

# Oil Content Distribution of Meadowfoam Seeds by Near-Infrared Transmission Spectroscopy\*

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Meadowfoam (*Limnanthes* spp., Limnanthaceae) is a recently domesticated herbaceous winter–spring industrial oilseed crop (Jolliff 1989). The virtually pure raw source of long-chain fatty acids has unique composition and very high oxidative stability (Isbell et al. 1999; Muuse et al. 1992). Initial commercial sales were substantially for high-value personal care products. Other market applications may develop with the evolution of such things as price, utilization experience (Isbell et al. 1999), derivative development, and supply logistics.

Increased oil yield per hectare remains a top priority for advancing meadowfoam profitability for farmers and commercialization into broader industrial markets. Many variables interact to influence oil yield of meadowfoam; environment, management, genetics, and pests can have major effects. Improved understanding of the effects of these variables may contribute to improving oil yield. Analysis of bulk seed samples can mask the cause and effects of some variables, and does not allow for the partitioning of variance for measuring important cause and effect relationships. Thus, single-seed analysis provides a means of characterizing variation.

Single-seed oil determination of meadowfoam by near-infrared transmission spectroscopy (NITS) is a fast, efficient, nondestructive procedure, amenable to substantial automation compared to traditional chemical analysis (Patrick and Jolliff 1997). This technology has potential applications evaluating oil content and variability within individual flowers, plants, populations, or bulk samples. It provides the prospect to quantify the effects of numerous kinds of management, environmental, and genetic variables on the oil content of seeds.

The objective of this paper is to determine the distribution of oil content in seed from meadowfoam plants by NITS single-seed oil determinations. This information could be useful in selection and management research programs designed to increase oil yield.

## METHODOLOGY

Single-seed oil determinations were made with a Tecator Infratec 1255 scanning monochromometer (Foss NIRSystems, Inc.), with a custom 23 single-seed scanning tray, and an improved NITS (850–1050 nm) calibration with a 3.0% standard error of cross validation (SECV). The calibration was developed from 966 meadowfoam seeds representing 21 individual sources, representing a variety of genetic origins from our breeding program over 7 growing seasons (Patrick and Jolliff 1997).

From our elite breeding materials an additional 78 plants were surveyed for high mean and high variance of oil content by NITS single-seed oil determinations of a random sample of 23 seeds from each plant. Hereafter, a survey refers to a 23-seed random sample from a plant. The 10 plants having surveys of highest mean oil content and highest oil content variance were selected for evaluation. The mean oil contents of these plants were determined by NITS single-seed oil determinations of all seeds from each plant. These selected plants were surveyed an additional three times, to compare plant mean oil content and survey mean oil content. In addition, single-seed mass determinations were made for all seeds from five of these plants.

## RESULTS AND DISCUSSION

The NITS single-seed oil determinations of surveys from 78 meadowfoam plants indicated a wide range of oil content and variance. Survey mean oil content varied from 19.5% to 38.8% with a mean of 29.0%. The standard deviation varied from 2.8% to 13.4% with a mean of 6.1%. The oil content distributions of survey results from three plants are compared in Fig. 1.

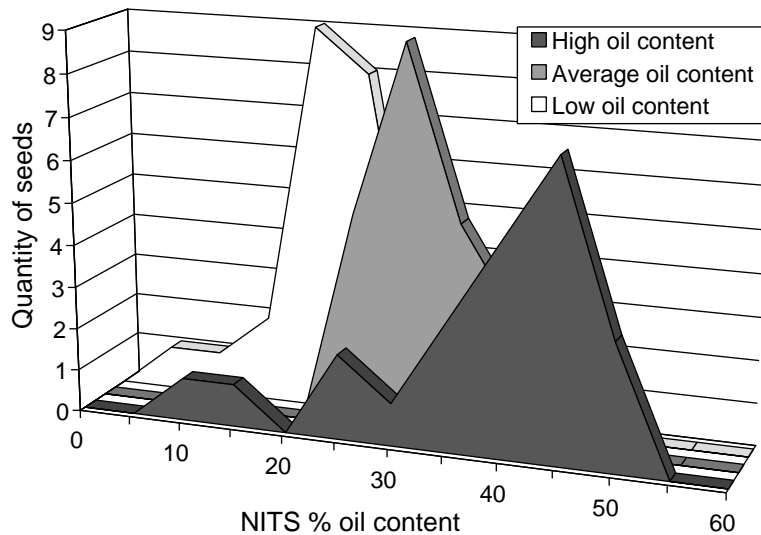
NITS single-seed oil determinations were performed on 3,685 seeds from the 10 selected plants. The mean oil contents of these plants ranged from 29.2% to 36.2%, and the oil content standard deviations ranged from 6.2% to 9.1%. For the 3,685 seeds, the oil content mean was 31.6%, the oil content range was 2.3% to

