

TEMPERATURE REQUIREMENTS DURING GERMINATION IN SUNFLOWER

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Abstract

Germination trials were carried out at several temperatures (3-40.5°C) on 22 sunflower cultivars. Germination % and time were analyzed for each cultivar at each temperature. The aim of the research was to establish possible behavioural differences among cultivars; results showed high variability, with high germination time at low temperatures. There were significant differences among cultivars, a fact of extreme interest for research into inbred lines with high viability and vigour, particularly at low temperatures.

Introduction

Temperature requirements during germination of various species give valuable information for planning in agronomics. Not only minimum but also optimal and maximum germination temperatures are of interest in this respect. It is also essential to test high values of germination energy, particularly at low temperatures to enable genetic improvement. Such values may be an indication of genetically induced "vigours" in different cultivars, that is where they are not related to agronomical or environmental variables. One useful species to test in this respect is sunflower, increasingly widely grown in the Mediterranean area. It is a crop for which research into genetic improvement would increase yield and widen its area of cultivation.

At present a temperature of 6°C is considered the minimum, (9,10) and 25°C the optimal for germination. Lines which do not require such high temperatures during the early stages of development should be developed (4). The sowing date should also be brought forward, in order to shorten the growth cycle and avoid periods of heat and drought which jeopardize yield (5). Research of this type has been done on other species (3), indicating that different varieties of soya react to high temperatures during germination in different ways. The effects of temperature during early stages of development have been tested in six soya cultivars (7) and similar tests have been carried out on maize. The present Authors (6) tested germination energy in several cultivars of Triticum durum. The aim of the present research was to establish the minimum, maximum and optimal germination temperatures for various sunflower cultivars in order to provide useful genetic information for improving the species.

Materials and Methods

Trials were carried out at the Seed Testing Laboratory, Pisa University in 1983. Samples of the following cultivars or hybrids of Helianthus annuus were used: "Airelle", "Ala", "Ala'", "Albinia", "Amiata", "Argentario", "Chernianka", "Egnazia", "Eliodoro", "Gianni", "INRA 6501", "ISCI 10", "ISEA PM 22", "Rekord", "Remil", "Romsun 52", "Romsun HS 52", "Romsun HS 90", "Romsun HS 301", "Siponto", "Uniflor 70" and "YU NS 65". All samples were taken from a collection of varieties gathered in 1982 from the "Torretta" experimental farm, Pisa University. Germination % at temperatures between +3°C and 40.5°C at 1.5°C intervals and germination energy were recorded.

Germination % was measured by a daily count of the number of seeds germinated in each sample and by recording the number of normal seedlings (normal root formation and cotyledon emerged from tegument) and the abnormal ones (1). Germination time was from 1 day at the highest temperatures to 55 at the lowest.

Germination cabinets where up to 24 different temperatures can be maintained at the same time were used; accuracy was within $\pm 0.2^{\circ}\text{C}$, improving to $\pm 0.1^{\circ}\text{C}$ above 22°C and below 12°C . Trials were carried out in fluorescent light with 1000 Lux lamps outside each cell, in three runs of 50 seeds for each temperature. Germination was in 15 cm Petri dishes between two filter papers and doses of distilled water were added according to the temperature tested. Transparent plastic sheets were used to minimize evaporation. No measures were taken to interrupt dormancy, to avoid modification of the effects of temperature alone. Nothing was given to the germinating seeds. Dormancy was in any case low since only 10 months had elapsed since the seeds had been harvested, during which time they had been kept at $+5^{\circ}\text{C}$ and 50% RH. A statistical analysis of data by the analysis of variants was made concerning germination % and Mean Germination Time (M.G.T.). Percentage germination % data were commuted to angular values before elaboration.

