TRIALS WITH WINTER-SOWN SUNFLOWER

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INTRODUCTION

In most countries sunflower is grown as a summer crop, rainfed in areas receiving adequate summer raifall favourable distributed, or as irrigated crop in areas receiving inadequate precipitation in which sowing is done in spring, as soon as temperatures are above around 10°C.

Most Mediterranean countries have long dry summers with their precipitation concentrating during November — April. Winters are relatively mild, with day minimum temperatures normally around 2—10°C. At seedling stage sunflower is more resistant to low temperature than at 6—8 leaf stage (Robinson, 1980). Therefore, it seems logical that sunflower be sown in these areas during the winter or early in the spring in order to economize on irrigation requirements. In Southern Mediterranean Spain where winters are mild, around 300.000 ha of sunflower are sown in March, but yields are low, 500—1 500 kg/ha, because of dry weather during summer (Gimeno *et al.*, 1985). Trials conducted at Cordoba, Spain. over three years, were given 1—2 irrigations because of below average precipitation. Yields declined with delay in sowing from December (2.0—2.5 t/ha) to 15 April (1.2—1.5 t/ha). Early studies in Cyprus (Hadjichristodoulou, 1984) indicated satisfactory growth of plants sown at 5 dates in fortnightly intervals, between March 1 and May 4.

In the U.S.A. sowing is done in early summer except in Florida, Hawaii and other areas with mild winters, where sunflower can be sown in winter. In Minnesota sowing in early May gave higher yields, hectoliter weight, oil percentage and larger seeds than April or June sowings (Robinson, 1970). In Georgia, the grain yield and oil content of seeds were higher when sunflower was sown from mid-March through April than later, May, June and July (Johnson and Jellum, 1972). In a study conducted in Central Oregon optimum sowing time was mid-May, with earlier sowings facing a frost damage and later sowings giving lower yields (Murphy, 1978).

One aspect of studies conducted in Cyprus since 1983 on the possibility of introducing sunflower cultivation, was the determination of optimum sowing date for high yields of grain, high oil content and low irrigation requirements.

MATERIALS AND METHODS

The sowing date trials were conducted at Akhelia, South West coast of Cyprus for three seasons, 1984—1986. In 1985 an observation sowing date nursery was sown at Dromolaxia (estern coast) and at Athalassa (central plain).

The climatic conditions at Akhelia are characterized by mild winters and relatively cool summers. Minimum temperatures in the winter are above 2°C (mean daily minimum temperatures during November-April 8—13°C), and maximum mainly below 33°C (mean daily maximum temperatures during the summer, May to September, 27—32°C). At the other two locations, where observation sowing date nurseries were grown in 1985, temperatures in the winter were lower than at Akhelia. At both locations the extreme minimum temperatures were as low as —4°C.

In the first season, five sowing dates between 1 March and 4 May 1984, in the second season seven sowing dates between 9 November 1984 and 2 May 1985, and in the third season seven sowing dates from 14 November 1985 to 12 May 1986 (Tables 1, 2, 3) were tested. A randomized complete block design was used with 3 replications in the firest year and four in the other two seasons. In the first season plots consisted of five, 5 m long rows, spaced 45 cm, with 30 cm within row spacing. In the second and third years spacing between rows was 70 cm and within row 20 cm. At sowing, 48.5 kg/ha N, 90 kg/ha P_2O_5 and 90 kg/ha K_2O were applied in 1984. In 1985 and 1986, 31 kg N and 143 kg P_2O_5 per ha were applied. Application of K_2O was not considered necessary. In these trials, the best available variety was used, namely Romsun HS 52 in 1984 and 1985, and Fundulea 55 in 1986.

