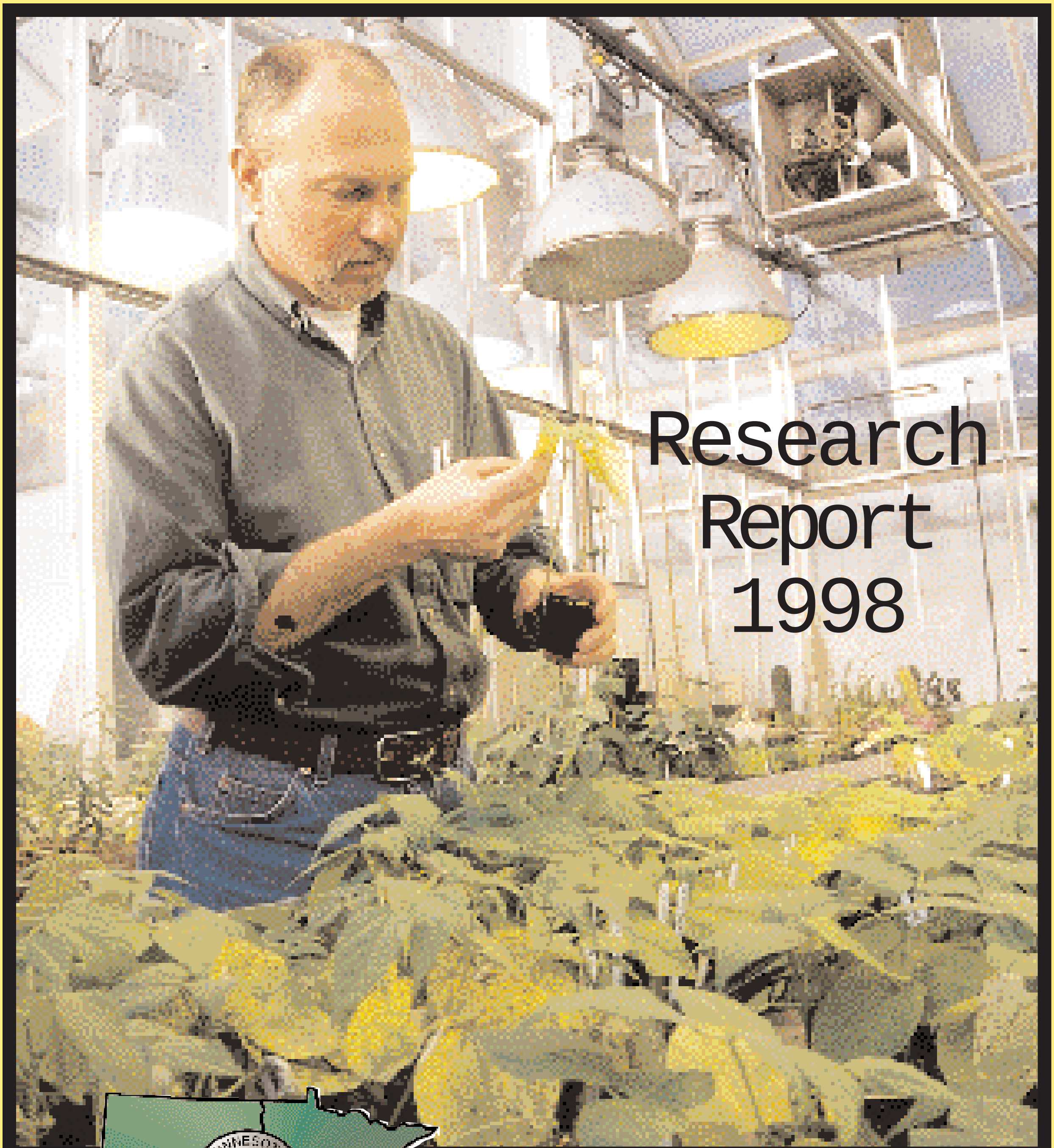
Northarvest Bean Growers Association



Research Report 1998

NORTHARVEST BEANS

Our Pride Is Growing

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Welcome to the Tour

Research Report, 1998 is the first annual publication devoted to the research funded by the Northarvest Bean Growers Association, the Minnesota Dry Bean Research and Promotion Council and the North Dakota Dry Bean Council.

A Northarvest committee oversees research funding. Current committee members include Mark Sletten, Hatton, N.D.; Mark Dombeck, Perham, Minn.; Mike Beelner, Park Rapids, Minn.; Gary Friskop, Wahpeton, N.D.; Tim Skjoiten, Hatton, N.D.; Mark Myrdal, Edinburg, N.D.; Jerome Hagemeister, Fessenden, N.D., Randy Carow, Perham, and George McDonald,

