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AGRONOMIC CHARACTERISTICS OF CONFECTIONERY SUNFLOWER GROWN IN FLORIDA, USA

Victor E. Green, Jr., Agronomy Department, IFAS,

University of Florida, Gainesville, FL 32611, USA

ABSTRACT

Testing of confectionery (non-oilseed) sunflower cultivars between 1978 and 1980 in north-central Florida on droughty sandy soils permitted the agronomic characterization of 22 cultivars of these striped, large-seeded varieties that are used for confection either in the shell or shelled, salted or unsalted or as bird feed, usually in the shell for tame and wild birds. Testing was performed at two locations and plantings were made in February, March, April, and August. The data show that sunflower could be added to the crops used in the multiple or relay systems of crop culture common in the area due to the ability of sunflower to grow on droughty soils early in the spring or late in the fall due to its deep rooting system and frost resistance early as seedlings or as maturing plants. The chief obstacle to successful sunflower culture in this area is the Alternaria leaf and stem black spot disease caused by the fungus Alternaria helianthi (Hansf.) Tubaki and Nishihara. The first epiphytotic of this disease to occur in the USA was in these and adjacent plots near Gainesville, Alachua County, Florida. Meteorological data including monthly rainfall, growing degree days (GDD) calculated from monthly maximum and minimum temperatures, and total radiation and photosynthetically active radiation are shown tabularly for 1978-1980.

Additional keywords for indexing: Helianthus annuus L., Sun-nuts, Birdseed, Non-oilseed sunflower, Striped sunflower seed, Linoleic acid, Fatty acids, Sunflower oil, Alternaria helianthi leaf and stem black spot disease.

INTRODUCTION

Seed of the confectionery sunflower, Helianthus annuus L., cultivars are large, enclosed loosely in large striped achenes and are usually used either as feed for tame or wild birds or are used as a snack for humans. They are sold shelled or unshelled, and salted or unsalted. Due to the deep rooting characteristics of sunflower and the ability of the species to withstand frost as seedlings or as maturing plants, confectionery cultivars offer a source of good food supplement in most areas of the world.

Green and Robertson (1983) pointed out that the 'sun-nuts' of this type sunflower had almost identical fatty acid composition as oilseed hybrids. Although the total oil content of the achenes which contain the sun-nuts is smaller in the confectionery hybrids than in the oilseed hybrids, since no genetic selection has been used for high or low oil content in the confectionery hybrids, it would seem preferable to grow the large-seeded, striped hybrids in which the nuts are loosely bound in the achenes, so that the nuts could be easily removed from the hulls by the teeth or by impact hullers than have a low energy requirement. The resulting nuts have high oil and high protein contents, and offer a good source of nutritive calories, especially for peoples in the developing countries of the world. The hybrids can be grown anytime during the year where water is available, the land is not subject to flooding, and the growing period is free from extremes in weather. Birds can be a problem when growing this crop. Sunflower seed are high in linoleic acid, an essential fatty acid in human nutrition. There is probably not a more palatable linoleic acid source than roasted and salted sun-nuts.

The objective of this research was to locate and test confectionery sunflower hybrids in north-central Florida over a 3-year period to determine whether it would be agronomically feasible to recommend the crop commercially.

MATERIALS AND METHODS

Eleven tests including 22 cultivars, two of which were open-pollinated varieties, were conducted from 1978 to 1980. Four tests in 1978 were planted in March, April, and two in August. In 1979, there were four tests planted in February (two), April, and August. In 1980, two tests were seeded in March, and one in mid-August. The exact dates and cultivars are seen in Table 1. The tests of 2 April 1979 and 6 March and 14 August 1980 were planted at the Campus Agronomy Farm. The remaining tests were planted 8 miles west at the Green Acres Farm.
Rows always ran north and south to facilitate hand harvest and were always about 91 cm. (36 inches) apart. Prior soil treatments were plowing and disking. Each time Treflan herbicide from Elanco Corporation and Furadan insecticide/nematicide from FMC Corporation at the recommended rates were applied into the soil a few weeks before the seed were dropped. Fertilizer treatments included pre-plant application of 672 kg. of 4-8-16 including micronutrients necessary for plant production in north-central Florida. Side dressings of ammonium nitrate were applied before the plants reached the toolbar height to facilitate coverage of the incorporated material. Amounts varied according to the amounts of rainfall received before lay-by time, ranging from 112 to 336 kg per hectare. Seed were hand planted in sufficient quantity so that the plots could be hand thinned to a stand of about 55,000-62,500 plants per hectare. Cultivation was seldom necessary due to pre-plant herbicides and the covering of side-dressed nitrogen fertilizer. All tests were planted in randomized complete blocks with either four or six replications.

