

Varieties of Flax and Disease Resistance

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THE flax crop is affected by a variety of diseases. At one time wilt was the limiting factor in flax production on old land. In time highly wilt resistant varieties were developed and the hazard from this disease was essentially eliminated.

A few years ago rust injury to flax became increasingly serious, being especially destructive in 1941 and 1942 on Bison, the variety then most commonly grown. A number of varieties recently developed have a high degree of resistance to this disease and while generally not as resistant to wilt as Bison and Buda, they appear sufficiently wilt resistant for most farm conditions. These new varieties, now in increasing production, should in time reduce the losses from rust about as effectively as the earlier varieties checked the losses from wilt.

In 1942, and to a much larger extent in 1943, the pasmo disease, previously considered of minor importance, proved to be very destructive. This disease caused severe injury to "Golden," a variety then grown extensively in eastern North Dakota because of its resistance to rust. PasmO was also present in 1944, but the infestation was more spotty and generally much less destructive. The varieties now available vary in the degree of susceptibility to pasmo, but none can be considered as having satisfactory resistance.

Plant pathologists¹ describe pasmo as a disease caused by a fungus (*Septoria linicola*)² which over-winters on diseased flax stubble, straw and trash in the field and on bits of straw and chaff carried with the flax seed. These over-wintering spores germinate in the spring, grow and produce other spores which are spread by wind and water to growing flax. With favorable moisture, humidity and temperature these spores germinate, grow and penetrate the tissues of the flax plant

and, as growth continues, produce more spores to infect or re-infect other plants. Early infection is noted first on the older leaves, forming greenish yellow to brown lesions. Stem lesions appear later on the lower portions of the stem. These lesions or blotches have a brownish color and as they enlarge and join may more or less cover the entire stem.

Low areas in a field where growth is heavy generally are most favorable for infection and spread of the disease. Hence pasmo first appears as small "sick" appearing brown spots in the field, which may enlarge rapidly and eventually extend over the entire field. PasmO may be readily distinguished from rust. PasmO produces a brown irregular-shaped lesion or blotch. Rust pustules have a more distinct circular outline, have a bright orange color in the early stage, and are dark or almost black in the mature or over-wintering stage.

Reducing the Opportunities For Infection

While the wilt and rust diseases may be effectively controlled with the use of rust resistant varieties now available, meeting the pasmo problem is more difficult. Moisture, high humidity and the right temperature favors early infection when the disease organism is present. To hold down the amount of early infection, and thus prevent or delay the heavier infestation until the crop is more advanced, the following recommendations are made: (1) Do not sow flax on fields cropped to flax the preceding year, and preferably not adjacent to diseased

¹For a more complete discussion of pasmo see the following: Flor, H. H., N. Dak. Agric. Exp. St. Bimonthly Bul. Sept. 1943; also Brentzel, W. E. Journal of Agr. Res. 32:25-27, 1926

²Perfect stage recently named *Mycosphaerella*.

fields of the year before. (2) Plow under or destroy before May 10 all diseased flax stubble, straw or chaff on which the pasmo organism overwintered, thus destroying the opportunity for a heavy early infestation. (3) Do not spread manure containing diseased flax straw on land where flax is to be sown. (4) Clean seed thoroughly to remove bits of diseased straw or chaff. (5) Use a variety having as much tolerance to pasmo as possible without sacrificing necessary rust protection. (6) Sow early, in soil where weed competition is not likely to be great. Diseases spread most rapidly in fields where growth is heavy and morning dew stays on long. The above suggestions will also help to hold down the early rust infection.

Varieties of Flax

Following herewith is a brief description of each of the leading varieties now available for sowing and a comparison of their plant characteristics, yielding capacities and reaction to the important flax diseases (See also Table 3)¹: The reaction of a variety to a disease can be described in relative terms only. How does it compare with other varieties? Varieties appearing to have little or no resistance are said to be susceptible. A variety said to be immune is considered not subject to attack from the particular disease. In all instances these terms are with reference to races or strains of the disease known to occur in this area.

