Predicting NuSun Hybrid Oleic Acid Concentration Through Early Sampling

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Introduction

The ability to predict the oleic acid concentration of the NuSun sunflower crop in any given year and area would be of benefit to the sunflower industry. The processors of NuSun sunflower have set the minimum standard for oleic concentration at 55% for the 2001 year and this standard will continue in future years (National Sunflower Association NuSun Committee, Bismarck, ND). If a season is cooler than normal and oleic concentration appears to be low or close to the minimum standard, shipments of seed from southern production might be sent to the northern processing plants to lower the risk of not meeting the frying industry requirement. Traditional linoleic sunflower hybrids produced in latitudes of 44 to 48^{o} N versus sunflower hybrids produced in latitudes of 29 to 39^{o} N varied by 40% in linoleic acid (Robertson et al., 1979). Therefore, a method to predict the harvested oleic concentration of the NuSun crop either by gas chromatographic analysis of immature seeds sampled a few weeks after flowering or by weather data would be of great value to the industry.

Lacombe and Berville (2000) analyzed the desaturase transcript accumulation and oleic concentration of traditional and high oleic sunflower seeds. Their objective was to determine oleic acid accumulation in seeds based on the activity of two enzymes, $\triangle$ 9 and $\triangle$ 12 desaturases. Seeds collected at 12, 16, and 24 days after flowering appeared to easily identify whether the seed was high oleic or traditional linoleic. Miller et al. (2001) collected seeds at 13 and 20 days after flowering and analyzed the oleic concentration of immature embryos by gas chromotography. They determined that at 20 days after flowering, an accurate determination could be made whether an embryo had a high oleic or a low oleic acid concentration. These results indicated that an early generation selection procedure could be implemented by breeders to identify embryos with a high oleic concentration.

The objective of this study was to determine whether analysis of seeds sampled from a NuSun hybrid at 21, 28, 35, and 42 days after flowering and weather data could predict the oleic acid concentration of that hybrid at harvest.

Materials and Methods

The NuSun hybrid Mycogen 8377 NS and the traditional hybrid Seeds 2000 Bigfoot were planted at three different dates, May 18, May 29, and June 7, 2001. The plot was located at the North Dakota Agricultural Experiment Station, Fargo, ND. Twenty heads of the NuSun hybrid were bagged just before flowering in each of the three planting dates. Two heads of the

traditional hybrid were bagged. Plants of the first, second, and third planting dates started flowering July 27, August 3, and August 10, respectively. Sampling of seeds of the first planting date occurred August 17, August 24, August 31, and September 7. Sampling of seeds of the second planting date occurred August 24, August 31, September 7, and September 14. Sampling of seeds of the third planting date occurred August 31, September 7, September 14, and September 21. All heads were harvested October 11 after a hard freeze, and samples were taken from these heads for analysis.

Approximately 20 seeds harvested from each head at each sampling date were weighed and then dried at 110 C for four hours and weighed again to determine the moisture content. The same 20 seeds were used to determine oleic acid concentration by gas chromatography.

Growing degree day data (45 F used as the base temperature), minimum temperatures, maximum temperatures, and solar radiation (Langley's, cal/cm^2) were calculated from NDAWN daily observations recorded on the web site www.est.nodak.edu/cgi-bin/wthrtable.cgi. Correlation analyses were calculated between oleic concentration and the following variables: Growing degree days (GDD) total from planting to sampling (S) date, GDD from flowering to sampling date, GDD for the one week before sampling date, minimum temperature mean for flowering to sampling date, minimum temperature mean for the one week before sampling date, maximum temperature mean for flowering to sampling date, maximum temperature mean for the one week before sampling date, solar radiation total from planting to sampling date, solar radiation for flowering to sampling date, and solar radiation for the one week before sampling date.

Results and Discussion

The oleic acid concentration was the highest from plants which seeds were planted on May 29 (67.0%) (Table 1). The oleic acid concentration of samples from the first planting date (May 18) started high (69.3%) but ended the lowest at harvest (61.9%) when samples were compared. The late planting date seed samples were only 2.0 percentage points lower in oleic concentration than the middle planting date seed samples (65.0% versus 67.0%, respectively). The 61.9% oleic concentration for the first planting date was not expected because the lowest oleic concentrations usually occur in plants which have been planted late. However, the weather in August 2001 was quite warm, and many days had high temperatures of 90 F or higher. The warm year was also reflected in the oleic concentrations of the traditional check hybrid (26.1%). The overall oleic concentration of all plants of the NuSun hybrid sampled at harvest was 64.6%.