During the growing season the following data were collected: planting and emergence dates, as well as heading and physiological maturity dates, plant heights, stand counts, bird and insect damage, disease index, and lodging. At maturity, seed heads were counted in the center row of 3-row plots and from the two center rows of 4-row plots. The heads were measured as to their diameter. The heads were cut, bagged, dried to constant weight, threshed, and the seed were transferred to the laboratory where the following procedures were accomplished: screening over hardware cloth to remove pieces of the heads, cleaning in a Bates Aspirator to remove empty achenes and dust, and samples were selected for moisture determination and weights per unit volume. Finally 200 seed from each sample were weighed. Clean seed per plot weights were extrapolated to hectare yields. Temperatures from a local weather station near the experiments were used to calculate the growing degree days (GDD) accumulated from emergence to heading. Rain data as well as total radiation and photosynthetically active radiation data were used from the weather station also.

To ascertain whether there is any correlation between the number of days required from plant emergence and the heading date of the test entries, and possible yields, correlation coefficients were calculated for each of the tests during the three years. Regression equations were also calculated for each of the tests to show the relationships. Such data were not calculated for the time between flowering and maturity, since the available hybrids all physiologically mature in about 29 to 33 days regardless of the flowering date no matter what date or month of planting.

In the experiment planted on 16 August 1979 at the Green Acres Farm disease ratings were made for each plot from just before flowering almost to physiological maturity. They were made at weekly intervals on 1, 8, 15, 22, and 29 October. These data were averaged and graphed with a smooth curve of the data. A regression equation was calculated from the data giving: $R = 2.05 + 3.43D - 0.415D^2$, where R is the numerical rating and D is the weekly rating date in October.

RESULTS

All the agronomic and meteorological data gathered and calculated are shown in Tables 1 through 5 and in Figure 1. The individual figures in the tables and graph represent the average derived from summing the data for each plot in each replication for an individual entry or cultivar and dividing by the number of plots of that entry in the test. Discussion of the data follows.

DISCUSSION

Days from emergence to flower. Over the 11 plantings, days from emergence to flowering varied from 44 to 69. August plantings made when days were shortening as to total hours of sunlight were earlier than when planted during other months when the days were getting longer. Time from emergence to flowering was longest for the 2 February 1979 and the 6 March 1980 plantings which were made during the coldest seasons. Number of days required for those plantings averaged 68. Correlation coefficients and regression equations from these data showed that there was no significant relation between the number of days from emergence to flowering and the yields that were obtained in these tests.

Plant heights: The shortest plants grew in plots and in an area where continuous tobacco had been grown for years. The sunflower plants grew only to 109 cm. The tallest plants grew from February plantings, growing into long days, averaging about 174 cm. April plantings were slightly taller than August plantings and were about equal in height to March plantings, other than those after tobacco.

Seedhead diameter. The smallest head diameters accompanied plants grown on the nematode-infested soil following continuous tobacco from the 6 March 1980 planting. The largest seedheads grown from March 14, 1978 planting gave the highest yield of clean seed.

Seed yields. Highest yields were from early plantings and decreased almost linearly through March and April plantings, with the lowest yielding plantings being in August. This is largely due to disease damage from the fungus leaf and stem black spot caused by *Alternaria helianthi*. Figure 1 shows progress of the disease in the 16 August 1979 planting. This figure was taken from the data shown in Table 5, which see. The data in Table 1 show that yields of at least 2,930 kg/ha are possible under Florida conditions when conditions of weather, pests and diseases are not limiting.

200-seed weights. The weight of 200 seed is standard among sunflower research scientists as a measure of plumpness or fullness in achenes. For those who prefer the 1,000-seed weight, this figure is multiplied by five. It is closely allied with the weight per unit volume as shown in Table 6 and recorded as kilograms per hectoliter. No data show for 1978 as the term was just then beginning to surface, especially in the USDA National Oilseed Sunflower Performance Trials in the USA.

Earle, Vanetten, Clark, and Wolff (1968) remarked on the difficulty of finding sufficiently detailed analytical information in readily available journals on the sunflower characteristics. This still holds today as regards the confectionery industry. They showed figures for the 1,000-seed weight of some confectionery types, which I have divided by 5 to compare with the current usage: Arrowhead-- 18.2 g/200 seed; Mingren: 20.4; Mingren large: 36.0; and Mingren small: 15.4. The Florida data show that the 1979-grown seed weights approach that of Mingren and that the 1980 seed approach that of small Mingren seed.