Bison, which for several years was the principal variety grown, has excellent resistance to wilt, fair tolerance to pasmo but is very susceptible to races of rust now common in this area. Bison is a good yielding variety, matures mid-early, has good height, blue flower, mid-size brown seed. Lacking in resistance to rust its use is limited chiefly to areas with little or no danger from rust. Since it is the variety most extensively grown until recently, and one most flax growers are familiar with, it is used here as the standard for comparison.

Buda (N.D.R. 119) is one of the older varieties in production, released from this station in 1925. Buda is a

highly wilt resistant variety and is classed as moderately resistant to rust, being resistant to some races of rust thought not to all. Buda, therefore, is a safer variety than Bison under rust conditions. This variety also has a fair tolerance to pasmo, grows as tall or slightly taller than Bison, has weaker straw, a small brown seed with satisfactory oil content and high iodine number². In the variety trials over a series of years the yields of Buda have generally compared favorably with those of Bison and exceeded Bison in rust years. Being late in ripening, however, is a disadvantage in years when late summer drouth and high temperatures are experienced. Comparing Buda yields at Fargo for 19 years, Buda yielded more than Bison in 9 of those years, yielding the same as Bison one year and averaging for the period 16.1 bushels or about the same as Bison (see Table 1).

"Golden"—The varieties of Golden flax in distribution under the names of Viking and B. Golden, are very similar if not identical. This flax has a short straw, growing to about three-fourths the height of Bison, has a large pale pink blossom and produces fairly large bright yellow seed. This Golden flax ripens later and less uniformly than Bison, is moderately resistant to wilt, highly resistant or practically immune to the races of rust known to occur in this area, but is highly susceptible to pasmo. This flax is an excellent yielder, when conditions are reasonably favorable, but lack of plant height for convenient harvesting and ability to withstand weed competition, plus its susceptibility to pasmo are serious disadvantages. No. R522 (C.I. 977) is a taller and later ripening selection from B. Golden, highly rust resistant, excellent yielder but susceptible to pasmo.

Walsh has been in production for about 15 years but compared with other varieties did relatively best in the rust years, 1942 and 1943. Walsh is moderately resistant to wilt, highly resistant to rust and slightly less susceptible than the Golden to pasmo. This variety has a large blue

¹Trials at Dickinson in cooperation with the Division of Cereal Crops and Diseases, R. W. Smith in charge. Trials at Edgeley, Langdon and Williston under supervision of superintendents, J. P. Tiernan, V. Sturlaugson and W. H. Huber, respectively.

²Iodine number is the index commonly used to measure the relative drying quality of oils.

Table 1—Comparing the average yields (bushels per acre) of Bison and Buda for all the years grown in trials at the North Dakota stations.

	Fargo 1926-44 (19 yrs.)	Edgeley 1929-44 ^b (9 yrs.)	Langdon 1928-44 ^b (9 yrs.)	Dickinson 1928-44 ^c (14 yrs.)	Mandan 1928-40 (11 yrs.)	Williston		Weighted average 70 station years
						Dry Land 1928-32 ^d (4 yrs.)	Irrig. 1941-44 (4 yrs.)	
Bison	16.0	11.8	12.1	5.4	5.7	13.5	15.8	10.9
Buda	16.1	11.2	13.5	4.5	4.8	11.5	18.6	10.9

^aNine years, not grown 1933 to 1939 incl. ^bNine years, not grown 1930 and 1933 to 1939 incl. ^cOmitting 1936, 1937, 1938, comparable yields not obtained. ^dNot grown 1931.

flower, large bolls, large brown seed, does not grow quite as tall, ripens slightly later and less uniformly than Bison. Walsh bolls frequently do not have as full a set of seed, thus yields are less consistent than with other varieties. A more dependable variety than Bison in a rust year.