Table 1

Effects of sowing date on Romsun HE 52 sunflower hybrid in 1984 at Akhelia

Sowing date	Flowering date	Grain yield (kg/ha)	1 000-grain weight (g)	Oil content (%)	Volume weight (kg/hl)	Head diameter (cm)	Number of grains per head
1 March	4 June	4 196 ab *	71 ab	48.6 a	41 a	18 bc	963 a
16 March	8 June	4 936 a	74 a	47.7 ab	41 a	17 c	1 041 a
3 April	16 June	3 641 b	70 ab	45.9 bc	39 b	21 a	961 a
18 April	26 June	3 508 b	64 ab	46.8 ab	39 b	20 ab	928 a
4 May	9 July	2 671 c	62 b	44.7 c	38 b	19 abc	1 036 a
Mean		3 790	68	46.7	40	19	986
CV (%)		12.7	9.6	2.3	1.9	7.6	11

* Bird damage reduced yields by 5—10%.

Table 2

Effects of sowing date on Romsun HS 52 sunflower hybrid grown in 1984—1985 at Akhelia

Sowing date	Flowering date 1985	Grain yield (kg/ha)	1 000-grain weight (g)	Oil content (%)	Volume weight (kg/hl)	Head diameter (cm)	Number of grains per head
9 November 1984	14 March	—	—	—	—	19 cd	—
3 December 1984	9 April	—	—	—	—	19 cd	—
7 January 1985	20 May	3 389 ab	77 a	42 ab	37 a	23 a	990 a
6 February 1985	27 May	3 493 ab	78 a	43 a	36 a	22 a	1 086 a
4 March 1985	4 June	3 885 a	59 a	47 a	40 a	22 a	1 231 a
5 April 1985	13 June	4 055 a	82 a	42 ab	33 a	20 bc	876 a
2 May 1985	3 July	2 982 b	61 a	45 a	34 a	17 d	838 a
Mean	—	3 561	71	44	36	20	1 004
CV (%)	—	13.4	19.4	5.1	8.9	6.5	15.7

Table 3

Yield and quality of sunflower variety Fundulea 55 sown at seven sowing dates in 1985—1986

Sowing date	Grain yield kg/ha	Flowering date	Maturity date	1 000-grain weight (g)	Oil content (%)	Volume weight (kg/hl)	Head diameter (cm)	Number of grains per head
14 November 1985	1 002 c	7 March	30 April	64 ab	44 b	41 a	15 c	222 b
13 December 1985	1 700 b	4 April	30 May	66 a	47 ab	40 ab	19 ab	427 a
20 January 1986	2 661 a	25 April	20 June	57 bc	48 a	37 b	20 a	604 a
13 February 1986	1 762 b	12 May	30 June	51 cd	44 b	34 c	20 a	538 a
12 March 1986	1 659 b	27 May	5 July	43 d	44 b	30 d	19 ab	510 a
14 April 1986	1 633 b	17 June	20 July	46 d	47 ab	34 c	17 bc	498 a
12 May 1986	1 735 b	5 July	4 August	46 d	47 ab	34 c	17 bc	560 a
Mean	1 736	—	—	53	46	37	18	480
CV (%)	22.4	—	—	5.9	3.1	3.2	8.9	17.1

Most of the trials were conducted under irrigated conditions, because rainfall in Cyprus is very variable, both within season and between seasons (Hadjichristodoulou, 1982). Irrigation was applied as needed to secure normal growth of the plants. One trial, however, in the 1985—1986 season was sown rainfed, in order to assess the possibility of growing rainfed sunflower.

Data were recorded on emergence date, plant height every 15 days, flowering date, maturity date, grain yield, 1 000 — grain weight, volume weight, head diameter, and N and oil content of the seed.

RESULTS

The main body of the results refers to the irrigated trials, only when specifically mentioned, results refer to the rainfed trial.

Phenology. The periods from sowing to emergence, from emergence to flowering and from flowering to maturity was shorter in the spring than the winter sowings (Fig. 1). In 1984—1985, the period from sowing to flowering was 125—133 days for the first three sowing dates (November-December-January) but shortened to 110, 92, 71 and 62 days for the February, March, April and May sowings, respectively. Similar were the results of the 1985—1986 trials (Fig. 1). The total period from sowing to maturity was almost six months for the November 1985 sowing and was shortened to three months for the May sowing.