In a paper on the industrial characteristics of the 1979 yields by Green and Lofgren (1981), it was shown that seed from the August planting date, being lighter, adhered more tightly to the kernels, and gave the highest hullability scores ever recorded in the trade. Therefore, every effort should be made to grow the largest seed possible on very large heads so that shelling is facilitated. Seed from the other 3 plantings in 1979 had very acceptable hullability scores.

Weight per volume of the achenes (kilograms per hectoliter). Most of the equipment available in the USA is pint or quart cups and convertible scales which weigh in avoirdupois units and convert to pounds per bushel. In this paper, that method of measurement was used, and the resulting figures for pounds per bushel were multiplied by 1.287 to get kilograms per hectoliters (kg/hl). The proposed rules of the US Federal Grain Inspection Service suggest that oilseed sunflower seed weigh at least 25.0 pounds per bushel (32.2 kg/hl) for both US No. 1 and 2 seed. Minnesota standards are the same as those proposed by the USA for oilseed sunflower, but in addition, Minnesota has separate requirements for confectionery type. The minimum test weight for the larger seeded types for grade No. 1 is 24 lbs/bu, or 30.0 kg/hl, at a maximum of 10% moisture; No. 2: 22 lbs/bu. (28.3 kg/hl) at 12% moisture; and No. 3: 21 lbs/bu. (27.0 kg/hl) at 14% moisture.

Achenes grown in two August 1978 tests and in the April 1979 test approached the Minnesota standard for MN No. 1 and individual entries exceeded the requirement. Achenes in the other tests would have been very suitable for birdfeed but would not have been suitable for making whole sun-nuts for the trade.

Table 1. Recapitulation of the agronomic and laboratory characteristics. This table is offered to give an overall view of the characteristics that are discussed earlier.

Table 2. Growing degree days (GDD) per day, 1978-1980. 0-26.7C (32-80F). This table gives the number of growing degree days per day (GDD) for the three years that the confectionery sunflower cultivars were under investigation. Each figure represents the average GDD per day during each month of the year, 1978-1980. The temperature range of 0-26.7C (32-80F) seems to best represent the temperatures that existed in the plots at planting time to about the optimum for growth of the crop. The GDD above and below these extremes are ignored in this table, as those temperatures seem detrimental to plant growth in sunflower.

Table 3. Rainfall by month at Agronomy and Green Acres Farms, 1978-1980. The rainfall amounts and distribution were such that no irrigation water really needed to be applied to sunflower. However, in 1978 each test received irrigation water as follows: 14 March--100 mm; 13 April--51 mm; and 17 August--38 mm. To the author's knowledge, no Florida sunflower field, experimental or commercial, has ever suffered from a lack of natural moisture in the form of rain. However, in dry years or seasons, sunflower yields should be enhanced by judicious applications of irrigation water. Farmers should be prepared for this eventuality.

Table 4. Solar radiation, Main Station, 1978-1980. Both photosynthetically active radiation and total radiation are shown in this table. These figures should be equally applicable at both farms located at about the same elevation and eight miles apart.

Table 5. Disease ratings for Alternaria helianthi, Green Acres, August 1979 test. To chart the progress of the Alternaria leaf and stem black spot disease, these data were gathered and are shown to accompany Figure 1. The number of active leaves remaining on the plants as averages for the cultivars on 31 October are shown along with the dates of physiological maturity in November 1979. The active leaves were usually the upper leaves of the plants capable of photosynthesis since the disease begins on the lower, older leaves and proceeds upward on the plant.

Figure 1. Progress of Alternaria helianthi leaf and stem black spot disease, Green Acres Farm, Fall 1979.

This figure depicts the average disease index: 0 = no disease and 5 = epiphytotic on six confectionery hybrids over six replications from before flowering to the beginning of senescence or physiological maturity. Readings were made weekly on the same day of the week. The shape of this curve drawn from the data is typical of the progress of the disease noted in all plantings of both oilseeds and confectionery cultivars at all times of the year when sunflower is flowering and losing some of its natural resistance to the disease. However, the intensity varied over the plantings. The regression formula for predicting points on the curve is: $R = 2.05 + 3.43D - 0.415D^2$, where R = the rating and D = the date of the rating in October.

Alternaria leaf and stem black spot disease is the chief obstacle to successful sunflower production in north-central Florida. When the disease strikes early in the flowering period, a large portion of the center of the flower disk contains empty achenes and the florets tend to adhere to the disk, even after senescense. The later the disease strikes during flowering, the smaller the sterile center of the disk.