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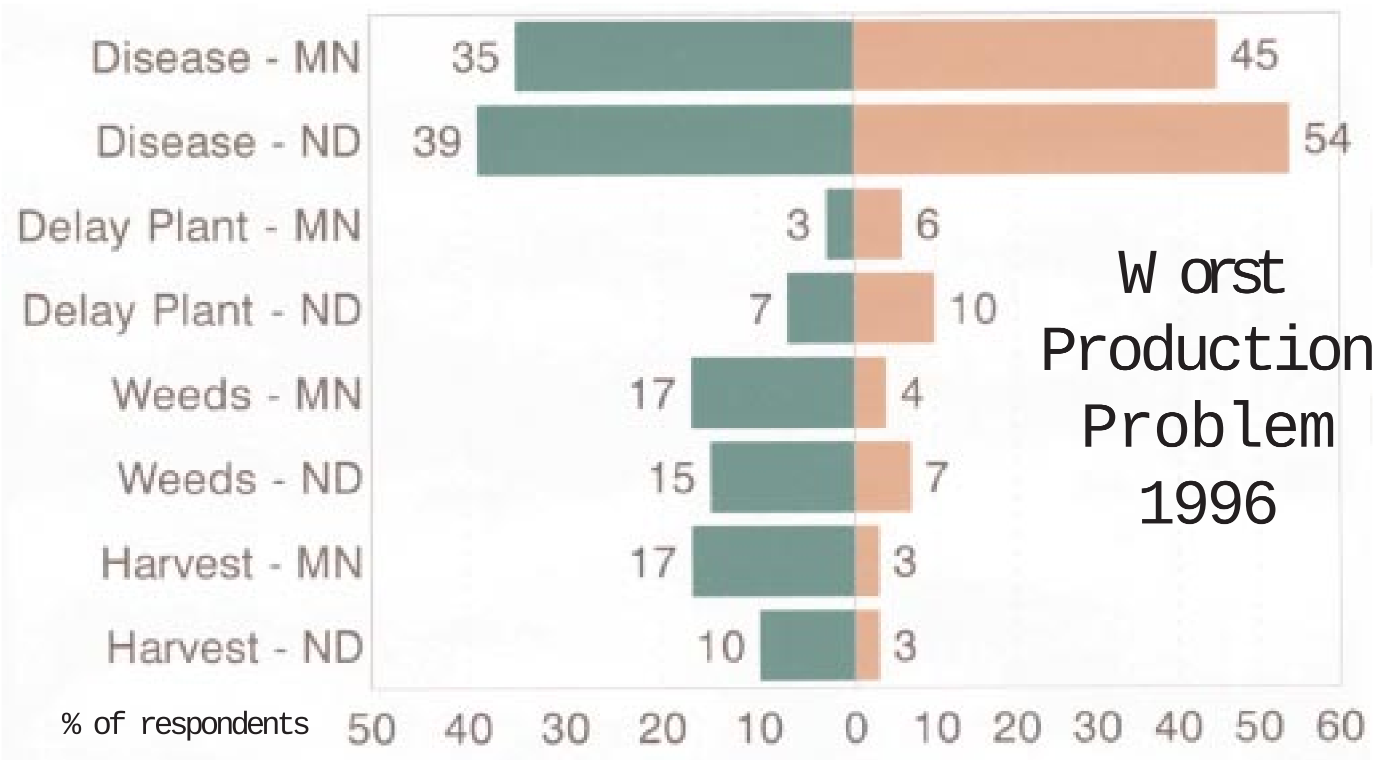

Grower Survey

Questionnaire Focuses Research

By Art Lamey and J. L. Luecke
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A grower survey was mailed to all Northarvest growers late in 1996. This survey is an ongoing project to define grower practices and problems and their research and extension needs.

The worst production problem in 1996 was disease, as reported on 45% of Minnesota and 54% of North Dakota respondents' acres. This is slightly higher than in 1995, when disease was the worst production problem on 35% of Minnesota and 39% of North Dakota respondents' acres.

White mold was the worst disease problem in 1996 on 76% of Minnesota and 68% of North Dakota respondents' acres. Rust was the second worst disease problem. Root rot also was cited as a serious problem in some areas of Minnesota.

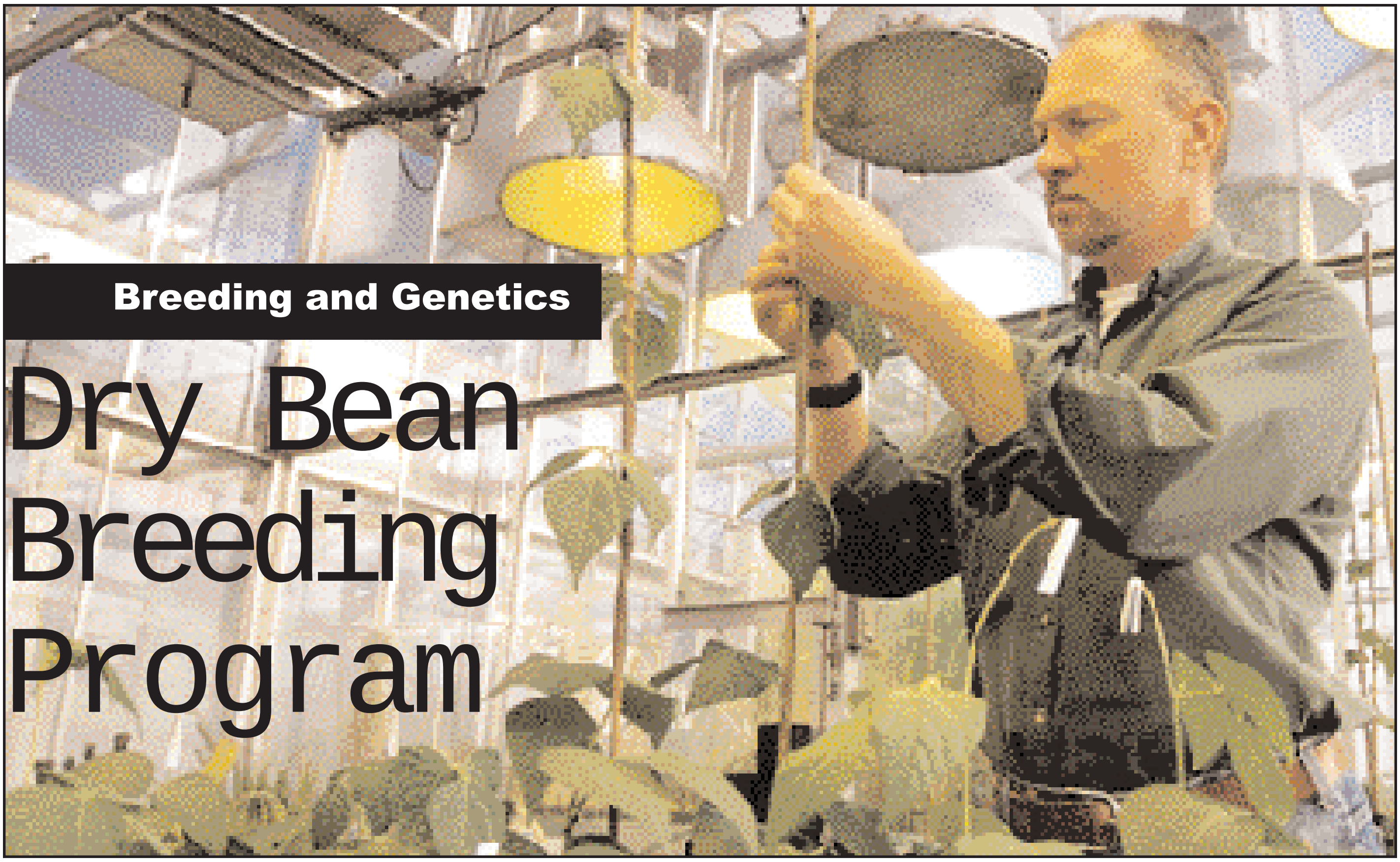
Benlate and Topsin M were used for white mold control on 22% of North Dakota and 44% of Minnesota respondents' acres. The use of white mold fungicides in 1996 was double that in 1995. Minnesota respondents broadcast treated three times as many acres as they band treated and North Dakota respondents broadcast treated about 60% of their acres.

