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SUNFLOWER – A POTENTIAL CROP FOR THE U.K.

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SUMMARY

Sunflower grown in the UK produces a high quality oil but few commercially available varieties are sufficiently early maturing for our northern climate. Varieties maturing within 140 days are required as harvest after the end of September increases the risk of disease and an unacceptably high seed moisture content. Many aspects of agronomic practice and methods of disease control were examined in order to select those most suited to UK conditions. More than 200 varieties and breeding lines were grown during the period 1985–1990. Data are given on the phenology and yield of selected varieties, as affected by sowing dates, row spacing, seed rates and fungicides. If a wider range of early maturing varieties, which meet specified phenological and yield criteria, were available, it would enhance the potential for sunflower as an alternative oil crop in the UK and elsewhere in northern Europe.

INTRODUCTION

Sunflower crops grown under cool conditions produce a high quality oil with a good spectrum of polyunsaturated fatty acids (Anon, 1989). The high content of linoleic acid and absence of linolenic acid make sunflower oil nutritionally superior to oil from other temperate crops such as oilseed rape and soya bean. (Bunting, 1977). The estimated annual market potential for sunflower grown in the UK is 100,000 t. However, at present the crop is grown on less than 1000 ha producing about 2000 t because, until recently, most available varieties grown commercially have matured too slowly under UK conditions. Northern maritime climates present an additional constraint to sunflower production by favouring disease caused by Botrytis cinerea (Rawlinson & Dover, 1986). Infection occurring late in the season can decrease yield and early infection can cause losses in both yield and oil quality (Lamarque, 1985). Sunflower was grown successfully in England in the last century (Wilson, 1849) and in the 1940s (Hurt, 1946) with a limited resurgence of interest in the 1970s (Bunting, 1974), but varieties then available were late maturing. Our aim has been to examine a wide range of recent varieties and breeding lines, using different cultivation methods, with and without pest and disease control, to select promising early maturing varieties and agronomic practices appropriate to UK climatic conditions. Field experiments since 1985 on the agronomy, phenology and pathology of sunflower, involving measurements on more than 200 varieties and breeding lines were designed to reveal the characteristics required for a successful cool–climate ideotype. Modifications of European and American agronomy practices were tested to select optimum sowing dates, row–spacing, seed rate, fungicide type and timing, herbicide type and fertiliser rate. Selected data from this range of work are presented.

METHODS AND MATERIALS

Most experiments at Rothamsted Experimental Station were done on fallow land or on sites previously cropped with cereals. The soil was a silty clay loam over clay with flints, overlying chalk. Full details of cultivations, agronomy and fertilizers used are given elsewhere (Rothamsted Experimental Station, Yields of the Field Experiments 1985–90). The herbicide trifluralin was incorporated into the seed–bed, followed by linuron used pre–emergence, in all experiments except where herbicides were tested. Plots were usually 10m x 3.5m wide. The desiccant diquat was used in all experiments from 1987. In most experiments which tested agronomic practices the variety Sunbred 246 was used as a standard late maturing variety, and Sigco S47 as a standard early maturing variety. Fungicides were applied at the recommended rates on up to five occasions at two–week intervals from the early flowering stage. Different fungicides were not tank mixed but applied sequentially. Phenological measurements were made twice weekly throughout the growing season using a growth stage key commonly used in France (Anon., 1984), and records of disease incidence and severity were made at regular intervals. Plots were harvested by hand and the heads threshed by stationary Wintersteiger or Hege smallplot combines. Oil analysis was determined by Nuclear Magnetic Resonance (Newport Analyzer 4000, Oxford Analytical Instruments Ltd). Fatty acid content in 13 varieties was measured (Sigco Research Inc, Minnesota, USA) in seed harvested in the USA and France; these seed lots were sown and harvested at Rothamsted and the fatty acid content of parent and progeny seed compared. Components of yield were measured at or after harvest. Meteorological measurements were recorded at a site <1km from field experiments and are summarised in Rothamsted Experimental Station Reports for 1985–1990.

