

GERMINATION WITH ALTERNATE TEMPERATURES OF WEEDS INFESTING IRRIGATED VEGETABLES

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RESUMEN

GERMINACION BAJO TEMPERATURAS ALTERNADAS DE MALAS HIERBAS INFESTANTES DE CULTIVOS EN REGADÍO

En una cámara de germinación se expusieron a temperaturas alternadas de 30/20 °C, 25/15 °C y 15/10 °C, con un fotoperíodo de 14 horas, semillas de diversas especies de malas hierbas que infestan cultivos de verano en regadío, tales como *Amaranthus retroflexus* L., *Setaria viridis* (L.) Beauv. y *Echinochloa crus-galli* (L.) Beauv.

La germinación de *A. retroflexus* y *E. crus-galli* fue más temprana cuando las temperaturas fueron más altas. Los porcentajes finales de germinación fueron iguales para 30/20 °C y 25/15 °C. *E. crus-galli* no germinó a 15/10 °C.

Las semillas de *S. viridis* germinaron antes y más intensamente a 25/15 °C que a las otras temperaturas, a las cuales la germinación fue baja e igual.

Se discute la posibilidad de emergencia de estas especies en función de las posibles temperaturas a ocurrir en la estación de crecimiento de los cultivos de verano.

Palabras clave: Germinación. Malas hierbas. Temperaturas.

SUMMARY

In germination chamber, the seeds of *Amaranthus retroflexus* L., *Setaria viridis* (L.) Beauv. and *Echinochloa crus-galli* (L.) Beauv., weeds infesting spanish summer crops, were exposed to alternating temperatures of 30/20 °C, 25/15 °C and 15/10 °C with a photoperiod of 14 h.

The germination of *A. retroflexus* and *E. crus-galli* took place earlier when the temperatures were higher. The final germination percentages were the same for 30/20 °C and 25/15 °C. *E. crus-galli* did not germinate at 15/10 °C.

The seeds of *S. viridis* germinated faster and more intensively at 25/15 °C than at the other temperatures, at which germination was low.

The possibility of the time of emergence of these species is discussed in terms of the foreseeable temperatures existing in the grown season of summer crops.

Key words: Germination. Weeds. Temperatures.

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INTRODUCTION

A. retroflexus, *S. viridis* and *E. crus-galli* are weeds infesting irrigated summer crops in Spain, such as maize and vegetables. Their emergence occurs during growth season of the crop as long as the water in the soil is not a restrictive factor.

A. retroflexus germinates better in the light than in darkness (Bedin *et al.*, 1981) and within a temperature range of between 14° and 39.5 °C, depending on storage time of their seeds (Schonbeck and Egley, 1980). It germinates at its best between 30 °C and 40 °C (Taylorson and Hendricks, 1969).

The germination percentage of *S. viridis* seeds increases with temperatures above 20 °C (Kohout, 1981) and the time of maximum germination is speeded up with growing temperatures (Blackshaw *et al.*, 1981a). It has been found that with alternate temperatures of 27/15 °C there was a high germination percentage after 6 and 12 days from placed to germinate (Pike, 1984).

In the case of *E. crus-galli*, the seeds germinated in a range of between 13° and 40 °C (Rahn *et al.*, 1968). After the dormancy stage, the temperatures above 20 °C stimulated the germination (Kohout, 1981). A high degree of germination was also found 7 days after sowing the seeds at a depth of 5 cm in the field and at 17 °C (Keelley and Thullen, 1989) as well as after 7 days in the light under artificial conditions and at a temperature of 24 ± 2 °C (Melkianian, 1988).

In view of the controversies found with regard to the effect of temperatures on the germination of these species, this study was designed to know how the germination capacity of their seeds was affected by different alternating temperatures, close to those that may occur in the first centimetres of the soil in field conditions between May and October, when maize and vegetable crops are grown in Spanish conditions.