Since band application is more economic than broadcast, it is surprising that more respondents did not use band application. Wet conditions may have prevented some respondents from using band application. There also appears to be a trend toward more bean growers who also grow sugarbeets using 22 inch row spacing, making band application difficult or impractical.

Rust fungicides were used on 24% of Minnesota and 37% of North Dakota respondents' acres. For both states, this is half again as many acres as were treated in 1995. This increase was due primarily to a tripling of Tilt treated acres in Minnesota and a doubling of Tilt-treated acres in North Dakota. Tilt has been available the past several years in both states under a section 18 specific exemption. The final registration of Tilt has not occurred, although Novartis expects that registration may occur by the 1999 cropping season.

Rust and use of rust fungicides has been of more concern to North Dakota dry bean growers due to the preponderance of pinto acres in North Dakota.

However, new pinto varieties have been released recently with resistance to the predominant rust



Breeding and Genetics

Dry Bean Breeding Program

By Ken Grafton
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North Dakota State University

The long-term objective of the dry bean breeding program at North Dakota State University is to develop high yielding, high quality, adapted bean cultivars for production in the Northarvest region. Approximately 350 unique, controlled hybridizations are made in the greenhouse each year to reach this objective (in 1996-97, 472 unique hybridizations were made). Parental germplasm consists of adapted cultivars grown in the Northern Plains, breeding lines developed at NDSU, and germplasm possessing desirable traits from other breeding programs. Unadapted germplasm lines from other sources are evaluated for desirable traits and introgressed into adapted material (e.g., pre-breeding). Each year, the breeding program evaluates material from around the world as possible sources of resistance to white mold, rust, root rot, and bacterial blights.

The breeding scheme used in the program is known as the pedigree method, described as follows: After unique hybridizations are made, the hybrid (F1) seed is grown in both the greenhouse and field to ensure seed production (year 1). F2 seed harvested from these F1 plants are planted in a spaced plant arrangement in North Dakota so that single F2 plants can be selected for maturity, plant architecture, number and location of pods, lack of diseases, and appropriate seed characteristics (year 2). The F2 generation is the generation where maximum variability in a population exists and is an excellent stage to select for highly heritable traits. Approximately 200,000 individual plants are evaluated at this stage. The best populations are identified and the best plants are selected from these populations. The F3 progeny from selected individual F2 plants are grown in a winter nursery for seed increase; these lines also are tested for reaction to bean common mosaic virus (BCMV) and rust in the greenhouse (year 2.5-3). Lines found to be resistant are harvested in bulk and the resultant F4 lines are planted in plant rows at 2-3 locations in North Dakota (year 3). Single plants are selected from lines that perform well at all locations and advanced one generation (F5 generation) in the winter nursery (year 3.5). The F6 seed is then used for a preliminary yield test (2-3 reps at each of 3 locations, depending on seed availability) for one year (year 4). If a line performs well, it is single plant selected to begin pure line development and also entered into advanced yield tests (3 reps/ location; 4 locations) (years 5 and 6). A selection pressure of 10-15% is placed on materials entered into plant rows and yield tests, ensuring that only superior lines will be selected. Elite lines that perform well in the advanced yield trials are then entered into variety trials for three years (years 7, 8, and 9). The time required to release a variety after the initial cross is made is usually 10-12 years, although it may be reduced considerably if off-season nurseries are used.

Winter Nursery

Off-season nurseries are used to reduce the number of years needed for experimental lines to reach near-homozygosity, allowing yield tests to begin earlier in the breeding cycle. Several years can be eliminated from cultivar development if winter nurseries are used. As in past years, a winter nursery will be conducted in Puerto Rico. The 1997-98 winter nursery will consisted of over 2,800 rows, almost twice as large as last year s nursery of 1,600 rows.