At all three planting dates, the oleic acid concentration dropped from the first sampling date to the harvest sampling date. The largest drop was from seed harvested in the first planting date (69.3% to 61.9%) (Table 1). The oleic acid concentration of seed sampled from the second planting date dropped a similar amount as in the first planting date (6.8 versus 7.4 percentage points, respectively). The oleic acid concentration of seed sampled from the third date dropped the least (3.6 percentage points).

Correlations between the oleic acid concentration of seed harvested on October 11 and the samples taken at 21, 28, 35, and 42 days after flowering indicated that the best predictor of final

or harvest oleic acid concentration was the second sampling date or 28 days after flowering (0.97) (Table 2). Over all planting dates, oleic concentration in seed sampled at 28 days after flowering would drop an average 3.2%. Therefore, an early prediction of harvest oleic concentration could be made and considered quite accurate. The moisture content of this sample averaged 47.7%, therefore, oleic acid is produced by the plant quite early after flowering and pollination.

Prediction of oleic acid concentration by weather data was highly variable (Table 3). The best correlations were found to be with Growing Degree Day total to sampling date (-0.67), Growing Degree Day flowering to sampling date (-0.72), solar radiation total to sampling date (-0.72), and solar radiation one week before sampling (-0.70). Even though literature has indicated that minimum temperature has an influence on oleic concentration, there was no indication of that relationship in this study.

Although the correlations between oleic concentration and some weather data were significant, caution must be made in that these weather data are only an indication of the year, and therefore correlations were not considered by the authors high enough to be accurate predictors. The gas chromatographic determination of oleic acid concentration in seeds sampled 28 days after flowering appears to be the most accurate predictor.

References

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Table 1. Oleic acid concentration and moisture percent of seed harvested at various sampling dates and planted at three different dates, Fargo, ND, 2001.

Planting Date	Sampling Date (DAF)[1]	Oleic %	Moisture %	Traditional Check Oleic %
5/18	8/17 (21)	69.3	63.2	28.6
	8/24 (28)	64.8	47.8	23.9
	8/31 (35)	65.9	33.5	24.1
	9/07 (42)	62.8	18.3	25.3
	10/11 (H)	61.9	12.1	23.5
5/29	8/24 (21)	73.8	62.6	32.4
	8/31 (28)	70.7	49.2	27.1
	9/07 (35)	67.7	33.9	28.5
	9/14 (42)	67.4	22.5	26.3
	10/11 (H)	67.0	13.3	26.1
6/7	8/31 (21)	68.6	65.5	30.5
	9/07 (28)	68.2	46.1	28.7
	9/14 (35)	67.9	35.2	21.0
	9/21 (42)	64.7	22.0	19.8
	10/11 (H)	65.0	13.8	18.6
EXP MEAN		67.2		
C.V. %		13.0		
LSD 0.05		5.6		

[1] DAF, days after flowering; H, mature seed at harvest.

Table 2: Correlations between oleic acid concentration of seed at harvest (H) and oleic acid concentration of seed sampled (S) 21, 28, 35, and 42 days after flowering.

Variables	Correlation
Oleic % (H) vs. oleic % S1 (21)	0.71*
Oleic % (H) vs. oleic % S2 (28)	0.97**
Oleic % (H) vs. oleic % S3 (35)	0.88**
Oleic % (H) vs. oleic % S4 (42)	0.95**

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

Table 3: Correlations between oleic acid concentration of seed at harvest (H) and several weather data variables observed at the planting site, Fargo, ND, 2001.

Variables		Correlation
Oleic % (H) vs.	GDD (Total to S)	-0.67*
	GDD (FLW – S)	-0.72*
	GDD (1 week)	0.18
	MIN TEMP (FLW – S)	-0.03
	MIN TEMP (1 week)	-0.06
	MAX TEMP (FLW – S)	0.19
	MAX TEMP (1 week)	0.17
	SOLAR RAD (Total to S)	-0.72*
	SOLAR RAD (FLW – S)	0.41
	SOLAR RAD (1 week)	-0.70*

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