RESULTS

Table 1 shows a typical contrast in crop establishment, phenology, oil content, yield and disease in two varieties grown in cool wet and warm dry seasons. The development and yield of the early maturing variety, Sigco S47, was less affected by seasonal weather conditions than Sunbred 246. For the late maturing variety, worthwhile increases in yield of up to 1.0t/ha were obtained from populations of c.90,000/ha sown on 25cm rows (Table 2). A similar increase in yield from the early maturing variety was obtained with a population of 140,000 plants/ha on the same narrow row spacing. In 1985–1988, when rainfall was above average during flowering and maturation in July and August, generally >50% of heads were infected by Botrytis (Table 3). However, in 1990, when rainfall in those months was below average and temperature above average, the incidence of Botrytis at harvest was <5%. The use of fungicides produced a small increase in yield in the early varieties but had little effect on the late maturing varieties. The method of application, by hydraulic, electrostatic or mist–blower sprayers, had little effect on yield (unpublished data). Fatty acid analysis, on late maturing varieties such as Sunbred 246, showed a parent to progeny increase in linoleic acid from 60.6% to 72%, and early maturing varieties such as Sigco S47 from 63% to 72% when grown at Rothamsted. Sigco varieties, S69 and S64 gave increases of 40%, i.e. rising from 50% to 70% in both varieties.

Table 1 Development, yield and disease of late and early maturing varieties (Sunbred 246 and Sigco S47) in a cool wet season, 1988 (A) and a warm dry season, 1990 (B)

Sow dates	15-28 March		5 April		15-19 April		24 April		2-10 May	
Years	A	B	A	B	A	B	A	B	A	B
Variety	Sunbred 246									
No. of days to:										
50% Emergence	32	28	28	31	28	20	28	16	16	15
1st Anthers	124	124	112	97	105	94	106	95	97	84
Anthesis	136	136	126	110	118	105	116	106	111	96
Flowering (days)	12	10	14	11	13	10	10	10	14	12
Maturity	191	165	166	143	161	139	160	140	148	134
Height (cm)	77	103	114	116	103	124	91	119	115	122
%Oil(90%DM)	41.3	46.0	41.5	48.7	40.3	49.6	38.1	49.2	44.6	48.7
Oil yield (kg/ha)	307	1339	685	1513	684	1640	157	1712	823	1717
%Heads+Botrytis	58.1	2.5	76.7	5.2	67.6	1.8	89.7	4.8	98.0	1.8
Pop'n('000s/ha)	16	97	69	107	45	106	6	106	68	111
Seed yield (t/ha) @ harvest	0.74	2.91	1.60	3.11	1.69	3.30	0.41	3.48	1.85	3.53
Variety	Sigco S47									
No. of days to:										
50% Emergence	32	25	17	23	15	16	22	15	13	11
1st Anthers	117	102	101	90	95	83	98	85	86	72
Anthesis	129	125	112	104	107	95	111	96	100	86
Flowering (days)	12	14	11	14	12	12	13	10	14	10
Maturity	152	151	139	130	131	120	139	123	126	111
Height (cm)	71	64	73	74	78	75	79	75	87	83
%Oil(90%DM)	34.7	34.1	35.0	36.9	34.6	36.8	37.1	39.0	38.4	41.9
Oil yield (kg/ha)	509	284	590	634	708	740	482	931	776	945
%Heads+Botrytis	9.9	2.8	9.5	5.2	19.4	3.1	29.4	2.1	30.5	2.0
Pop'n('000s/ha)	114	102	118	106	120	101	44	105	92	107
Seed yield (t/ha) @ harvest	1.47	0.83	1.68	1.72	2.05	2.01	1.30	2.39	2.02	2.26

Table 2 Effect of row–spacing and plant population on yield of early (E) and late (L) maturing varieties, Sigco S47 and Sunbred 246 respectively. (Selected data from comparisons of seed rates ranging from 60,000 to 200,000/ha on row–spacings of 25, 38 and 50cm).

Year	Highest yield			Lowest yield			Differenc t/ha
	Final plant pop'n/ha	Row space cm	Yield t/ha	Final plant pop'n/ha	Row space cm	Yield t/ha	
1986 L	89,000	25	1.75	118,000	38	1.15	0.60
1988*L	90,000	50	2.39	45,000	50	1.99	0.40
1989+L	87,000	25	4.41	131,000	25	3.40	1.01
1989+E	140,000	25	2.94	177,000	25	2.07	0.87
1990L	112,000	25	3.55	130,000	38	2.85	0.07

*test of 50 cm row spacing only

+test of 25cm row spacing only.

