ning 14 days after Hybrid 894 flowers, bird damage readings are taken on a weekly basis. Agronomic data, including oil percentage, hull-to-seed ratio, height, head diameter and stage of maturity are also noted, and simple correlations between the agronomic data and bird damage percentage obtained.

Due to stress problems at the time of the second and third planting dates in 1985, we could not complete an analysis of the effect of planting date on amount of bird damage sustained, but plan to carry out the experiment at two locations in 1986. □

PURPLE-HULLED SUNFLOWER

Greg Fox[1] and James Hanzel[2]

[1]*Stauffer Seeds, Fargo, N.D.*
[2]*Dept. of Agronomy, North Dakota State University, Fargo.*

Recent studies have shown that purple-hulled sunflower derived from purple-hulled inbred, Neagra de Cluj (NDC), contain high levels of red pigment (anthocyanins) in the hull. These red pigments can be used to replace synthetic food dyes currently under severe FDA scrutiny. Also, there appears to be some bird advertant properties associated with the anthocyanin content of the NDC derived purple-hulled sunflower (1). Not all purple-hulled sunflower contain such high levels of anthocyanin. Screening of all purple-hulled accessions in the USDA World Collection of Sunflower (1982) indicated that anthocyanin content of individual entries ranged from 0.05-2.20% and fit a normal distribution.

In 1984 NDC was crossed with 13 production cytoplasmic male sterile (cms) females. The resultant sterile hybrids were observed in Jamaica 1984-1985 and in the Northern Great Plains in 1985. Three of these cms hybrids were evaluated at eight environments as unreplicated four-row or two-row plots with two commercial check hybrids (Cal West 54K and Cal West 57K) (Table 1). In addition, NDC was sterilized with gibberillic acid (GA) and crossed with two USDA RHA male lines (273, 274). The fertile hybrids were evaluated at Casselton, N.D., in 1985 as single-row, 20-foot observation plots.

The general appearance of all hybrids made with NDC, regardless of female cms parent or RHA male parent, was the same at all environments. The hybrids were very tall, 2.5-4.0 meters high, and very vigorous with extremely large heads. Achenes were generally well-filled, quite heavy and contained copious amounts of purple pigment. When evaluated across eight diverse environments, the three purple hybrids had significantly higher test weight, lower percentage oil (dry), later bloom date and higher harvest moisture than the two check hybrids; the yield and grams of oil/liter of seed (g oil/l) were no different (Table 2). When low-heat-unit, later-planted sites are removed, the yield and oil content improved considerably for the purple-hulled hybrids (Table 3). This was expected as they are extreme full season hybrids. The yield performance of these purple-hulled, cms hybrids is quite remarkable when one considers that only cross-pollinated florets produced seed (many empty hulls were observed during harvest).

The two fertile hybrids evaluated at Casselton, NDC x RHA 273 and NDC x RHA 274, produced remarkable amounts of seed; mean seed yield/plant was 160g with 33.9% oil (dry) and 120g with 35.8% oil (dry), respectively. Such seed yields would indicate that acre yields of 4,000-5,000 lbs. are possible with these hybrids.

While the yield potential of these purple-hulled hybrids appears quite high, the percentage oil is consistently low (Tables 2 and 3). This is somewhat misleading because oil produced per unit volume (g/l) is not significantly different from that of the checks. Low oil content measured was percentage oil (w/w) and high test weight appears to be associated with the very hard, heavy hulls of these purple-hulled hybrids. The weight of the hull through simple dilution effect causes percentage oil to be low in these purple hulled hybrids; while the actual oil produced per unit volume (bushel) is the same for both types (purple-hulled vs. normal oil seed).

The results of this study indicate that purple-hulled sunflower derived from NDC has excellent yield potential with a very heavy, high test weight seed. Oil content of the purple hulled hybrids is consistently lower than check hybrids when measured as percentage oil (w/w). However, oil content measured on a volume basis (g/l) is no different from that of the check hybrids. It remains to be seen whether bird advertant properties and high anthocyanin content can be maintained with reductions in hull weight. □

REFERENCES

1. Mason, J.R., M.A. Adams, R.A. Dolbeer, R.A. Stehn, P.P. Woronecki, and G.J. Fox. 1986. Contribution of seed hull characteristics to resistance of sunflower to blackbird damage. **North Dakota Farm Research** 43. (In Press).