Koto is one of the first of the newer varieties brought forward to help meet the rust problem. Koto is from a cross (Russian x Argentine) x Bison made at the Northern Great Plains Field Station, Mandan. It is a blue flowered, brown seeded flax with height and maturity about the same as Bison. Koto seed is about equal in size or slightly smaller than Bison, has a slightly lower oil content, but the oil has a higher iodine number. Koto is immune to many of the known races of rust but it is susceptible to some races now occurring in North Dakota and so under some conditions has shown considerable rust. While it has been superior to Bison under the rust conditions prevailing the last three years, it lacks in resistance when compared with the Golden, Walsh, and other resistant varieties. Koto has satisfactory resistance to wilt, is about as tolerant to pasmo as Bison and Buda, appears to be an excellent yielding variety and while lacking some in resistance to rust it should find a use in those sections of the State where the rust hazards are not so great and until more resistant varieties with good plant characters can be made available.

Biwing is from a cross between Bison and Redwing made at the Minnesota Experiment Station and released in 1942. Biwing has satisfactory height, is earlier maturing, and has more tolerance to rust than

Bison, but is not sufficiently resistant under severe rust conditions.

Victory (No. 5585) is from a Czechoslovakian flax crossed with Argentine, and a selection from this crossed with Smoky Golden. This variety as it is now in production is somewhat variable in type, ripens mid-late, has a large white flower, large brown seed of satisfactory oil content and high iodine number. Victory is moderately resistant to wilt, highly resistant to rust¹ and rather susceptible to pasmo. The increase of this variety was begun in 1941 and it is now in fairly extensive production. Victory appears to be a good yielding variety when not severely damaged by pasmo. Early sowing to better "escape" severe pasmo infection or high temperatures is recommended.

Renew is from a cross Newland x (19 x 112E) made at the Great Plains Field Station, Mandan. Renew, released in 1943, is highly resistant to those races of rust common to this area, comparing favorably with the Golden and Walsh in this respect. Compared with Bison, Renew is more susceptible to pasmo, lacks some in resistance to wilt, but should be sufficiently resistant for most farm conditions. Renew grows about as tall and matures about the same time, or slightly earlier than Bison; has a blue flower, and slightly smaller, dark brown seed. Renew should yield satisfactorily under most conditions and unless damaged seriously from pasmo, appear to especially good advantage in a rust year. This variety will probably find its largest use in the southern and western sections of the State where early maturity is desired.

No. 5128 (Golden x Rio) developed at the North Dakota Experiment Station and released in 1943, is high-

¹About 25 percent of the divergent plant lines in this variety appear susceptible to certain races which have been found in North Dakota.

ly resistant or immune to those races of flax rust common to this area. Compared with Bison it is less resistant to wilt, and is more susceptible than Bison to pasmo, though more tolerant than Victory and Renew. This numbered flax grows fully as tall as Bison, has a blue flower, and a larger brown seed. The oil content and drying quality of the oil, as measured by the iodine number, is about the same as Bison. It is an excellent yielding variety under reasonably favorable condi-

tions, but later in ripening than Bison, a factor which may be a disadvantage in some years when late drouth or high summer temperatures occur. Under extremely wet conditions which existed at Fargo this past year, late varieties including No. 5128 were injured most from the excess water. Because it is rather late in blossoming and ripening, sowing early is urged so that the crop may be more advanced should high summer temperatures or drought occur.

Table 2—Comparing the average yields of promising new and standard varieties of flax for the years grown in field plot trials at the several stations.

Variety	Average yields in bushels per acre					
	Fargo	Edgeley	Langdon	Dickinson	Williston (Irrig.)	Weighted Average (12 sta. years)
	1941 to 1944	1943 to 1944	1943 to 1944	1943 to 1944	1943 to 1944	
Bison	13.8	10.5	17.6	6.4	20.6	13.8
Buda	15.5	13.3	19.9	7.0	21.7	15.5
Golden	17.4	11.6	19.9	7.2	29.3	17.1
Walsh ^a		12.1	19.0	
Koto	17.0	14.4	21.0	7.9	26.7	17.3
Renew	15.6	15.3	22.5	7.4	26.0	17.1
Victory	17.6	14.5	22.2	9.5	26.6	18.0
No. 5128	17.7	14.5	22.9	10.4	30.2	18.8
Crystal ^b		12.6		
Royal ^c		12.8	d	8.2
R 522	16.1			9.1	30.3

^aIn the trials at Fargo, 1931 to 1940, Walsh averaged 13.5, Buda 14.5 and Bison 15.4 bushels per acre. Not grown 1941 to 1944.