Results

Highest germination % values are obtained at lowest temperatures and decrease gradually as the latter rise. There is no significant difference in results in the interval between 6°C and 23°C , but a rapid fall is revealed above 25°C , reaching almost zero at 37°C (fig. 1). This indicates that during germination, sunflower tends to be inhibited by high temperatures. M.G.T. varies from a maximum of over 40 days at the lowest temperature (3°C) to a minimum of about 1 day at the highest (40°C). Germination is however almost nil at this temperature and seedlings showed abnormalities in development. M.G.T. falls rapidly between 3°C and 4.5°C from 43 to 30 days, but is fairly constant following this (fig. 2).

Fig. 1: Helianthus annuus, germination % at each temperature

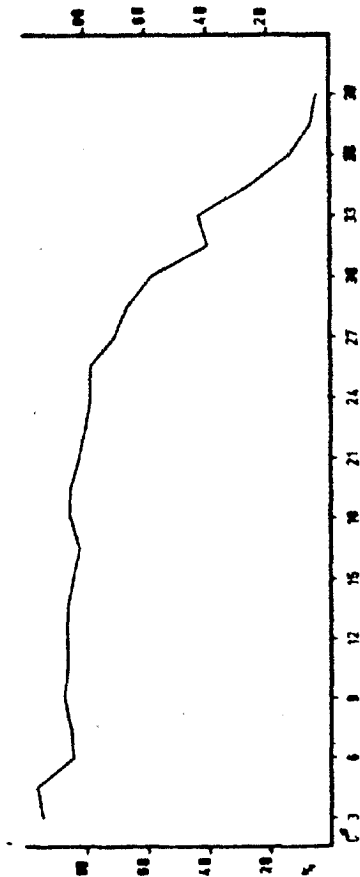
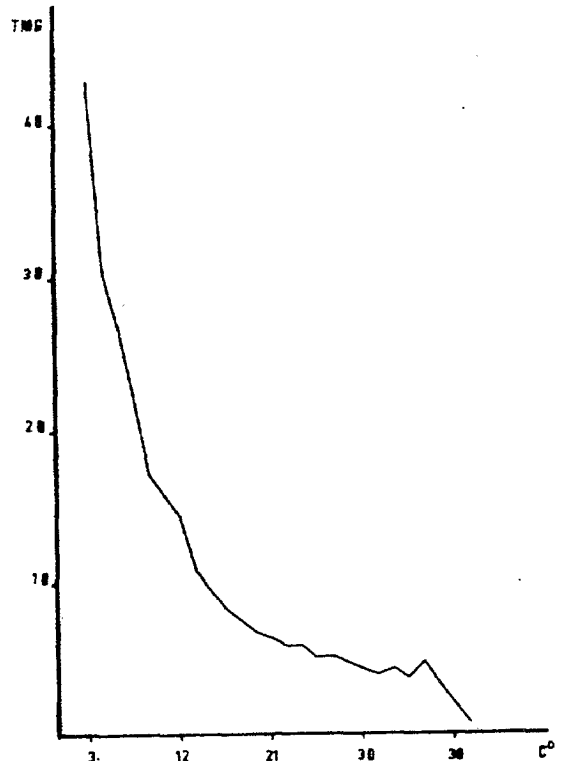


Fig. 2: Helianthus annuus mean M.G.T. at each temperature



Mean germination % does not achieve high values in all cultivars; only "Arielle" exceeds 85%. "Rosmun HS 301", "Cherniaka", "INRA 6501" and "Rosmun HS 90" also have high germination % (>75%). The remaining cultivars fall into 2 groups: a) cultivars with 60-75% germination; b) cultivars with mean germination % over 50%; "Rekord" and "ISCI 10" are exceptions (45% and 25% respectively). Highest germination energy (M.G.T. ca. 9 days) was shown by "ISEA PM 22", "Rekord", "Uniflor", "Egnazia" and "Ala". In all other varieties M.G.T. varies between 10 and 11 days. Lowest germination energy was shown by "YU NS 65", "Gianni", "Rekord" and "ISCI 10" (Tab. 2).

