Oil Content, Fatty Acid Composition, and Other Agronomic Characteristics of Sunflower Introductions[1]

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Abstract

Twenty sunflower (*Helianthus annuus* L.) introductions and the variety Mammoth Russian were grown at Experiment, Georgia. Total oil, fatty acid composition, and other agronomic characteristics were used to evaluate the various introductions. Total oil content varied from 17.7 to 32.7%. All introductions were relatively low in palmitic, stearic, linolenic, and behenic acids. About 90% of the oil was composed of oleic and linoleic acids, and there was considerable variation in the ratios of these two fatty acids. Seed yields varied from 329 to 3,224 lb per acre and were related to the number and size of flowers. The more profusely flowering and higher yielding introductions originated in countries of lower latitudes.

Introduction

THE MAJOR USE OF SUNFLOWER (*Helianthus annuus* L.) in the United States has been for birdseed and snack foods, but it has potential as an oilseed crop to produce oil for human consumption. The refined oil compares favorably with other edible vegetable oils and is highly stable in respect to the development of rancidity (2,3). This report is concerned with the oil quality and seed production of several sunflower introductions grown at Experiment, Georgia.

Experimental Procedure

The 21 sunflower varieties were grown in a randomized complete block experiment with four replications on a Cecil sandy clay loam at Experiment. The identifying or Plant Introduction (P.I.) numbers and origin are given in Table I.

Seed were obtained from the North Central Regional Plant Introduction Station, Ames, Iowa. Before planting (mid-May), 36 lbs of nitrogen, 32 lbs of phosphorus and 60 lbs of potassium were applied broadcast. At maturity (mid-August), six feet of row were hand-harvested, the seed heads were air-dried and hand-threshed, and the seed was weighed. Total oil content, moisture, and fatty acid composition of seed were determined by procedures reported previously (6). Oil content was calculated on a dry-weight basis of the whole seed (kernel and seedcoat). Seed yields reported are an average of the four replications, and oil analyses were made from a composite sample of the four replications.

Results and Discussion

The sunflower introductions ranged in oil content from 32.7% for P.I. 257642, a U.S.S.R. introduction, to 17.7% for P.I. 170406, a Turkish introduction (Table I). Some of the introductions produced a relatively high amount of oil per acre when compared with the average of all the introductions. P.I. 263178 yielded a total of 848 lbs of oil per acre, and P.I. 250085 produced 799 lbs of oil per acre. There was no consistent relationship between latitude of origin and oil content. Oil contents for some of the high-oil Russian lines were lower than expected. It was observed that the kernels of these lines were not well developed, possibly because of lack of adaptation to this area. This would account for lower oil contents calculated on a whole-seed basis.

All the introductions were relatively low in saturated fatty acids. The range of palmitic acid was from 4.6 to 6.8% of total oil, stearic acid from 1.7 to 3.9%, and behenic acid from 0.3 to 1.0%. A low content of saturated fatty acids is reported to be desirable for edible uses (1).

Oleic and linoleic acids comprised about 90% of the total oil content of all the sunflower introductions.

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TABLE I

Total Oil Content, Fatty Acid Composition, and Agronomic Characteristics of Sunflower Introductions