^bIn trials since 1942, average yield 3 years 14.7, Bison 14.1, Buda 15.2, and Victory 17.5 bushels.

^cGrown only 1943--1944, no serious rust damage, average yield 10.1, Bison 12.3 bus.

^dGrown only in 1944—yield 17.1, Bison 13.6, Buda 15.3 bushels.

Royal is a selection from Crown made at the University of Saskatchewan, Saskatoon, Canada, and released in 1938. Royal is moderately resistant to wilt and rust but susceptible to pasmo. Royal grows about as tall as Bison, ripens slightly later, has a blue flower, medium large seed of satisfactory oil content but lower iodine number than Bison. Royal seed is characterized by a yellow or yellowish-white shading on the broad end of the seed. In North Dakota tests so far, Royal has not proved to be especially high in yield. Its chief virtue compared with Bison, therefore, is rust resistance, but other varieties now in increasing production are superior in this respect. Until sufficient seed of the more resistant varieties are available Royal, which is a safer variety than Bison in rust areas, should be used. Observations at the University of Saskatchewan indi-

cate that Royal may be more resistant to frost in the spring than Bison.

Crystal developed at the Minnesota Agricultural Experiment Station is from a cross, Bison x Ottawa 770B. While Crystal is now under early increase and release in Minnesota, seed of this variety is not likely to be available generally for at least one more year. This new variety is moderately resistant to wilt, highly resistant to rust and compares favorably with Bison and Buda in tolerance to pasmo. Crystal grows mid-tall, has a bell shaped white blossom, ripens mid-late and has a dull yellow colored seed.

Cultural Suggestions

Competition from weeds is one of the most serious problems in successful flax production. Flax, therefore, should be sown only on land relatively free from weeds and weed seeds. Preparation of land and

seed beds for flax should preferably begin a year or more before the flax is to be sown. The most successful flax farmer is one who manages his fields so that weed competition is always at a minimum and then in his cropping program he sows flax following the crop where the weed competition would be the least. Usually this is after corn or some cultivated crop. It may be grass land, if this has been down to grass long enough to permit rotting of the buried weed seeds. Early sowing of flax is generally advisable, and in a firm seed bed.

Spring plowing of stubble land is a common practice in the lighter soils and insures relatively clean flax. When sown in this manner the soil should be plowed, well packed and the flax sown the same day. Some growers when sowing on summer fallow prefer to replot the fallow

low in the spring, pack and seed immediately.

Relatively good results have been obtained the last few years where flax was sowed on burned-over stubble fields, and with little or no seed bed preparation. This practice, however, should be limited to stubble land, where the crop had followed a well kept fallow and produced a heavy growth that effectively smothered weeds, leaving a heavy stubble for snow catch and a good spring burn. The firm seed bed which this method provides and the better surface moisture conditions for prompt and even germination, are some of the advantages of this practice. Sowing in this manner on weedy fields or where there may be a heavy grasshopper infestation is not advisable. Similarly on light soils that blow badly, burning stubble may be inadvisable.

Table 3—A classification of the leading flax varieties with respect to some plant and seed characteristics and their reaction to important diseases.