MATERIALS AND METHODS

Wet seeds of *A. retroflexus*, kept in dry storage for 17 months at a temperature of between 4 °C and 10 °C, and those of *S. viridis* and *E. crus-galli*, kept for 30 months in similar conditions as the former, a test was carried out subjecting them to alternate temperatures of 30/20 °C, 25/15 °C and 15/10 °C, with a photoperiod of 14 h, and 15000 lux. Were placed 100 seeds of each species per Petri disk with a diameter of 14 cm, buried at a depth of 1 mm

in a mixture of 33 % sand and 67 % soil, which was always kept moist with water. The germinated seeds were counted every four days and the test was concluded on 32 nd days.

A completely random design was used with four repetitions per treatment. The variance analysis of results was carried out following the double factorial model.

$$X_{ijk} = \mu + E_i + T_j + ET_{ij} + \epsilon_{k(ij)}$$

RESULTS AND DISCUSSION

Figures 1, 2 and 3 show the germination speed of the three species studied.

A. retroflexus was speeded up as the temperatures grew, with a germination maximum of 55 %, being reached after 8 and 12 days at 30/20 °C and 25/15 °C respectively, while 18 % was reached after 24 days for 15/10 °C.

E. crus-galli germination was slightly earlier at 30/20 °C than at 25/15 °C, with a maximum of 13 % after 28 days at the first temperatures and a maximum of 20.5 % after 32 days at the last temperatures. No germination took place at 15/10 °C while Rahn *et al.* (1968) found germination in a range of between 13 and 40 °C.

The germination speed of *S. viridis* took the following course: 25/15 °C > 30/20 °C > 15/10 °C, and maximum germination of 23.5%, 3% and 6% was reached after 20, 8 and 24 days respectively, being the optimum close to 27/15 °C found previously (Pike, 1984). These results differs with the obtained previously, where the germination speed grew to increase the temperatures (Blackshaw, 1981).

Table 1 shows the mean percentages of germination for each species at the temperatures tested. The previous analysis of variance showed very significative effects of temperatures and species on the germination, as well as of the interaction temperatures-species.

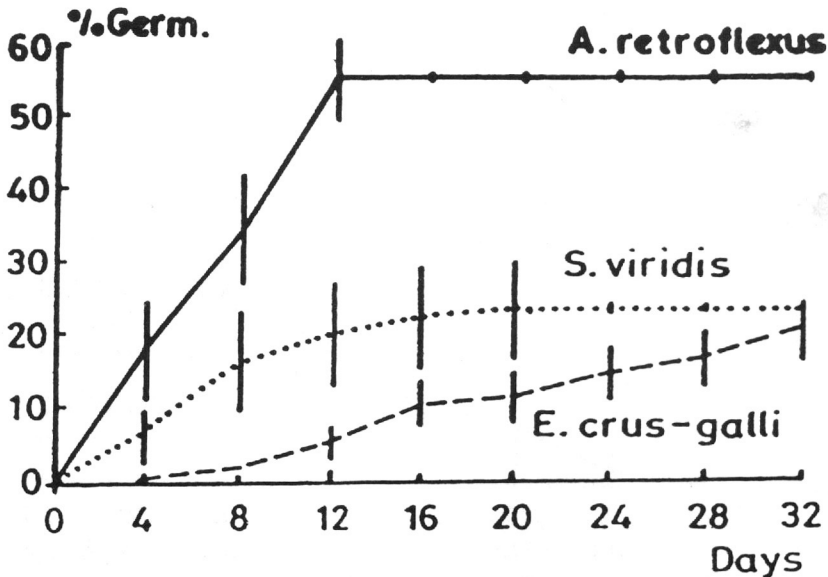


FIG. 1.—Evolution of mean percentages of germination at 30/20 °C. Bars indicate \pm s. e.

