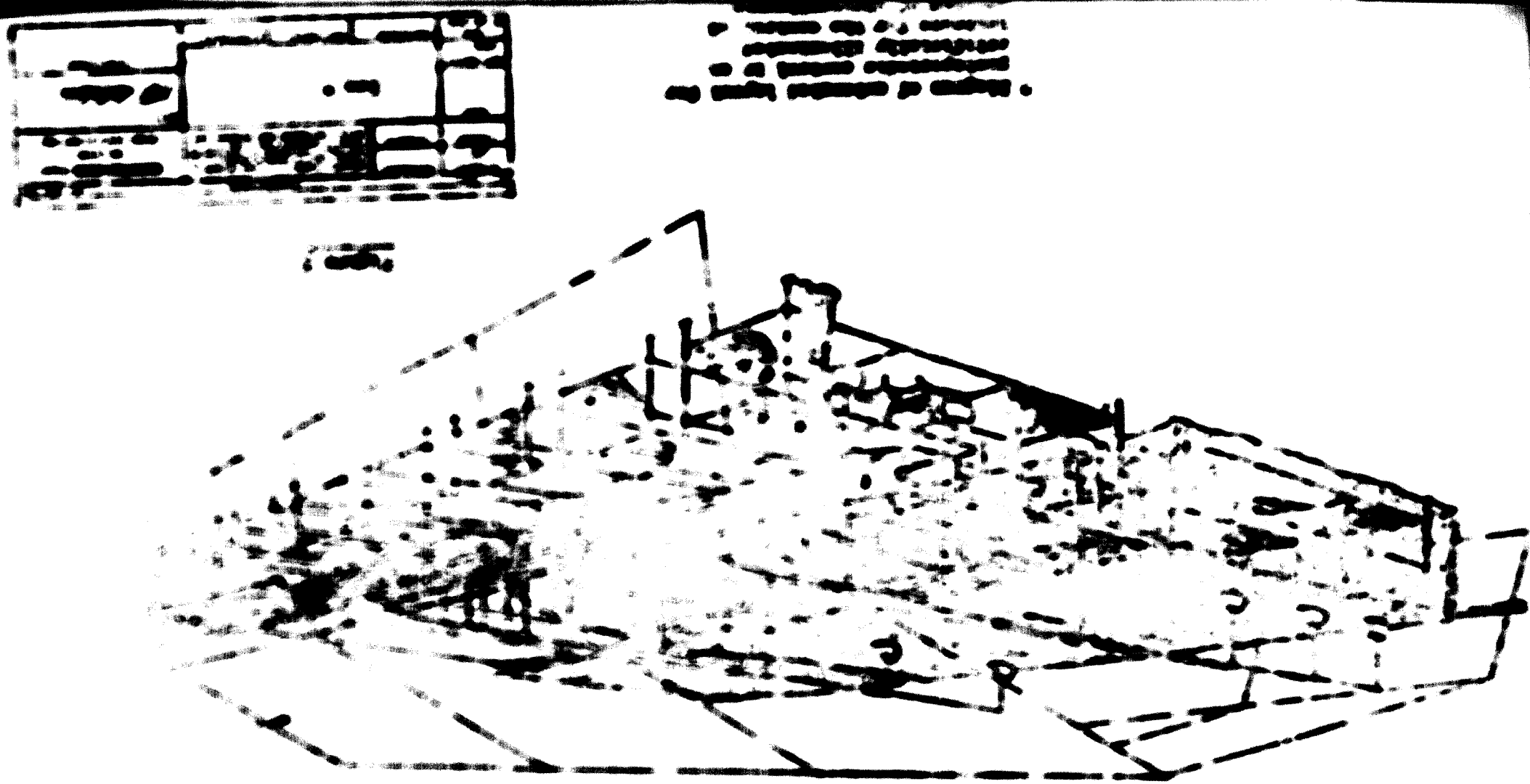
To achieve darkening, the awnings are allowed to unroll down to the ground.

Black film will of course be fixed, again using clips, at the beginning and end of the plot along the perimeter of the poles and small arches.