The rate of increase in plant height and the final height at maturity were lower in the early sowings than the late sowings (Fig. 2). The final height of plants was 102 cm for the November sowing and increased to 144 for the May sowing.

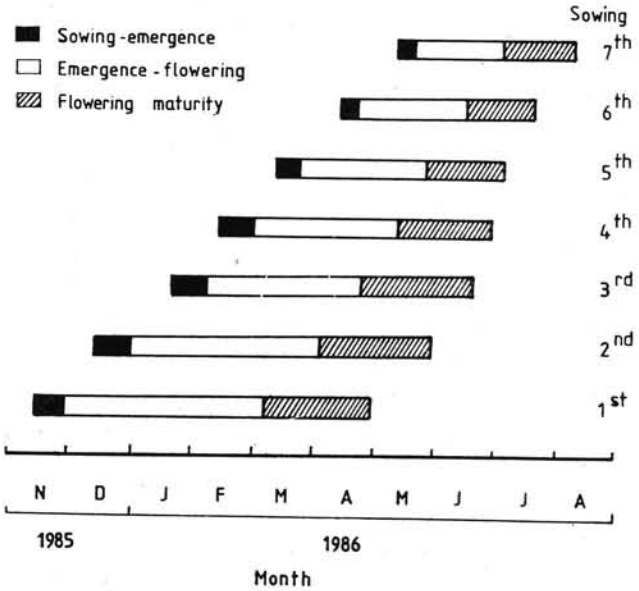

Fig. 1 — Duration of growth stages of sunflower hybrid Fundulea 55 at seven sowing dates

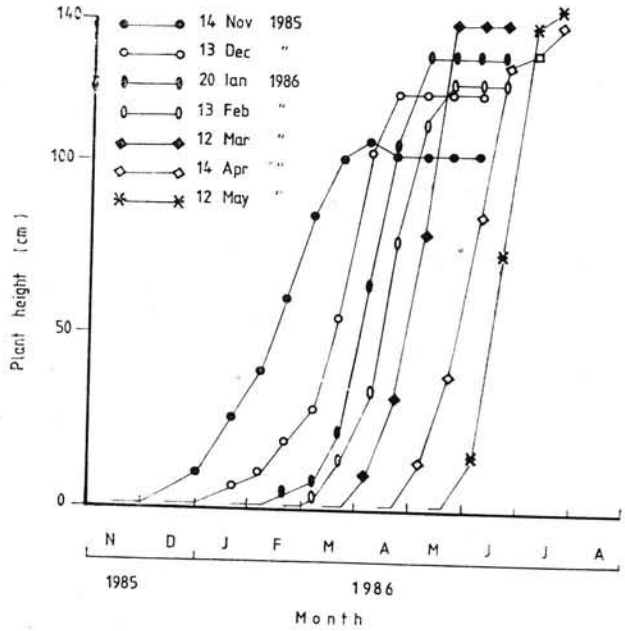

Fig. 2 — Effects of different sowing dates on height of sunflower hybrid Fundulea 55

Grain yield. In 1984, the grain yield of the sowings on 1—16 March was around 4.5 t/ha, reduced to 3.6 t/ha for the two sowings in April and to 2.7 t/ha for the sowing on 4 May (Table 1). In 1984—1985, the grain yield of the sowing during 7 January to 5 April 1985 was similar, 3.4—4.0 t/ha, reduced to 3.0 t/ha in the 2 May sowing (Table 2). No valid comparisons were possible with the sowings in November and December 1984 because of severe bird damage on grain yield. In 1985—1986, grain yield was the highest with the sowing on 20 January, 2.7 t/ha, it was reduced to around 1.7 t/ha for four later sowings up to 12 May and an earlier one, 13 December. The lowest yield (1.0 t/ha) was given by the earliest sowing, 14 November.