Yield Tests, Breeding Nurseries, and Variety Trials

The breeding program has yield tests and/or breeding nurseries at nine locations in North Dakota and Minnesota (Erie, Hatton, Forest River, Johnstown, Page, Carrington, Crete, Park Rapids, and Perham). In 1997, pinto (P) navy (N), and miscellaneous (M) bean class variety trials were grown near Erie (P,N, &M), Hatton (P,N, &M), Forest River (P&N), Crete (P&N), Perham (M), and Park Rapids (M); preliminary yield tests were grown at Erie, Hatton, Johnstown, and Perham (kidney and crans only). Approximately 1,000 plots variety trial plots were harvested, in spite of the fact that about 400 plots were abandoned because of severe flood damage. An additional 4,500 plots from yield trials and breeding nurseries were harvested in 1997.

Breeding nurseries were located at Erie, Hatton, Johnstown, and Perham (irrigated). Germplasm evaluation nurseries were at Erie and Perham; the Midwest regional Performance Nursery (a four state trial coordinated by NDSU) and the Cooperative Dry Bean Nursery (12 states and provinces, coordinated by the University of Idaho) also were at Erie. Disease nurseries were at Page (white mold), Hatton (rust), Erie(common blight), and Perham (root rot). Breeding nurseries, yield trials, and other trials will total more than 7,000 plots planted on over 35 acres.

1997 Season

The 1997 growing season was, for the most part, good early on, except for areas that received excessive rainfall. The growing season was conducive to white mold, which was reported as early as July 20 in some production fields. Late July and August were, for the most part, dry, which minimized white mold damage. Common bacterial blight was particularly evident throughout much of the region. The breeding project lost yield trials at Hatton, Forest River, and Perham because of excessive rainfall. However, a few miles away from these damaged sites at Hatton and Perham, breeding nurseries were good to very good, and with the site at Erie, allowed for over 4,000 single plant selections of pinto, navy, pink, black, dark red kidney, light red kidney, and cranberry market classes to be made. These single plant selections were evaluated in the seed lab for seed quality traits, with the lines having the best traits entered in the 1997-98 winter nursery. The remaining lines will be evaluated in 1998 in North Dakota. Approximately 90-95% of the breeding effort is placed on pinto bean and navy bean improvement.

Breeding lines were evaluated in the greenhouse for the presence of BCMV resistance genes I, bc22, and bc3 during the winter. Incorporating adequate levels of BCMV resistance into pinto bean breeding lines improves the overall desirability of experimental lines because of the threat of virus infection in western seed producing states. Lines also were evaluated for rust resistance, using a composite of isolates collected from North Dakota. High levels of resistance were identified in lines from a number of market classes. Given adequate funding and greenhouse space, the breeding program would prefer to supplement field inoculation of both rust and white mold with greenhouse evaluations.

Canning Evaluation

Canning trials of pinto bean and navy bean breeding lines are conducted for all advanced and some preliminary trials, depending on seed supply, in collaboration with Dr. Sam Chang, Department of Food and Nutrition. In these canning trials, experimental lines are rated on overall appearance, on a subjective scale of 1 = superior to 7 = poor appearance (4 = average), relative to released commercial cultivars (prior to 1995, a 1 to 5 scale was used). These cultivars also serve as yield and agronomic checks in the yield trials. In 1997, more than 1000 samples from the were canned, using seed from breeding lines and cultivars grown at several locations in 1996. The objective of these canning tests is to identify both potentially superior genotypes, which would be advanced for further evaluation, as well as inferior genotypes, which would be eliminated from the breeding program.

White Mold

White mold continues to be a serious management problem for dry bean growers and is ranked as the disease of most concern to producers.

The potential for improved genetic resistance as a control measure has been demonstrated. Two major mechanisms of genetic resistance to white mold exist: 1) avoidance - usually associated with improved plant architecture; and 2) physiological - associated with biochemical functions at the cellular level.

Generally, greenhouse and laboratory methods screen solely for physiological resistance, whereas field plantings screen for both physiological and avoidance mechanisms. Thus, greenhouse and laboratory resistance may not correlate well to field resistance.

BREEDING PROGRAM Continued on next page

Breeding Program

Continued from page 5

The breeding project has relied on evaluating material in the field at Oakes, where a 12 entry National White Mold Nursery also is grown. This national nursery is grown in Michigan, New York, Nebraska, Colorado, and Ontario, Canada. In the 1994-96 nurseries, an NDSU navy bean breeding line, 88-106-04, had the lowest score of any adapted navy experimental line or cultivar when averaged over all test locations, indicating that progress is being made to minimize white mold damage. In the 1997 nursery located near Page, N.D., a navy line ND 97-076-01 was one of the most resistant lines evaluated in North Dakota and Michigan. An additional NDSU nursery of 138 lines was evaluated for reaction to white mold. Obviously, the major challenge remains to transfer this resistance into pinto bean where resistance remains woefully inadequate.

Rust

Rust has, at times, been a severe disease problem, particularly for pinto bean producers. This fungal pathogen is composed of many races (at least 80 in the United States and over 200 worldwide) and has the capability to increase in variability, since it can complete its entire life cycle on the bean plant.

Resistance usually is controlled in a single gene fashion, whereby one gene in the plant imparts resistance to one specific race of the pathogen. Often, this type of 'vertical resistance' is short-lived, because the selection pressure placed on the rust race forces a change in the rust population. As a result, a new rust race is developed, and the former resistant variety becomes susceptible. This was observed in the pinto variety Olathe which, when first grown in North Dakota, was completely resistant, but is now susceptible to at least one component of the rust population.

Two NDSU dry bean breeding lines exhibit different traits in test plots.

Technicians, using a stationary thresher, harvest dry bean lines from a test plot.

The dry bean breeding program currently is involved in determining the inheritance of broad-based rust resistance genes that were found in tropical germplasm. This resistance may be the result of one gene conferring resistance to more than one race, or a tight (linked) cluster of genes. By understanding the mechanism of inheritance, we will be better able to develop an efficient breeding strategy to utilize this new source of resistance.