This end closing will remain in place permanently, even during the hours of light when the awning is rolled up at the top of the framework.

The connectors to which the framework for the flower-support net is attached are fixed to the iron poles. This structure, which is easy to handle and light-weight, can easily be moved into different types of shelters, and its mobility enables it to be used on the plots where photoperiodic control has gradually been introduced with substantial savings in investment.

The hardware for holding the shading net in place consists of tubular galvanized steel poles 3 m high placed at intervals of approximately 10 m, over which the shading net is spread, using horizontal iron pipe members with a diameter of 3/4 inch.



This system has proved to be very functional and economical, and the spreading and rolling up of the film is very quickly accomplished by comparison with other systems [illegible] in hothouses. Furthermore, during the day, the black film [illegible] growing [illegible] light damage the [illegible] located underneath.

. [illegible]

For the [illegible] of 1,[illegible] by the above-mentioned systems, the following [illegible] are required:

.1 For fall [illegible] kg of black polyethylene 0.07 mm thick and as wide as the protective [illegible] or one part of it.

For fertilizing irrigation: around [illegible] kg of 40 mm tubing with a wall thickness of [illegible] mm and two holes 1.[illegible] mm in diameter on opposite sides at intervals of 30 cm.

.2 In addition, approximately [illegible] m of extruded polypropylene net with 12 [illegible] measuring [illegible] mm to support the flowers is required. This net will be attached to a framework made of bars of the type used for reinforcing concrete and will be placed over the bed as soon as the rooted cuttings have been transplanted. It will be gradually raised as the plants grow, to be finally fixed at a height of [illegible] to 60 cm above the ground.

5.[illegible] (a) For setting up the shelter for photoperiodic control described under point 4.[illegible] (a), the material required will be 4[illegible]0 kg of polyethylene 0.10 mm thick and 5.[illegible] m wide. For shading and hail-protection, around 1,40[illegible] m² of Moplen RO net 1.60 m wide (8.50 x 1.6[illegible]) with [illegible],600 [illegible] per dm² is required.

5.2 (b) The shelter for photoperiodic control is the same as in the preceding case. The shading net, which is of the same type, will be of a width suitable for the protective structure.

The plastic film for rain-protection will be the one to be used for the crop to be grown after the chrysanthemums.

5.2 (c) The amount of black film required for photoperiodic control in the installation which we set up in hothouses with lighting possibilities depends on the shape of the hothouse and, consequently, on the dimensions of the beds. Each area to be darkened will comprise 4, 5 or 6 beds, depending on the growing programme.

Very roughly, around 250 kg of black polyethylene film 0.10 mm thick and of a suitable width for the size of the area will be required.

6. Conclusions

Even in the cultivation of chrysanthemums, plastics have made possible considerable improvements in growing techniques.

Controlled cultivation using the short-day technique can be achieved in the case of very large areas only with black film.

Mulching and fertilizing irrigation are essential to reduce the risk of cryptogamic disease and produce high-quality flowers.

Even darkening of the environment and rain-protection can be achieved on a large scale only by using appropriate plastics.

It can therefore be affirmed that it has been possible to popularize this flower, which is going to awaken so much interest in the flower markets of all the countries of the world, and produce it in the quantities which are more and more being demanded, only as a result of the use of plastics.

Abstract

The various uses of plastics in the controlled cultivation of chrysanthemums are examined.

Total mulching of the ground, by preventing water evaporation, hinders or even prevents attacks by Septoria Chrysanthorella and Cladosporium, which cause so much damage to unmulched crops.

Fertilizing irrigation using tubes under the mulch makes possible irrigation without wetting the plants and timely application of the necessary fertilizer, once a week from the second to the eighth week, with substantial savings in application costs and more immediate and marked effect.

The photoperiodic control is achieved using black polyethylene film. This has made it possible to spread controlled cultivation of chrysanthemums over all the seasons of the year: out of doors, with protection from a shading net, transplanting from 10 May to 10 July and cutting of the flowers from mid-August to mid-October; in cold greenhouses, with transplanting in the second half of July to obtain flowers for All Souls' Day; in other seasons in hothouses using artificial light.