Tab. 1: Helianthus annuus, germination % (mean values for each temperature)

Airelle	87.0%	a A	Remil	69.2%	be BD	Ala"	59.1%	ef CE
Romsun HS 301	77.1%	b AB	Siponto	68.6%	be BD	ISEA PM 22	58.9%	ef CE
Chernianka	76.3%	bc AB	Amiata	68.4%	be BD	Egnazia	58.8%	ef CE
INRA 6501	75.3%	bc B	Romsun 52	67.7%	be BE	Ala	55.0%	fg DF
Romsun HS 90	75.0%	bc B	Uniflor 70	66.4%	ce BE	YU NS 65	54.6%	fg EF
Eliodoro	72.2%	bd BC	Argentario	64.4%	df BE	Gianni	53.4%	fg EF
Romsun HS 52	70.3%	bd BC	Albinia	64.1%	df BE	Rekord	45.6%	g F
						ISCI 10	24.8%	h G

D.M.S. (P=0.05) = 6.55 (P=0.01) = 8.61

Tab. 2: Helianthus annuus, M.G.T. (mean value for each temperature)

ISCI 10	12.75	a A	Romsun HS 301	10.99	be BE	YU NS 65	10.44	cg BH
Gianni	12.06	ab AB	Ala"	10.79	be BF	Albinia	10.26	dh CH
Eliodoro	11.68	ac AC	Chernianka	10.77	be BF	Amiata	9.96	di CH
Remil	11.62	ac AC	Argentario	10.76	be BF	Ala	9.67	ei DH
Romsun 52	11.16	bd BD	INRA 6501	10.65	cf BG	Egnazia	9.36	fi EH
Airelle	11.14	bd AD	Siponto	10.57	cf BH	Uniflor	9.16	gi FH
Romsun HS 52	11.02	bd AE	Romsun HS 90	10.53	cf BH	Rekord	8.93	hi GH
						ISEA PM 22	8.82	i H

D.M.S. (P=0.05) = 1,33 (P=0.01) = 1.75

Cultivars with germination % > 75% show 10-11 day M.G.T.; "ISEA PM 22", "Egnazia", "Ala" "Rekord" and "YU NS 65" with germination % < 60% have high germination energy. "Gianni" and "ISCI 10" show low values in both germination % and energy. Figs. 3 and 4 show the different values of M.G.T. of cultivars at high and low temperatures.

Fig. 3: M.G.T. in Helianthus annuus: temperatures for lowest values

- A = Airelle
- B = Argentario
- C = Remil, Siponto, Romsun HS 90
- D = Isea PM 22, Eliodoro, Romsun 52, Ala'
- E = Uniflor, Albania, ISCI 10
- F = Romsun HS 301, INRA 6501, Gianni, YU NS 65
- G = Rekord, Ala, Amiata, Cerniankana
- H = Egnazia

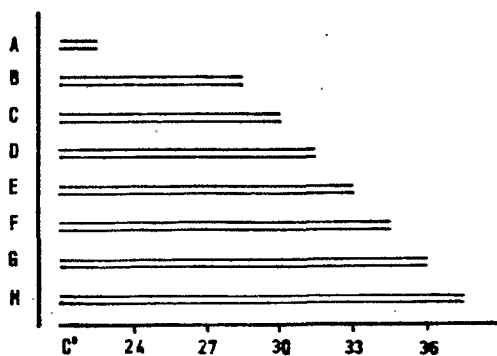
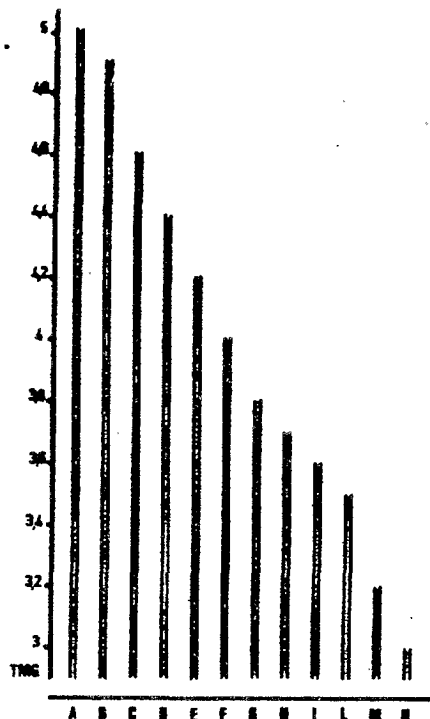


Fig. 4 - M.G.T. in Helianthus annuus: lowest values.