CONCLUSION

Eleven tests were conducted at two locations with 22 cultivars in north-central Florida to characterize available varieties of confectionery sunflower and to determine whether the area was suitable for production of this type of sunflower. The vegetative stage was longest as the plants grew into longer days of daylight. There was no relation between length of growing season and yields of achenes. The largest seedheads gave the largest seed and the largest yields of seed. Seed in many of the tests were larger than northern-grown Arrowhead seed. The 1979 grown seed were heavier than regular Mingren seed. All of the seed were suitable for the birdfeed trade and many were acceptable for the confection trade. Individual entries approached the standards for Minnesota Grade No. 1 for size and weight per unit volume. The tests showed that confectionery sunflower could be grown at almost any time of the year without having to irrigate during the three years 1978-1980. The only disease of any consequence was Alternaria leaf and stem black spot which varies in incidence and severity depending on the growing season. It is recommended that plantings be made in mid-February to mid-March. If this is not possible, then growers should wait until August. Sunflower is resistant to frost in the seedling stage and also when the plants are maturing.

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Table 1 Confection and Birdseed Sunflower Hybrid Characteristics, Gainesville, FL. 1978 - 1980. RECAPITULATION--AGRONOMIC AND INDUSTRIAL CHARACTERISTICS

Acc. No.	1978	1978	1978	1978	1979	1979	1979	1979	1980	1980	1980
	Date of Planting										
	Mar 14	Apr 13	Aug 17(W)	Aug 17(E)	Feb 2	Feb 28	Apr 2	Aug 16	Mar 6	Mar 12	Aug 14
Yields, Kilograms/Hectare	2930	910	1180	1290	1680	2310	1740	1140	670	1490	----1/
Emergence to Flowering, Days	52	51	50	51	67	58	58	45	69	58	43
Plant Heights, Centimeters	159	147	135	137	162	182	137	135	109	145	124
Seedhead Diameters, Cm.	23.9	14.0	14.7	15.4	18.2	17.6	18.1	12.4	11.9	14.7	12.7
Test Weights, Kg/Hl	23.2	20.3	30.6	31.4	25.1	28.2	30.6	27.4	25.4	25.2	----1/
Weights of 200 Seed, Grams	----	----	----	----	20.9	19.7	23.3	14.5	17.5	15.2	----1/
Number of entries represented in each of these averages	12	12	5	3	6	6	6	6	9	9	10

1/ The Fall 1980 test was devastated by Redwing Blackbirds and could not be sampled for yields and other parameters.

Table 2 Growing Degree Days (GDD), 0-26.7C for sunflower, per day at the Green Acres (GA) Farm and the Agronomy Farm (AY), 1978-1980, Gainesville, Florida.

	Growing Degree Days (GDD) per day, 0-26.7C											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
1978												
GA	----	----	15.3	18.0	20.9	22.9	23.2	22.6	22.1	18.8	18.0	13.9
AY	11.3	10.8	16.3	19.7	22.3	24.1	24.4	24.2	23.6	21.1	19.8	15.8
1979												
GA	10.9	11.9	15.3	18:8	20.0	22.2	23.4	23.1	23.4	18.7	15.7	----
AY	12.6	13.1	17.1	20.8	21.8	23.4	24.7	24.2	24.4	20.8	18.2	14.6
1980												
GA	----	----	----	----	----	----	----	----	----	----	----	----
AY	13.7	11.7	17.8	19.3	22.0	23.4	24.5	24.5	23.8	20.6	16.9	12.4
AVERAGE												
GA	10.9	11.9	15.3	18.4	20.4	22.6	23.3	22.8	22.8	18.8	16.8	13.9
AY	12.6	11.9	17.1	19.9	21.6	23.6	24.6	24.3	23.9	23.9	18.3	14.3

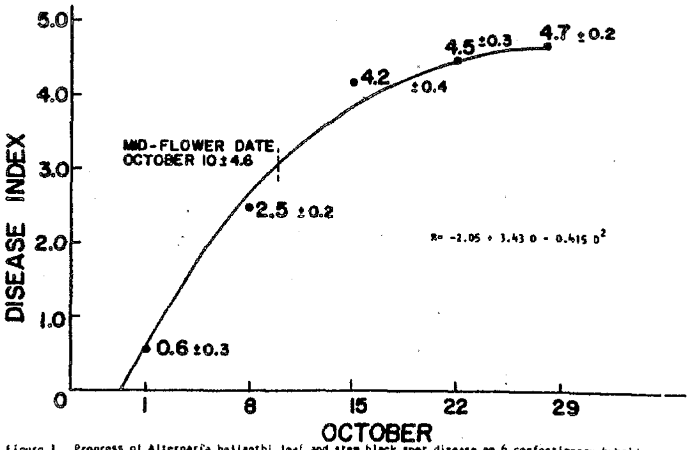

Figure 1. Progress of *Alternaria helianthi* leaf and stem black spot disease on 6 confectionery hybrids planted 16 August 1979 at Gainesville, Florida, USA. 0=no disease and 5.0=an epiphytotic.