TABLE 1. Eight Locations in Which Three Purple-Hulled Hybrids were Evaluated in 1985.

Location	Planted	Harvested
Dolan, SD	May 23	October 16
Harvey, ND	May 24	October 22
Mott, ND	May 28	October 15
Leonard, ND	May 30	October 18
Rugby, ND	June 3	October 29
Edgeley, ND	June 4	October 31
Raub, ND	June 7	October 30
Quinter, KS	June 22	November 6

TABLE 2. Mean Performance of Three Sterile, Purple-Hulled Hybrids (P-1, P-2, and P-3) and Two Check Hybrids Across Eight Environments.

Hybrid	Days to Mid-bloom	% Harvest Moisture	Test Weight	Yield (Lbs/a)	% Oil (dry)	G Oil/ Liter
P-1	77	7.7	35.7	2261	36.0	155
P-2	77	9.6	34.7	2135	34.8	147
P-3	77	9.1	34.6	1991	36.4	153
C/W 54K	72	3.0	30.6	1951	43.4	160
C/W 57K	72	3.8	30.6	2140	44.1	163
F-test	**	**	**	n.s.	**	n.s.
LSD 0.05	.75	3.8	1.8	383	2.0	13

***Significant at the 0.01 level.*

TABLE 3. Mean Performance of Three Sterile, Purple-Hulled Hybrids (P-1, P-2, and P-3) and Two Check Hybrids Across Six Environments (dropped Raub and Rugby, ND).

Hybrid	Days To Mid-Bloom	% Harvest Moisture	Test Weight	Yield (lbs/a)	% Oil (dry)	G Oil/ liter
P-1	76	8.2	37.2	2564	37.8	169
P-2	77	8.3	36.3	2421	37.3	163
P-3	77	6.7	37.0	2206	39.0	173
C/W 54K	72	3.6	31.5	1961	44.6	169
C/W 57K	72	3.7	31.6	2270	45.4	173
F-test	**	*	**	n.s.	**	n.s.
LSD 0.05	.56	3.2	1.3	396	1.8	9

,Significant at the 0.05 and 0.01 levels, respectively.*

CHEMICAL INDUCTION OF CYTOPLASMIC MALE STERILITY IN SUNFLOWER

C.C. Jan[1]

[1]*USDA/ARS, North Dakota State University, Fargo.*

Before planting, 24,000, 22,400 and 8,000 seeds of HA 89 were soaked in five, 50 and 500 ppm mitomycin C solutions, respectively, for 40 hours. Similarly, 24,000 HA 89 seeds each were used for five, 50, 500 and 5,000 ppm streptomycin treatment and the nontreated check. Male-sterility was identified at M-1 as sectorial, semi and complete, and further verified by planting the open-pollinated M-2 seeds in progeny rows. The untreated HA 89 did not produce any true male-sterile plants. The five, 50 and 500 ppm mitomycin C treatment resulted in one, zero and one male-sterile mutants, respectively. The five, 50, 500 and 5,000 ppm streptomycin treatment produced two, eight, five and two male-sterile mutants, respectively.

All the 19 mutants and CMS HA 89 had the same responses when tested against restorers RHA 266, 274, 280, 296 and RCMG1, 2 and 3. HA 89 did not restore any of the mutants. RHA 266, 274, 280 and 296 restored full fertility for all nineteen mutants. RCMG1 was a nonhomogeneous restorer with inconsistent restoration. RCM2 and RCMG3 restored only one (different) of the mutants. Streptomycin proved to be a more effective mutagen than mitomycin C for inducing cytoplasmic male-sterility in sunflower. Male-sterile lines so produced can quickly be used for hybrid seed production without drastically altering current fertility restoration systems. □