Table 3 Incidence of Botrytis cinerea and seed yield of fungicide treated plots of early (E) and late (L) maturing varieties, in relation to mean rainfall and temperature for July and August 1985-1990.

Year	1985	1986		1987		1988		1989	1990
Variety*	L	E	L	E	L	E	L	E	E
%heads +F	71	83	29	39	75	11	87	4	1
infected (-F)	(67)	(84)	(61)	(47)	(76)	(20)	(92)	(6)	(3)
Yield (t/ha)	3.58	2.45	1.81	1.71	-	1.78	2.76	2.63	2.51
Yield (t/ha) response to fungicide	+0.08	+0.73	-0.37	+0.08	-	+0.04	-0.12	+0.03	+0.14
Rain (mm)	112	148		122		155		85	70
No.rain days	33	25		28		36		18	19
Mean temp. (°C)	15.3	15.1		15.4		15.0		17.5	17.5

* L = Sunbred 246 in 1985 to 1987 & Vincent in 1988.

E=Sigco S10 in 1986 & 1987; Sigco S47 in 1988 to 1990

Fungicides used:	1985,1987,1988 carbendazim + vinclozolin
	1986 prochloraz + iprodione + chlorothalonil
	1989,1990 prochloraz + vinclozolin
Application by:	1985,1987,1988 hydraulic; 1986 electrostatic
	1989,1990 mistblower

DISCUSSION AND CONCLUSIONS

Sunbred 246 has been grown commercially in the UK (Osborne, 1988) but attains few of the phenological criteria required, from any sowing date, for regular, successful harvesting, although in warm dry years good yields can be obtained. Sigco S47 was sufficiently early maturing, but yields were consistently less than those of later maturing varieties. However, later sowings combined with high plant populations enabled yields of Sigco S47 to exceed the 2t/ha required for economic viability in the UK (Sells, 1991). Both varieties when sown in April and May emerged quicker, flowered and matured earlier and yielded better than when sown in March (Table 1), indicating that early sowing is not a means of significantly enhancing maturity or yield in the UK.

As Botrytis infection appears to be directly related to weather conditions and crop maturity, late maturing varieties benefited from mid–April sowings, but earlier maturing types were sown over a wider period of time without undue delay in maturity. The establishment and yield of Sunbred 246 was less from all sowing dates in a cool, wet year than from sowing in warm, dry years, but establishment, plant development and yield of S47 were little affected by such differences in seasonal conditions. The best yields from the late maturing variety came from crops grown on narrow row spacings with established plant populations of c 90,000/ha. For the early maturing variety best yields were obtained from crops on narrow rows with up to 140,000 plants/ha. As plant populations increased, head size decreased (Rothamsted Experimental Station Report, 1988) bringing the advantage of quicker drying and a decrease in incidence and severity of Botrytis on heads. Fungicides had little effect on the control of Botrytis cinerea, or on the yield of the late maturing variety. Fungicides used on the early maturing variety decreased the number of heads infected and gave a small, positive yield response in some years.

Our results over five years have shown that sunflower in the UK is a possible spring–sown alternative to oilseed rape as a source of oil and meal to offset imports of soya. The potential of the crop would be enhanced by the availability of a greater range of higher yielding, early maturing varieties, with seed in sufficient quantity for commercial development studies and selection to suit local conditions. The high quality edible oil is further enhanced in the UK by up to 40% greater linoleic acid content. The few new early maturing varieties now commercially available, which respond better than later maturing varieties to fungicide treatment, may be grown regularly and harvested satisfactorily under the variable weather conditions in the UK. Late maturing varieties require 1200–1300 accumulated day degrees (ADD) (calculated over base of $6^{\circ}C$) to reach maturity, whereas early maturing types require less (1000–1100 ADD) and so take maximum advantage of the short UK summer. Early varieties allow a wide range of sowing dates to be used without yield penalty therefore soil preparation in spring can usually be done in conditions which provide good seed–beds. However, infection by Botrytis cinerea remains a significant problem causing yield loss in cool, wet years. There is a significant correlation between the rate of capitulum maturation and the appearance of disease symptoms, and in unfavourable seasons the development of Botrytis can be delayed by using a desiccant when seed moisture is 30% or less. New varieties which more closely meet the following criteria would enhance the potential of the crop in the UK: number of days taken from sowing to 50% emergence, <20; to the appearance of the first anther rings, <85; to anthesis, <100; to maturity, <140. Crop height, <100cm; oil content @ 90% seed dry matter, >45%; seed yield, >2.5t/ha.