The breeding program has cooperated extensively with USDA-ARS and other state scientists to incorporate high levels of rust resistance into the major bean market classes. To date, this collaborative relationship has resulted in the release of 13 rust resistant pinto lines and 11 navy lines. These lines provide unique sources of resistance to both public and private bean breeders. This year, approximately 90 lines were evaluated at the rust nursery site near Hatton to identify those lines with desirable agronomic traits.

Root Rots

A nursery composed of 160 entries was evaluated in a root rot infested field near Perham, MN. Lines were evaluated for root health by digging five random plants from a row and recording the amount of root damage using a rating scale of 1 = no damage to 5 = severe damage. As expected, the susceptible cultivar Montcalm had the highest average rankings, while some resistant lines, such as FR 266, Wisc. RRR-36, and G 122, had values of 1, 2, and 2, respectively. In addition to the root rot evaluation nursery, F2 populations were grown nearby and root health was used as one of the traits as single plant selections were made.

Common Bacterial Blight

A nursery consisting of 50 entries, of several market classes, from the USDA-ARS was grown at Erie, ND. These lines were thought to possess blight resistance derived from a wild species of bean. The nursery relied on natural infection of common blight, which occurred shortly after flowering. High levels of resistance were identified in some, but not all, of the lines.

Accumulation of Mineral Elements in Bean Seed

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The agronomic performance of different bean genotypes has been evaluated for many decades in field trials. The primary purpose of such work is to identify high yielding, disease resistant varieties with good harvesting and cooking qualities. Little or no attention was paid to mineral composition in these trials despite the importance of seed minerals for human nutrition. In particular, research on accumulation of calcium and iron in bean seed is needed since processed foods sold in the United States must have on their labels the reference daily intakes (RDIs) for these two elements.

Two years ago we started preliminary screening of seed from Red River Valley bean variety trials for nitrogen, phosphorus, potassium, calcium, magnesium, iron, manganese and zinc, all elements essential for both human and plant nutrition. This preliminary work revealed that important genotypic differences in mineral accumulation occurred in seed of locally adapted varieties. Some highlights of our research during the past year will now be discussed.

1. Seed Calcium Accumulation: Seed calcium concentration in three field experiments involving eight bean cultivars (two navy, two kidney, one great northern, one pink, one pinto, and one cranberry) was found to be inversely related to seed weight. There was a 2.9-fold difference between average seed calcium concentration of Voyager , a navy bean and that of Cran-09 , the lowest calcium accumulator. The navy bean Norstar is an average or slightly above-average calcium accumulator by market-basket navy-bean standards. However, it was found to accumulate only 67% as much seed calcium as Voyager . High seed calcium in beans is not only important from the human nutrition viewpoint, but is important also because of its possible better cookability and of its possible better germination as compared to low-calcium seed.

2. Seed Iron Accumulation: Seed-iron concentration was not related to seed size, but was affected by variety. Voyager was the high seed-iron accumulator at all sites, in addition to its high calcium status.

Norstar, growing on a calcareous soil at Johnstown in 1997, showed no zinc deficiency symptoms.

An experimental line, which performs well on non-calcareous soils, displayed severe zinc deficiency symptoms when grown on a calcareous soil at Johnstown. Photos: John Moraghan

3. Seed Zinc Accumulation: Some varieties perform better on certain high-lime soils in the Red River Valley because they are efficient zinc accumulators. However, some poor-performing genotypes on such soils have excellent agronomic characteristics when grown on lower pH soils with increased zinc availability.

High seed-zinc concentration appears to be a characteristic of zinc-efficient cultivars. As a result, we are investigating whether seed-zinc concentration can be

Disease Control

Managing Irrigation, Fertilizer To Reduce

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Control of white mold is a serious problem for edible bean growers. There are several questions about management practices that might be used to aid in the control of this disease. This study was designed to develop answers to some of those questions. Some of these questions and answers provided from the results of this study are listed below.

1. Does timing of in-season nitrogen applications affect yield and white mold severity?

In this study, yields were increased by about 250 lb. per acre in one of three years by delaying the second of two 60 lb. nitrogen per acre applications of a nitrogen fertilizer until about two weeks after blooming. This delay in nitrogen application also reduced the number of plants which were infected with white mold. This delay did not cause a yield reduction in each of the other two years.

A delay in the second application of fertilizer nitrogen should aid in reducing the severity of white mold without reducing yields.

2. Did amount of irrigation water and use of Benlate affect yield and the percentage of plants affected by white mold?

Throughout this study, the levels of irrigation used had no effect on grain yields or the percentage of plants infected with white mold. The effect of fungicide use varied. In 1996, for example, the use of Benlate at the recommended rate had no significant effect on yield of red kidney beans even though yields averaged about 2800 lb. per acre.

The use of Benlate also produced a reduction in the percentage of plants infected. In 1997 the use of Benlate reduced the percentage of plants infected with white mold which had a positive effect on yield. The use of Benlate in 1997 produced an average increase in yield of about 125 lb. per acre.

3. Did the management practices used affect canopy width or plant height?

Light red kidney beans were grown in 1995 and the canopy did not close with any of the treatments used. In 1996, none of the factors studied affected plant height when measurements were taken throughout July. When measurements were taken on July 23, canopy width was greater when the second half of the needed nitrogen was applied before bloom. The irrigation management strategies and use of Benlate did not affect either canopy closure or plant height.

The use of the split application of Benlate increased yields by about 125 lb. per acre. This increase in yield

Weed Control

New Herbicides Screened For Crop Safety

Dry beans treated with high rates of Raptor herbicide show signs of injury in a NDSU trial. Photo: Richard Zollinger

By Richard Zollinger
Department of Plant Sciences
North Dakota State University

In 1997, several trials were conducted to evaluate the safety of two new herbicides on dry beans.