Head size. It was measured as head diameter at maturity stage. In addition, the number of grains was estimated from grain yield, number of heads and 1 000 — grain weight. In 1984, the head diameter was the highest, 20—21 cm, with the April sowings and the lowest, 17—19 cm, with the March or May sowings (Table 1). In 1985, heads were large, with 22—23 cm diameter for sowing between January and 4 March, and tended to be smaller for earlier or later than this period sowings (Table 2). In 1986 the smallest heads were produced by the November and May sowings and the largest by the January and February sowings (Table 3). The number of grains per head in 1984—1985 ranged from 838—1 231 with no significant differences among sowing dates. In 1985—1986 the number of grains per head was 222 for the November sowing and increased to 427—560 for other sowings (Tables 1, 2, 3).

1 000 — grain weight. It was similar over a wide range of sowing dates and it was 62—

72 g in 1984, 60—82 g in 1985 and 43—66 g in 1986 (Tables 1, 2, 3). In 1986, there was a tendency for reduced 1 000 — grain weight with delay in sowing date from 14 November 1985, 64 g, to 12 May 1986, 46 g (Table 3).

Volume weight. The range of volume weight of sowing dates was 38—41 kg/hl in 1984, 33—40 kg/hl in 1985 and 34—41 kg/hl in 1986 (Tables 1, 2, 3). The differences among sowing dates were not significant in most cases. April-May sowings gave lower volume weight than the earlier ones. In 1985—1986 the highest volume weight was given by the November-December sowings and the lowest by the February-May sowings.

Nitrogen content. Nitrogen content of dry matter of seeds was similar in all sowing dates and it was on average 3.4% in 1984 and 3.7% in 1985.

Oil content of seed. In 1984, the oil content of the March sowing was the highest, 48.6% and was lower, 45%, with delay of sowing until May. In 1985, the oil content ranged from 44% to 48%, with no consistent trend between sowing dates.

RAINFED TRIAL

In the rainfed trials, yields were extremely low, ranging from 150 to 565 kg/ha. This was caused by moisture stress, because precipitation was below average in spring 1986, being 78 mm, 40 mm, 7 mm, 6 mm and 11 mm in January, February, March, April and May, respectively. There was no rain in June. In general, early sowing gave higher yield than later sowings (Table 4). Also volume weight, 1 000—grain weight and the number of grains per head tended to be reduced with delay in sowing. The mean oil content was 42% with no significant differences among sowing dates. Head size, 1 000—grain weight and volume weight of the rainfed trial were much lower than in the irrigated trials (Tables 1, 2, 3 and 4).

Table 4

Effects of sowing date on sunflower variety Fundulea 55, grown under rainfed conditions

Sowing date	Grain yield kg/ha	Volume weight (kg/hl)	1 000-grain weight (g)	Number of grains per head
14 November 1985	430 ab	41 a	38 a	163 ab
13 December 1985	583 a	40 ab	35 abc	256 a
21 January 1986	565 ab	39 ab	36 ab	223 ab
13 February 1986	220 ab	31 d	28 c	126 ab
13 March 1986	220 ab	31 d	28 c	126 ab
14 May 1986	149 b	31 cd	30 bc	74 b
Mean	377	35	33	166
CV (%)	44.8	5.4	9.2	37.8

WINTER SOWING IN OTHER AREAS

A sowing date nursery during 1984—1985 at Nicosia (centre of the island) and at Dromolaxia (eastern coast) showed that winter sowing is risky. All winter sown plots were killed by frost (—4°C). A few plants that survived were at the seedling stage. The late sowings failed to produce any seeds because of moisture stress.

DISCUSSION AND CONCLUSIONS

The general conclusion from the studies in Cyprus and other countries is that sowing date is a significant factor affecting yield, yield components and some quality characteristics. Additionally, the choice of optimum sowing date may reduce the cost of production by reducing irrigation requirements and weed control expenses.

Sowing in autumn, November-December, gave lower grain yields because of slow growth rate and reduced total plant growth, which was expressed as reduced plant height and small size of heads. Weed competition is higher in the November-December sowings because of the slow growth of the sunflower plants. Sowing in January allows for a presowing mechanical control of weeds germinating soon after the first rains in late autumn-beginning of January. In sowing date trials with limited irrigation in Spain yields were the highest for December sowing and declined linearly with delay in sowing (G i m e n o *et al.*, 1985).