Table 3 Rainfall in millimeters, by month at the Agronomy Farm and the Green Acres Farm, 1978-1980, Gainesville, Florida, USA.

Month/Year	1978 mm.	1979 mm.	1980 mm.
AGRONOMY FARM			
January	157	255	157
February	126	85	48
March	115	30	75
April	16	208	106
May	88	85	129
June	99	116	58
July	263	112	220
August	245	188	81
September	06	311	94
October	12	03	43
November	02	34	51
December	122	155	07
Annual Total, mm	1251	1582	1069
GREEN ACRES FARM	1978 mm.	1979 mm.	1980 mm.
January	---	230	140
February	---	59	25
March	101	34	127
April	09	172	135
May	94	106	159
June	99	113	96
July	269	189	238
August	125	170	126
September	17	249	32
October	01	05	---
November	64	39	---
December	53	125	---
Annual Total, mm	---	1491	---

Data courtesy Dr. Darrell E. McCloud, Professor, Agronomy Department, IFAS, UF, and Mr. Rick Hill, Lab Technologist at the Agronomy Farm and to Dr. Al Norden, Professor, and Mr. Harry Wood, Agricultural Technician at the Green Acres Farm.

Table 4 Solar Radiation: Photosynthetically Active Radiation (PAR) and Total Radiation (TOTAL) recorded at the Main Station Agronomy *Farm, 1977-1980, Gainesville, Florida. By Month.*

	Photosynthetically Active (PAR) and Total Radiation[1/]							
	1977		1978		1979		1980	
Month	PAR, E/M^2	TOTAL MJ/M^2	PAR, E/M^2	TOTAL MJ/M^2	PAR, E/M^2	TOTAL MJ/M^2	PAR, E/M^2	TOTAL MJ/M^2
January	----	----	664	341	631	316	644	298
February	----	----	651	325	669	333	822	380
March	----	----	1030	515	1112	564	974	462
April	----	----	1347	688	1151	574	1215	594
May	----	----	1349	668	1335	663	1309	633
June	----	----	1259	610	1247	614	1280	624
July	----	----	1180	567	1336	655	1338	644
August	1219	562	1227	606	1170	568	1320	633
September	1138	551	1044	515	804	425	1084	521
October	976	496	901	448	976	517	862	437
November	682	316	702	347	805	364	635	325
December	554	291	602	298	652	304	624	317
TOTAL	----	----	11,956	5,928	11,888	5,897	12,109	5,866

[1/] E/M^2 = Einsteins per square meter; MJ/M^2 = megajoules per square meter. To nearest unit.

Data furnished by Dr. D. E. McCloud, Professor (Agronomist) IFAS, University of Florida, Gainesville. Mr. Rick Hill, Observor. PAR recorded with a Licor Quantum Sensor and Integrator. Total radiation measured with an Eppley Pyronometer and recorded on a Kipp and Zonen integrator.

Table 5 Disease ratings after flowering over 5 dates and the number of active leaves remaining on the plants of 6 commercial sunflower confection hybrids, Green Acres Farm, Gainesville, FL 1979.

Acc. Designation	Brand	Hybrid	*Index of Disease on the indicated Date* 10/1	10/8	10/15	10/22	10/29	*Number of Active Leaves* Oct. 31	*Date of* Physiological Maturity, Nov.
C-7	Sheyenne	853	0.8	2.6	4.4	4.7	4.9	8.7	10
C-9	Sheyenne	923	0.7	2.3	3.9	3.9	4.3	13.5	12
C-12	Sigco	924	1.1	2.8	3.7	4.5	4.6	10.8	11
C-13	Dahlgren	D-820	0.3	2.3	4.0	4.5	4.5	10.7	11
C-14	Dahlgren	D-933	0.3	2.2	4.4	4.8	4.8	8.1	9
C-15	Dahlgren	D-716	0.6	2.5	4.8	4.8	4.8	7.7	8
Mean			*0.6*	*2.5*	*4.2*	*4.5*	*4.7*	*9.9*	*10*

Test planted 16 August 1979.
Disease index for Alternaria helianthi 0.0 = disease free to 5.0 = epiphytotic
Active leaves are those still remaining on plants and capable of photosynthesis.