Broadstrike

One study was conducted to determine dry bean response to 1X and 2X rates of Broadstrike premixes, and evaluate herbicide treatments recently labeled in dry bean.

Data indicates excellent tolerance of dry bean to Broadstrike. All treatments gave complete redroot pigweed and common lambsquarters control. Pinto and navy cultivars used in this study show excellent tolerance to Broadstrike premixes applied PPI or PRE. Broadstrike + Dual PRE controlled less foxtail than PPI. Frontier PRE or POST did not control foxtail due to lack of rainfall for the critical weed germination period after application. Most treatments gave excellent wild mustard control. Only treatments containing Basagran and/or Pursuit controlled cocklebur.

Pursuit and Raptor

This experiment was conducted to determine weed control and dry bean safety from Pursuit and Raptor applied at different rates, alone or in tankmix combination, with different adjuvants, or in sequential applications.

Previous research has shown variable dry bean tolerance affected mostly by environment. Objectives were to increase dry bean safety while maintaining adequate weed control.

To our surprise no injury was observed with any treatment at any evaluation. Temperature and humidity prior to and after application were more moderate compared to conditions in 1995 and 1996 when dry bean stunting from Raptor was observed.

Pursuit at 0.72 oz WDG/A was enhanced more by Sun-It II than NIS. Adding Basagran to Pursuit + NIS increased general weed control over Pursuit + NIS at the last evaluation. However, addition of Basagran to Pursuit + Sun-It II did not increase weed control compared to Pursuit + Sun-It II alone. Other research has shown safening of dry bean to Pursuit by adding Basagran but no injury was recorded with either treatments. Increasing the Basagran rate from 0.5 to 1 pt increased weed control with Pursuit + NIS but did not further increase weed control with Pursuit + Sun-It II. Pursuit + Select at 8 fl oz/A gave excellent grass and broadleaf weed control.

The Raptor label in soybeans allows use alone at 5 fl oz/A or 4 fl oz/A only if a soil herbicide is applied prior to Raptor. Raptor gave greater lambsquarters control than Pursuit with similar adjuvants. Raptor at 3 fl oz/A + Sun-It II gave greater general weed control than Raptor at 3 fl oz/A and equal or greater weed control than Raptor at 4 fl oz/A + NIS. Evaluations of Raptor of weed control at an even lower rate of 2 fl oz/A + Sun-It II initially was lower but was equal to Raptor at 3 fl oz/A + Sun-It II at July 17. Addition of Basagran to Raptor antagonized grass and broadleaf weed control. Adding Sun-It II in the place of NIS did not overcome Basagran antagonism of Raptor. However, reducing the rate of Sun-It II from 1.5 to 0.5 pt/A resulting in less weed control. With the exception of cocklebur control at low rates, Raptor applied in sequential applications

Calcium For White Mold Control?

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Previous small-plot experiments showed foliar applications of calcium solutions could reduce white mold. In 1997, calcium solutions were tested for white mold reduction in strip trials in a grower s field near Crete, N.D., and at the Carrington ND Research Extension Center. Both trials were under center pivot irrigation.

At Crete, navy beans in strips 60 ft x 0.5 mile were band sprayed on 16 July and 23 July with Benlate 50W at 1.5 lb/A, calcium chelate at 2 gal/A, or with calcium sulfate at 5.5 lb/A in 50 gal water/A at 100 psi. One strip was left untreated.

White mold was evaluated on Aug. 1 at 12 sites, 200 ft apart in each strip and again on Aug. 8 at 10 sites, 250 ft apart in each strip.

At each site, 22 evaluations for white mold were made and percentage of infection was calculated. On Aug. 1, 9% of the plants treated with calcium chelate and 5% of the plants sprayed with calcium sulfate were infected. These infection rates were higher than that for Benlate-sprayed plants (2%) but were substantially lower than that of plants in the untreated strip (23%).

By Aug. 8, disease progressed, and 3% of the plants treated with Benlate were infected. Plants treated with calcium sulfate (12% infection) or with calcium chelate (9% infection) had much less white mold than plants in the unsprayed strip (41% infection). Yields at Crete were not determined.

At Carrington, a similar trial was made. Pinto beans in strips 20 ft. x 150 ft .were treated with Topsin M at 1.5 lb/A, calcium sulfate or calcium chelate at rates as before but in 37 gal water/A applied through drop nozzles at 35 psi.

Sprays were applied on July.y 11 at 5-10% bloom and again July 18. White mold was evaluated on Aug. 4 and 11. In addition to percent plants infected, disease severity was rated and yields were determined. By mid-season, plants in the trial were severely affected by white mold. For example, on Aug. 4, 94% of the plants in the untreated strip were infected with an average severity of 50%.

Topsin M reduced disease to 43% and severity to 30%. Plants treated with calcium sulfate had 83% infections and severity of 38%. The calcium chelate reduced infection by 9% and severity by 2%. By Aug. 11 only plants with Topsin M had reduced infection, but severity was reduced by all of the spray treatments. Untreated plants had the lowest yield (24.5 cwt/A) and Topsin M-treated plants had the greatest yield (36 cwt/A). Calcium compounds improved yield by 2-3 cwt/A compared to the untreated control.

These tests indicate that foliar-applied calcium may be a nutritional supplement that increases plant resistance to white mold. Strip trial results were similar to those in small-plot trials.