As regards the January-April sowing, in the majority of the cases yields were similar. Sowing in May gave consistently lower yield than all earlier spring sowings. In other studies yields of sowings decline linearly with delay in sowing from April 24 to June 28 (R o b i n s o n, 1980) and from March 17 to July 22 (J o h n s o n and J e l l u m, 1972). Oil content, another trait of economic importance was by 5—15 percentage points higher in the early sowings than in later sowings. (R o b i n s o n, 1970 ; J o h n s o n, 1972). In Cyprus, also, oil content was the same or higher in the early than later sowings. It can be concluded from these studies, that considering grain yield, oil content, irrigation requirements and cost of weed control, the optimum sowing date of irrigated sunflower in Cyprus is January-March.

The differences between winter and spring sowings in the length of time between emergence, flowering and maturity, are explained by the increase in growing degree-day (GDD) per day (R o b i n s o n, 1971, 1980). Plants of later sowings grew during warmer periods of the year, than those of early sowings. Sunflower is often classified as insensitive to photo-

period, because it flowers through a wide range of daylengths (Robinson, 1980). In Cyprus, sunflower flowers all the year around. Volunteer plants were found to flower between September — March.

Yield and all yield components were much lower in the rainfed trial than the irrigated trial. It seems, that though temperature at Akhelia favours the growth of winter-sown sunflower, variation in precipitation renders the crop unsafe to grow it commercially. In the other areas where winters are colder, winter-sown sunflower is exposed to frequent frost damage and thus it is not economic to grow it.

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ESSAIS AVEC LE SEMIS D'HIVER DU TOURNESOL

Résumé

Des essais avec dates de semis, avec les hybrides Romsun HS 52 and Fundulea 55, ont été effectués pendant trois saisons, dans une zone côtière du Chypre avec des hivers doux et températures minimes au-dessus 0°C. Les dates de semis ont renfermé la période Novembre — Mai. La croissance des plantes a été plus lente au semis d'hiver qu'au semis de printemps. Le plus grand rendement en grains a été obtenu au semis dans la période Janvier — Mars. Au semis de printemps, le rendement a été plus petit. Le gel a détruit les plantes en autres zones côtières ou dans les plaines centrales de l'île, où la température a baissé jusqu'à —4°C.

Le rendement du tournesol semé l'hiver, en culture irriguée, a augmenté jusqu'à 4 t/ha, avec une teneur en huile de 44—48%. En culture sèche, les rendements ont été toutefois très bas, environ 0,5 t/ha, sans être économiques pour les cultures commerciales.

Le semis d'hiver présente importance dans les pays méditerranéens avec des hivers doux, parce que les étés sont pratiquement sèches et le coût de l'eau d'irrigation est élevé.

EXPERIENCIAS CON GIRASOL SEMBRADO EN INVIERNO

Resúmen

Experiencias con datos de siembra, con los híbridos Romsun HS 52 y Fundulea 55 se efectuaron durante tres épocas, en una zona costal de Chipre de inviernos blandos, de temperaturas mínimas sobre 0°C. Los datos de siembra comprendieron el período Noviembre — Mayo. El crecimiento de las plantas fue muchomas lento en la siembra de invierno que en aquella de primavera. La mayor producción de semilla se obtuvo en la siembra del período Enero — Marzo. En la siembra de primavera la producción resultó menor. La helada destrujo las plantas en otras zonas costales o en las llanuras centrales de la isla, donde la temperatura bajó hasta —4°C.

La producción de girasol sembrada en invierno, en cultura de regadío aumentó hasta 4 t/ha, con un contenido de aceite de 44—48 por ciento. No obstante en la cultura sin regadío las producciones resultaron muy bajas, alrededor de 0,5 t/ha, no siendo económicas para las culturas comerciales.

La siembra de invierno presenta importancia en los países mediterraneos de inviernos blandos, puesto que los veranos son practicamente secas y el precio del agua de regadió resulta alto.