P.I. No.	Origin	Seed		Composition of Oil[a]						Air-dry seed	Plant height	Flower diameter	Flowers per 6-ft. row
		Moisture	Oil	16:0	18:0	18:1	18:2	18:3	22:0				
		%	%	% of total oil						lbs/A.	ft.	in.	
162453	Uruguay	5.7	28.0	6.8	3.9	39.0	49.5	0.2	0.6	2600	6.2	4.0	14
170404	Turkey	5.8	26.6	5.8	3.9	43.4	46.1	0.3	0.6	2145	6.3	3.0	25
170406	Turkey	5.7	17.7	5.8	3.3	43.2	46.3	0.3	1.0	1911	6.0	3.0	10
193755	Ethiopia	5.7	25.6	5.0	3.3	46.4	44.4	0.2	0.7	2366	6.6	2.5	48
201812–3	Canada	6.3	19.9	6.6	1.7	29.3	61.8	0.3	0.3	329	4.4	2.0	2
201812–10	Canada	5.5	20.8	5.0	3.9	56.2	33.5	0.4	0.9	572	5.6	4.5	1
201812–12	Canada	6.1	19.1	5.8	3.5	60.0	29.9	0.2	0.6	1105	5.0	3.0	4
243073	Jordan	5.7	22.2	5.3	3.1	46.2	44.1	0.4	0.8	2236	8.0	8.0	7
250085	Egypt	5.7	25.5	4.6	2.8	47.0	44.4	0.4	0.7	3133	7.0	8.0	7
250542	Egypt	5.1	26.2	4.7	2.3	49.6	42.8	0.3	0.3	2444	7.0	8.0	23
250852	Iran	5.0	21.4	5.4	2.9	42.5	48.3	0.3	0.6	2496	9.3	8.0	9
251901	U.S.S.R.	5.6	30.3[b]	5.3	2.9	47.1	44.3	0.2	0.3	1599	4.0	5.0	6
251902	U.S.S.R.	5.7	22.2[b]	5.4	3.8	47.4	42.6	0.2	0.5	1209	5.6	10.0	2
251993	Turkey	5.8	24.9	5.2	2.7	43.0	48.5	0.3	0.3	2639	8.0	7.0	7
253771	Iraq	5.6	23.9	5.6	2.8	39.3	51.3	0.5	0.5	2639	7.0	4.0	16
253776	Iraq	5.4	26.9	6.1	3.0	38.8	51.3	0.3	0.5	2726	7.0	3.0	28
257641	U.S.S.R.	5.2	28.4	5.6	3.4	46.1	44.0	0.4	0.5	1443	6.0	7.0	5
257642	U.S.S.R.	5.3	32.7	5.6	3.2	46.9	43.5	0.2	0.6	1658	6.3	6.0	5
263178	Tanganyika	5.5	26.3	5.5	2.8	46.0	45.1	0.2	0.4	3224	8.0	8.0	10
265449	Colombia	5.1	24.1	5.7	2.3	36.8	54.5	0.2	0.4	2841	8.0	7.0	14
Mammoth Russian		5.8	23.6	4.9	3.4	42.8	48.1	0.4	0.4	2405	7.0	6.0	18
Average		5.6	24.6	5.5	3.1	44.6	45.9	0.3	0.5	2078	6.6	5.6	12

[a] Fatty acids: 16:0 = palmitic, 18:0 = stearic, 18:1 = oleic, 18:2 = linoleic, 18:3 = linolenic, 22:0 = behenic.
[b] A recheck on analysis confirmed the apparently low oil content. Another lot of the same lines gave comparable results.

Similar results were obtained on a different group of introductions by Kinman and Earle (5). Oleic acid ranged from 29.3 to 60.0%, and linoleic acid ranged from 29.9 to 61.8%. The content of linoleic acid in edible oils is of interest, and in four of the introductions it comprised over 50% of the oil. The introductions with high linoleic acid had a wide range in latitude of origin: P.I. 201812–3 from Canada, P.I.'s 253771 and 253776 from Iraq, and P.I. 265449 from Colombia.

Linolenic acid ranged from 0.2 to 0.5% in the introductions. The gas-liquid chromatography procedure for fatty acid analysis utilized diethylene glycol succinate (DEGS) polyester as a liquid phase. Subsequent to analyzing this series of samples, butanediol-succinate (BDS) polyester liquid phase was used to determine whether or not values recorded for linolenic acid were correct. The DEGS liquid phase allows linolenic and eicosenoic acid to appear simultaneously whereas the BDS liquid phase separates them. Findings indicated that from 60 to 70% of the values reported for linolenic acid can actually be attributed to eicosenoic acid. The low content of highly unsaturated fatty acids is important in the stability of sunflower oil as previously reported (2).

The highest seed-yielding introductions originated in the lower latitudes. P.I. 263178 from Tanganyika, P.I. 250085 from Egypt, and P.I. 265449 from Colombia yielded 3224, 3133, and 2841 lbs per acre respectively. The seed yields were related to the number of flowers, but this was modified to some extent by the size of flowers. The number was related to latitude of origin; those from lower latitudes flowered more profusely at this location. Stands were fairly uniform in the various plots (about two plants per foot), and yields were consistent among replications. Apparently the differences in flowering and yields were attributable to environment. Plant height was associated with latitude of origin; the taller plants came from the lower latitudes.

Sunflowers are a developing agronomic crop in the United States at this time, and the yielding ability and oil characteristics exemplified in these introductions indicate their potential. Even though the introductions with the best oil characteristics may not always be the best seed-yielders at this location, this finding may differ at other latitudes. Desirable traits from individual introductions could be incorporated into a breeding and selection program. The sunflower introductions in this test had the following average composition: total oil 24.6%, palmitic and stearic acids 8.6%, oleic acid 44.6%, linoleic acid 45.9%, and linolenic acid 0.3%. In comparison, a typical analysis of soybeans shows the following: total oil 21.5%, palmitic and stearic acids 15.0%, oleic acid 26.0%, linoleic acids 50.0%, and linolenic acid 7.0% (4).

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