REFERENCES

Anonymous (1984). Les Stades Reperes du Tournesol. CETIOM.

Anonymous (1989). Alternative crop and livestock enterprises for UK agriculture. Report of the Novel Crops and Livestock Enterprise Review Group. Ministry of Agriculture Fisheries and Food. 115pp.

Bunting,E.S. (1974). New arable crops – retrospect and prospects. Journal of the Royal Agricultural Society of England, 135, 107–121.

Bunting,E.S. (1977). The potential of minor field crops in British agriculture. Proceedings of the 1976 British Crop Protection Conference–Weeds 3, 947–953.

Hurt,E.F. (1946). Sunflower for food, fodder and fertility. Faber and Faber, London.

Lamarque,C. (1985). Evolution permanente de la situation phytosanitaire de Tournesol en France. Phytoma, 20–24.

Osborne,R. (1988). Sunflower: a new crop in British agriculture. Proceedings of the 12th International Sunflower Conference, Novi Sad, Yugoslavia 1, 331–335.

Rawlinson,C.J.&Dover, P.A. (1986). Pests and diseases of some new and potential arable crops for the United Kingdom. Proceedings 1986 British Crop Protection Conference – Pests and Diseases 2, 721–732.

Rothamsted Experimental Station (1988). Annual Report for 1987,p63.

Rothamsted Experimental Station (1985–90). Yields of the Field Experiments, 85 to 90/R/Su/1 to 4.

Sells,J.E. (1991). The profitability of growing a consistent sunflower crop in the UK. AFRC Institute of Engineering Research, Silsoe, Bedfordshire.

Wilson,J.M.(1849). Ed. The Rural Encyclopedia IV, 385–386. A. Fullarton & Co., Edinburgh.

EL GIRASOL UN CULTIVO POTENCIAL PARA EL REINO UNIDO

RESUMEN

El girasol cultivado en el Reino Unido produce un aceite de alta calidad pero pocas variedades comerciales disponibles son suficientemente precoces para nuestro clima septentrional. Las variedades que maduran dentro de 140 días son requeridas ya que la cosecha después de finales de Septiembre incrementar el riesgo de enfermedades y un contenido de humedad inaceptablemente alto. Muchos aspectos de prácticas agronómicas y métodos de control de enfermedades fueron examinados para seleccionar los mas adecuados para las condiciones del Reino Unido. Mas de 200 variedades y líneas de mejora fueron cultivadas durante el periodo de 1985–1990. Se muestran los datos sobre fenología y rendimiento de las variedades seleccionadas, y el efecto del espaciamiento entre líneas cantidad de semillas y fungicidas.

Si un rango mas amplio de variedades precoces, con los criterios de fenología y rendimiento, estuvieran disponibles, se podria incrementar el potencial del girasol como un cultivo oleaginoso alternativo en el Reino Unido y en cualquier otro lugar del Norte de Europa.

LE TOURNESOL UNE CULTURE POTENTIEL POUR LE ROYAUME UNI.

RÉSUMÉ:

Le tournesol cultivé dans notre pays produit une huile de trés bonne qualité mais seules quelques variétés commerciales sont suffisamment précoces pour notre climat nordique. Les variétés arrivant à maturité dans les 140 jours sont nécessaires, les récoltes effectuées après la fin septembre augmentant les risques de maladies et l'obtention de graines dont l'humidité est inacceptable. De nombreux aspects des façons agronomiques et des méthodes de luttes contre les maladies ont été étudiés afin de retenir les plus adaptées à nos conditions. Plus de 200 variétés et lignées ont été cultivées pendant la période 1985-1990. Les résultats ont mis en évidence l'effet des dates de semis, des espacements entre rangs, du pourcentage de graines et des fongicides sur la phénologie et le rendement. Si une plus grande gamme de variétés précoces cadrant mieux avec les critéres spécifiques phénologiques et de rendement, était disponible, cela augmenterait le potentiel de la culture du tournesol en tant que culture oléagineuse de remplacement non seulement pour le Royaume Uni mais aussi pour le nord de l'Europe.