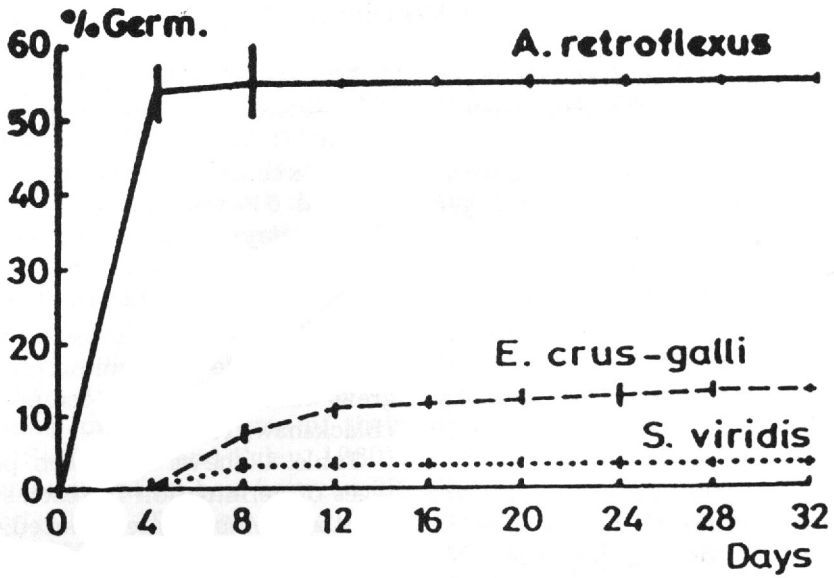


FIG. 2.—Evolution of mean percentages of germination at 25/15 °C. Bars indicate \pm s. e.

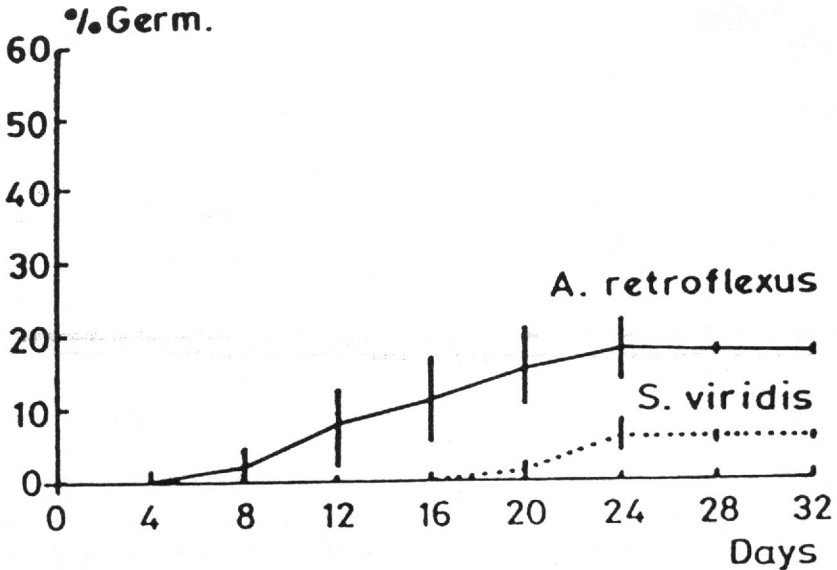


FIG. 3.—Evolution of mean percentages of germination at 15/10 °C. Bars indicate \pm s. e.

TABLE 1

Mean percentages of germination on 32 days.

Species (E)	Temperatures (T)		
	30/20 °C	25/15 °C	15/10 °C
<i>A. retroflexus</i>	55.0e	55.0e	18.0d
<i>S. viridis</i>	3.0ab	23.5d	6.0abc
<i>E. crus-galli</i>	13.0bcd	16.5cd	0.0a

Mean values followed by the same letter are not significantly different as determined by Fisher's LSD at the 5 % level.

We can see how *A. retroflexus* showed at 30/20 °C and 25/15 °C the higher percentages of germination, being significantly higher than at 15/10 °C and than in the other species at all temperatures.

The maximum percentages of *S.*

viridis and *E. crus-galli* were reached at 25/15 °C, being significant the differences with the other temperatures for *S. viridis* and only with 15/10 °C for *E. crus-galli*, where no germination was obtained.

CONCLUSIONS

By using seeds that had been stored long enough for their dormancy to be broken, we obtained that *A. retroflexus* presents the most varied range of alternated temperatures for its germination, so the seeds could germinate during all the growth season of the associate

summer crop.

E. crus-galli could germinate only in the summer time, while *S. viridis* would present higher germination at 25/15 °C, with a serious decrease of germination above or below of these temperatures.

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