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Environmental Influences on Seed and Oil Characteristics of

FLAX

The genetic constitution of flax plants determines the quantity and quality of oil produced. However, both of these seed characteristics are strongly influenced by environment, as reported in these analyses of flaxseed grown in different locations in California.

FLAX HAS BEEN an important oil crop in California's agriculture for over twenty years even though economic factors have caused the acreage to fluctuate from year to year. Since 1950, the California flax acreage has never amounted to more than 1.5% of the national flax acreage. However, the average yield in the State has been relatively high, ranging between 25 and 40 bushels per acre, as compared with a national average of under 10 bushels per acre.

Research efforts have been directed mainly towards obtaining maximum yields, but considerable effort has also been made to increase the oil content of the seed and improve the quality of the oil. In spite of increasing competition from other vegetable oils, linseed oil is still a basic drying oil in the paint industry. The genetic constitution of a flax plant determines the basic quantity and quality of oil it produces, but both of these characteristics are also strongly influenced by environmental conditions. This is especially evident in California where flax is grown under very different climatic conditions.

The quantity of oil produced is usually expressed as a percentage of the total weight of the seed. The quality of oil is indicated by the "iodine value," defined as the number of grams of iodine absorbed by 100 grams of oil. This constant is a measure of the degree of unsaturation of the oil and is a very useful index of the quantity of oxygen the oil is able to absorb. The higher the degree of unsaturation, the more oxygen linseed oil can absorb. When exposed to the air, oxidation of the linseed oil base paints results in rapid formation of a protective film. The drying time of linseed oil paints can be shortened considerably by incorporating chemical driers into the paint. Nevertheless, it has been observed that oils with high iodine value produce paint films of superior quality.

The rapidity of oxidation of linseed oil depends not only on the degree of unsaturation, but also on the relative proportions of the four major fatty acids (palmitic, oleic, linoleic, and linolenic) in the oil. The iodine value does not differentiate between these acids, and a better evaluation of the drying quality of linseed oil is possible by analytical methods which measure the proportions of each fatty acid in the glycerides of the oil. Such analyses have revealed that the oils with the shortest drying time are the ones that have the highest content of linolenic acid. Analyses of several hundred local and introduced lines of flax grown in California have shown that the linolenic acid content of linseed oil may vary from 41 to 57% with corresponding iodine values ranging from 162 to 208. Since a high quality drying oil must have an iodine value of 177 or over, many lines of flaxseed with desirable agronomic characteristics, but low iodine value, are not suitable for commercial production.

The ratio of unsaturated to saturated fatty acids in linseed oil is very high, approaching that of safflower oil. Some nutritionists attach particular dietetic importance to this ratio. The high linolenic acid content of linseed oil, however, has excluded it from the edible oils market because this acid is partly responsible for the appearance of undesirable off-flavors in refined oils soon after processing.

To obtain information on the degree of variation resulting from genetic and environmental sources, 14 commercial flax varieties listed in the tables were grown at five different California locations for determinations of seed weight, oil content and iodine value. The first five varieties listed in the tables are of major importance in California. New River and Imperial occupy the entire flax acreage in the Imperial Valley while Redwood, Argentine and B-5128 are grown in San Mateo County. Arny, Bolley, B-5128 and Redwood are major commercial varieties, and with Marine, occupy about 85% of the national flax acreage. All varieties in the tests were planted in wilt-free fields at the rate of 48 lbs per acre in three-row plots with rows 1 foot apart. Plots were located at the Davis and Riverside campuses of University of California; West Side Field Station, Fresno County; Imperial Valley Field Station, Imperial County; and in the coastal area of San Mateo County near Half Moon Bay.

Seed weight, iodine value and oil content were affected by the locations of these plantings. Best overall values for all three of these seed characteristics were obtained under the cool, long-growing season in San Mateo County. Considerable variability was observed, however, not only among varieties but also in the relative performance of individual varieties at the different locations. For example, in 1961 there was a difference of 3.5% in the oil content of Argentine between the Davis and the West Side Field Station tests. Also, there was a difference of 15 iodine value units in Punjab 47, and 1.38 grams in 1000-seed weight in Redwood between seed samples from the same two locations. It is of interest to note that the varieties did not always maintain the same relative ranking in each of the locations as far as seed weight, iodine value and oil content are concerned. Although not representing long term averages, data presented offers a measure of the magnitude of differences that could be expected among commercial varieties of flax grown in different areas of California.

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