\*Oregon Agricultural Experiment Station Technical Paper Number 11444

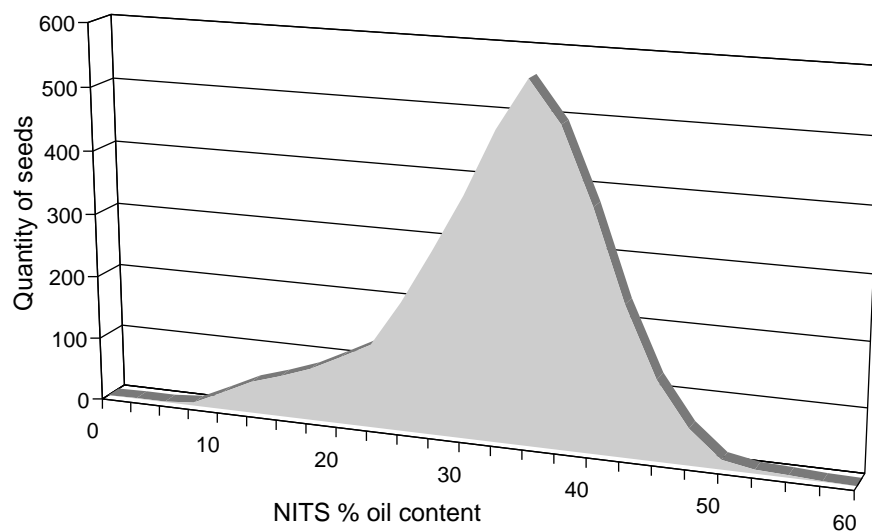
55.2%, and the oil content standard deviation was 7.2%. The oil content distribution of the 3,685 seeds is illustrated in Fig. 2. The additional surveys of these 10 selected plants indicated the mean difference between survey mean oil content and plant mean oil content was 3.1%.

Mass determinations of 2,939 individual seeds from 5 of the selected plants yielded a mean mass of 15.0 mg, a mass range of 1.8 to 27.3 mg, and a mass standard deviation of 4.4 mg. The mean seed mass of the plants ranged from 14.0 to 19.1 mg. A plot of oil content vs. seed mass is shown in Fig. 3. The correlation was 0.68.

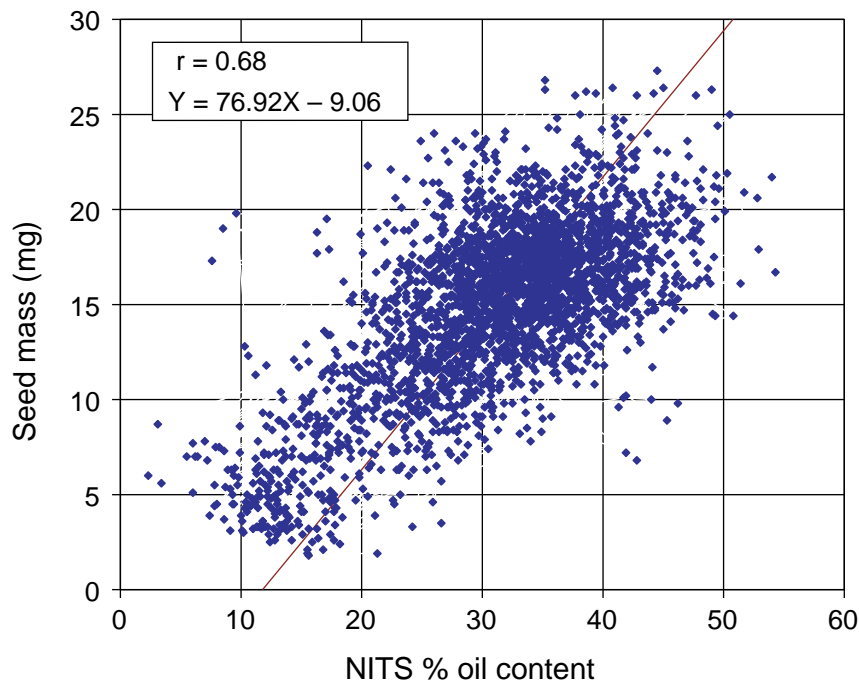
The highest meadowfoam seed properties found by this analysis were a seed of mass 27.3 mg and a seed of 55.2% oil content. These exceed the highest values of the calibration set, which are 21.9 mg and 45.7% (Patrick and Jolliff 1997). An improved NITS calibration is needed for more accurate oil determinations of seed with very high oil content (over 45.7%) and high mass (over 21.9 mg).



**Fig. 1.** Oil content distributions of 23 randomly selected seeds from 3 meadowfoam plants are compared, by NITS single-seed oil determinations.



**Fig. 2.** Oil content distribution of 3,685 individual meadowfoam seeds from 10 plants, by NITS single-seed oil determinations.



**Fig. 3.** Plot of NITS % oil content vs. seed mass (mg) with linear regression for 2,939 individual meadowfoam seeds from 5 plants, by mass and NITS single-seed oil determinations.

## CONCLUSION

Single-seed oil determinations of meadowfoam by NITS are quick, economical, and non-destructive. Selection of individual seeds is possible for use in cultivar improvement, breeding programs, and physiology studies where further use of live seeds is necessary. In maize (*Zea mays* L.), single-seed selection was found to be more effective in improving oil content than composite sample selection (Silvela et al. 1989). The identification of seeds with high oil content in plants of high oil content suggests a single-seed selection program to improve oil content.

The positive correlation between oil content and seed mass suggests an opportunity to use mechanical separations of high mass (i.e. high weight) seeds from bulk samples as a first phase process of selecting quantities of seeds for high oil content. NITS scanning would be used as the second phase to separate the highest oil content seeds from the high mass seeds. However, an improved NITS calibration should be developed for accurate oil determinations of seeds exceeding the characteristics of the existing calibration.

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