Combining calcium compounds with Topsin M

Heavy white mold disease pressure developed in a fungicide field trial at Carrington, N.D. By the end of the season, 97% of the unsprayed control plants were infected. Topsin M at 1.5 lb/A provided excellent white mold control resulting in a 10 cwt/A yield advantage. Among the calcium compounds tested as a supplement to Topsin M at 0.5 lb/A, calcium sulfate at 5.5 lb/A provided the best control. Control was significantly better than that provided by Topsin M alone at 0.5 lb/A and the calcium sulfate-Topsin M combination produced a yield advantage of 6 cwt/A over the untreated control. Combinations of calcium compounds with fungicides can provide suitable control at reduced cost.

Actigard May Jump Start Plant Defenses

By Jack Rasmussen and Ken Grafton
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North Dakota State University

Fungicides such as Benomyl and Topsin M are the traditional means of chemical control for white mold. However, Ciba-Geigy (now Novartis) recently developed new chemistry aimed at control of plant disease.

Ciba-Geigy (now Novartis) recently developed new chemistry aimed at control of plant disease.

The compound, known as Actigard, is not a fungicide in that it has no activity against the pathogen that causes white mold. Rather, Actigard is thought to prime or jump start the plants natural defenses to respond more quickly to infection than they normally would.

Research has shown that if a genetically susceptible plant responds to infection quickly enough, it is capable of resisting at least some pathogens. This phenomenon has been demonstrated in bean against some foliar pathogens, but has never been tested against white mold. The objective of this research was to investigate in small field plots whether Actigard could offer protection against white mold on dry edible beans.

> One application of Actigard reduced white mold infection to 25% and increased yield to 35.0 cwt.

Pinto beans (cultivar Othello) were grown at the Oakes, N.D., white mold nursery. Actigard was applied at early flowering when white mold infection occurs.

Control plants that received no Actigard had 80% white mold infection and yielded 29.5 cwt. One application of Actigard reduced white mold infection to 25% and increased yield to 35.0 cwt. Two applications of Actigard one week apart resulted in 37% white mold infection and yields of 34.5 cwt. No obvious plant toxicity was observed in any treatments.

The data suggest that Actigard may be useful in control of white mold, but further studies are needed to identify effective rates of application, timing of application, and the efficacy of white mold control against other established and experimental fungicides.

BREEDING AND GENETICS

Project Evaluates Canning Quality

By Sam K. C. Chang
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Dry bean cultivars developed without considering food quality attributes may not meet the requirements of the canners and consumers. Ideally, cultivars developed should give a high drained weight and good sensory quality after canning, without undue breakage or clumping.

The objective of our study is to collaborate with Dr. Ken Grafton s breeding project in identifying genotypes with acceptable canning quality.

Methodology

Approximately 1,200 bean samples, including navy, pinto, cranberry, and kidney beans, from various test plots were obtained from Dr. Grafton. These beans were equilibrated to 16% moisture content in a humidity chamber prior to canning. The beans were soaked, blanched and packed in a brine solutions in metal cans, which were retorted at 240 F for 45 min, and cooled to room temperature. After storing for a period of at least two weeks, the cans were opened and beans were scored for characteristics,including integrity of the beans, clumping, and starchy nature of the liquid brine, drained weight and textural properties.

Results

Among navy bean preliminary yield trials, 12 lines from Erie gave good canning quality attributes (little breakage, little clumping, low degree of starchiness), whereas eight lines from Hatton exhibited good canning quality attributes.

Navy advanced yield trials, including two lines from Erie, six lines from Hatton, and 10 lines from Johnstown, gave good canning quality attributes. Among advanced yield trial pinto lines, 16 lines from Johnstown, 10 lines from Eire, and three lines from Hatton had good canning characteristics.

Location had an effect on the quality of pinto and navy beans. Johnstown seemed to yield better pinto and navy lines for canning. The effect of location also varies by the year. Kidney advanced trial yield tests showed three lines from Perham produced good canning quality. Four cranberry advanced yield test lines and four cranberry pre-

Soil Management

Growing Beans In High Residue

By Edward J. Deibert
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Considerable information is available on the management of dry edible bean when grown under intensive fall and spring cultivation which leaves the soil bare with little protection against erosion.

The implementation of conservation tillage practices that leave adequate surface residue during the non-growing season and at least 30% residue cover after planting go a long way in protecting the soil from wind or water erosion. Surface residue will also trap snow, increase water infiltration to recharge the soil, conserve soil water by reducing evaporation and eliminate soil crusting problems which reduce seed emergence.

Over the last 5 years there has been increased emphasis on more reduced tillage. Although research is underway, limited information is available on the impact of leaving more surface residue on the growth and yield of dry edible bean. This information is essential for developing best management practices for producers considering growing dry edible bean under high surface residue conditions.

This research project was designed to measure the 1997 growth and yield parameters of pinto dry edible bean under four different initial surface residue cover conditions, created in the fall of 1996 by tillage systems (Plow-Disk-Field Cultivator with 0 to5% cover, Chisel Plow-Sweeps with 75-80% cover, Row Strip Tillage with 60-65% cover and No-Till with 85-95% cover), from an initial wheat residue level of 6500 lb/ac.

Four different N fertilizer rates (0, 40, 80, 120 lb N/ac spring broadcast as ammonium nitrate), planting with or without planter attached residue row cleaners and weed control with or without row cultivation were the other management variables compared. This study was conducted on a Fargo silty clay soil located north of Fargo, ND.

Primary weed control was to be achieved with a fall application of granular ethalfluralin 10G (Sonolan) at a rate of 1.25 lb ai/ac. Sonolan was broadcast on the soil surface of the Plow-Disk system and incorporated with the Field Cultivator operation and broadcast on the soil surface of the Sweep and Strip systems prior to incorporation with their respective primary fall tillage operation.