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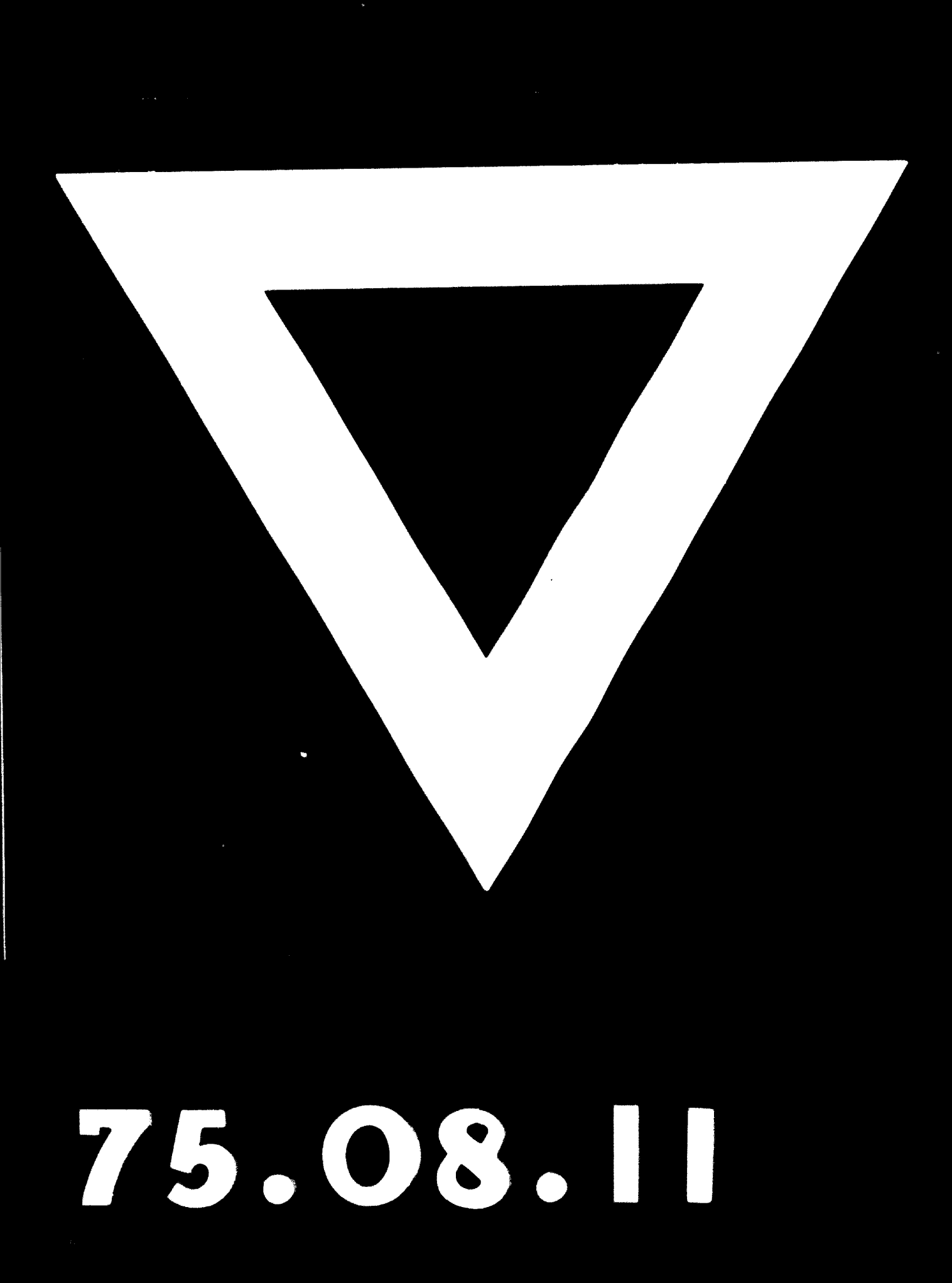

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