Variety	Color		Rel. Seed Size	Relative maturity	Resistance to Disease ¹		
	Blossom	Seed			Wilt	Rust	Pasmo
Bison	blue	brown	med.+	mid-early	v.good	poor	fair
Buda	blue	brown	small—	mid-late	v.good	fair	fair
Walsh	blue	brown	v. large	mid-late	fair	excel.	poor
"Golden"	pink	yel.	med.+	mid-late	fair	excel.	v.poor
Redwing	blue	brown	small	early	fair+	fair—	fair
Biwing	blue	brown	med.	early	v.good	fair—	fair
Koto	blue	brown	med.	mid-early	v.good	fair	fair
Renew	blue	dk. brown	med.	mid-early	fair	excel.	poor
Victory	white	brown	large	mid-late	fair+	excel.	poor
No. 5128	blue	brown	large	late	fair+	excel.	fair—
Royal	blue	brown	med.	mid-late	fair	fair+	fair—
Crystal	white	dk. yel.	med.+	mid-late	fair	excel.	fair
Shenenne (C.I.1073)	blue	brown	med.	early	v.good	excel.	fair

¹Refers to reaction to those races now common to this area. None of the flax varieties have satisfactory resistance to pasmo.

Summary

Rust resistant varieties should have preference in rust areas, in so far as the supply of seed permits. These varieties are Renew, Victory, No. 5128, Walsh, Royal, Golden and Buda. Since the supplies of seed of the newer resistant varieties are not sufficient, Walsh and Buda must still be grown on much of the acreage in this area. The Golden, because of short straw, may ordinarily be grown most satisfactorily on the heavier soils.

Buda, while the least resistant of these varieties to rust, has most tol-

erance to pasmo and as such deserves serious consideration when choosing the variety to grow. Of the more rust resistant varieties No. 5128 should have preference in the Northern counties and the earlier ripening Renew or Victory in the other sections of the State.

In the areas where the rust hazard is not so great varieties like Bison may still be grown. Koto, Renew, Victory, Buda and Walsh may also be used, in so far as the supply of seed permits.

To reduce the opportunities for pasmo and rust infection plow un-

der early or otherwise destroy disease infected stubble, straw or chaff on which the disease organisms have over-wintered. Similarly avoid sowing flax on land cropped to flax

the preceding year or adjacent to last year's diseased flax field.

A firm seed bed, relatively free of weed seeds, and early sowing is usually preferable for flax.

THE FATS AND OILS SITUATION

A Bureau of Agricultural Economics, U. S. Department of Agriculture summary says in part: New information provided by the December crop production summary and the Pig Crop Report points to a somewhat smaller production of fats and oils in the current crop marketing year than was indicated earlier. Output of domestic edible oils—cottonseed, soybean, corn and peanut—is now placed at about 2.9 billion pounds compared with 3 billion pounds indicated a month ago and 2.8 billion pounds produced last season. With a 29 percent reduction in the 1944 pig crop and a probable decreased yield of lard per hog as a result of a lighter trim of fat, production of lard and rendered pork fat in the year beginning October 1 will be at least 1 billion pounds less than the record output of 3,460 million pounds in 1943-44. Output of linseed oil from domestic flaxseed will be slightly under earlier expectations with the 1944 flaxseed crop now reported to be 55 percent smaller than the record-breaking crop in 1943.

Total production of fats and oils from domestic materials in 1944-45 probably will be slightly less than 10 billion pounds. This would compare with 11.2 billion pounds in 1943-44. Imports apparently will be about the same as or somewhat less than those of last season, depending partly on how much flaxseed may be obtained from foreign sources. Factory and warehouse stocks of fats and oils on October 1 were about 2400 million pounds larger than a year earlier. Nevertheless, total supplies of fats and oils in the current crop year are likely to be at least 800 million pounds less than in 1943-44. Demand, on the other hand, continues strong. Prices of most fats and oils probably will remain at ceiling levels through the present crop year. Total exports of fats and oils in 1945 may be as large as in 1944. The strong European demand for fats and oils to be supplied by the U.S. in 1945 parallels a similar demand in 1919, when exports of leading fats and oils rose to over 1 billion pounds, approximately 40 percent more than the 1910-14 average. Exports of U.S. lard and soybeans are likely to be fairly large for several years after 1945, but only if prices are permitted to adjust to international levels.

(A News Release from the Bureau of Agricultural Economics, U. S. Dept. of Agriculture, Jan. 9, 1945.)