- A = Remil, Romsun HS 301, Romsun HS 90
- B = Romsun 52
- C = Ala'
- D = ISCI 10
- E = Chernianka
- F = Gianni, Airelle
- G = Argentario, Romsun HS 52
- H = Amiata, INRA 6501
- I = Siponto
- L = Egnazia, Albinia
- M = YU NS 65, Eliodoro, Uniflor
- N = ISEA PM 22, Rekord, Ala



Germination at low temperatures (3°C-4.5°C) is above 90% for most cultivars; only "Gianni" and "ISCI 10" show lower % values (see Tab. 3).

Tab. 3 - Helianthus annuus: germination % at low temperatures

Remil	98.0%	a A	ISEA PM 22	97.0%	ab AB	INRA 6501	92.2%	ac AB
Egnazia	98.0%	a A	Ala	97.0%	ab AB	Chernianka	90.5%	bc AC
Albinia	97.0%	ab AB	Amiata	97.0%	ab AB	Rekord	86.0%	bd BC
Siponto	97.0%	ab AB	Eliodoro	96.0%	ac AB	Romsun HS 301	84.1%	cd BC
Romsun HS 90	97.0%	ab AB	Airelle	94.9%	ac AB	Romsun 52	84.1%	cd BC
Romsun HS 52	97.0%	ab AB	Argentario	94.0%	ac AB	Ala"	82.9%	cd BC
Uniflor 70	97.0%	ab AB	YU NS 65	94.0%	ac AB	Gianni	66.3%	de CD
						ISCI 10	46.0%	e D

D.M.S. (P=0.05) = 4.43 (P=0.01) = 6.04

In contrast to germination rate, where behaviour was fairly homogeneous, germination energy shows widely differing values (see Tab. 4); M.G.T. varies from 33-45 days.

Tab. 4 - Helianthus annuus: germination energy.

ISCI 10	45.38	Chernianka	37.41	be BE	ISEA PM 22	35.17	df B
Remil	40.18	INRA 6501	37.33	be BE	Egnazia	34.68	df CE
Gianni	39.68	Albinia	36.75	bf BE	Amiata	34.52	df CE
Romsun HS 52	39.29	Romsun 52	36.75	bf BE	YU NS 65	34.19	ef DE
Ala"	38.17	Siponto	36.57	bf BE	Argentario	34.19	ef DE
Airelle	37.61	Ala	35.40	cf BE	Uniflor	34.10	ef DE
Romsun HS 90	37.52	Romsun HS 301	35.28	df BE	Eliodoro	33.08	f E
					Rekord	32.86	f E

D.M.S. (P=0.05) = 3.9 (P=0.01) = 5.31

Discussion

Minimum germination temperatures in these trials proved to be lower than for other annual Spring-Summer crops such as sorghum and maize; temperatures were also seen to be lower than published hereto in the literature on sunflower. The data indicate that it would be interesting to examine cultivars for minimum germination temperatures, since this would indicate which cultivars or lines are indicated for early planting.

Results indicate that "Rekord", "Uniflor" and "Amiata" have high germination energy at all temperatures; "ISEA PM 22", "Egnazia" and "Ala" have a generally high germination energy except at low temperatures. "Airelle", "Eliodoro", "INRA 6501" and "Chernianka" have good germination % at all temperatures.

In the present Authors' opinion, this research indicates that the varieties differ in "vigour", since all those tested came from the same environment, in the same year and were stored under the same conditions, so that they should all have had the same reproductive characteristics. The As. also believe that it should be possible to distinguish differing levels of "vigour" among samples of the same variety from different localities; this would be most useful in judging the quality of seed. Further study should be carried out on differences in temperature requirements among varieties, particularly in the early stages of development, when sudden falls in temperature can damage sunflower.

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