Sonolan was broadcast on the soil surface late in the fall in the No-Till system, without incorporation. Glyphosate (Roundup RT) at a rate of 1 qt/ac with ammonium sulfate was applied prior to any fall tillage to control volunteer wheat and weeds that emerged after harvest and again as a spring burndown to control emerged weeds after the area was flooded but prior to planting.

Two row cultivation operations were performed where cultivation for weed control was included as a management practice.

A pinto dry bean class, variety Topaz (an early maturity vining type, with 92% seed germination and 1268 seeds/lb) was planted with a JD Maximerge II using a medium 56 cell seed disk. The planter vacuum was set at 6 psi and planted at 3 mph (approximately 1.25 inches deep) on May 29th in 22-inch row spacing at a seeding rate around 80,000 plants/ac, but some doubles were seeded. Data on plant emergence, days to flowering, dry matter (DM) production at growth stage R4-R5, seed yield and seed size were collected.

The summary and conclusions that follow are based on results from one site in 1997, a year plagued by spring flooding which caused poor weed control with the granular herbicide applied , wet soil conditions which delayed planting and yet limited precipitation caused plant water stress during a portion of the growing season.

1. Average surface residue cover was 4%, 54%, 58% and 80% in the spring pre-plant with 5%, 41%, 54% and 71% post-plant for the Plow, Sweep, Strip and No-Till systems, respectively. The addition of residue row cleaners at planting decreased surface wheat residue for these same systems by 2%, 16%, 15% and 26%. The planting operation reduced cover an average of 6% while row cleaners decreased surface residue cover an average of another 9%.

2. Plant population of pinto (Topaz) dry edible beans at nine days after planting averaged 74,000 plants/ac. Populations were 74,200, 72,000, 75,500 and 65,700 without row cleaners and 76,200, 78,200, 80,500 and 69,300 plants/ac with row cleaners for the Plow, Sweep, Strip and No-Till systems, respectively.

The addition of row cleaners improved the plant population by an average of 5%. A 9% increase in population, the highest, was observed with row cleaners on the Sweep (only 40% cover) which has a higher surface roughness than the other systems. After 18 days, plant populations (average over 80,000 plants/ac) were not significantly different among surface residue levels (tillage systems), even with the use of row cleaners.

3. N fertilizer applications and the addition of surface residue row cleaners had no influence on the number of days from planting to first flower initiation with this pinto (Topaz) dry edible bean variety. Flowering was delayed as surface residue level decreased. Plants flowered after 44 days with 4% residue cover (Plow) but required only 43 days for flower initiation with 39% cover (Sweep) and 42 days with 49% cover (Strip) or 61% cover (No-Till).

4. Average plant DM of pinto (Topaz) dry edible beans at growth stage R4-R5 gradually increased with each successive increment of N fertilizer with a significant increase over no N application. Although DM increased with the 80 or 120 lb/ac rate, the increase was not significantly greater than the 40 lb/ac rate. High surface residue cover systems (Sweep, Strip, No-Till) showed a greater DM response to N fertilizer than the Plow system. Plant DM at R4-R5 stage was not influenced by row cleaners but decreased significantly (average of 350 lb/ac) when two row cultivations for weed control were included as a management practice.

5. Average seed yield of the pinto (Topaz) dry edible beans was increased (480 lb/ac) by an application of 40 lb/ac of N fertilizer but the increase was lower (360 or 230 lb/ac) with higher rates of N fertilizer (80 or 120 lb/ac). No difference in seed yield was obtained among the four tillage systems irrespective of the surface residue cover level. Cultivation for weed control decreased seed yield an average of 120 lb/ac, also observed in other research trials. Using row cleaners at planting had no effect on seed yield. Seed moisture at harvest, although higher with high N fertilizer rates, was not always significantly different among the variables compared.

6. Although some differences were observed in the pinto (Topaz) dry edible beans, the 200 seed weight was not significantly influenced by N fertilization when averaged over all other treatments. Using row cleaners had no significant effect on seed weight. Seed weight increased when row cultivation for weed control was included, but seed weight decreased as the level of surface residue cover increased (tillage decreased). Since seed yields were similar among surface residue management systems, seed weight was controlled by the number of seeds per pod. The low surface residue system (Plow) had larger size seeds but a smaller number of harvested seeds caused by plant water stress and leaf drop which resulted in aborted seeds in the pods. The highest surface residue cover systems (Strip, No-Till), which showed less plant water stress, maintained a larger number of seeds per pod (no

Dry beans grow in a high residue trial conducted at NDSU.

Weed Control

W inning the W ar Against W eeds

Orvin Burnside
W eed Scientist
University of Minnesota

Minnesota and North Dakota dry bean growers indicated in a 1991 farmer survey that weeds were their major production problem. This need stimulated me to initiate weed management research in dry beans after a 12 year void in such research at the University of Minnesota.

Crop loss from weeds.

A basic principle of weed control is that every pound of weed growth in a field means a loss of a pound of crop growth because weeds compete directly with the crop for water, nutrients, and light.

One of our initial research studies showed that dry beans required weed control during the first 6 weeks after planting before they could effectively compete with weeds (See Figure 1). This means that dry beans are less competitive to weeds than other agronomic crops.

For example, give corn, soybean, wheat, or barley 4 weeks of weed-free conditions and subsequently emerging weeds will not be able to compete with those crops. Thus, farmers must give more attention to weed management in dry bean production fields than they give to other agronomic crops.

W eeds you need to control.

Another principle of weed management is that you generally have to control 5 to 20 weed species in a single field. If you miss controlling any one of these broadleaf or grass weeds, the escaped weed will fill in the spaces left by the controlled weeds and you have accomplished little in decreasing crop yield loss from weeds. Also, avoid growing dry beans on fields infested with perennial weeds. However, good weed control during the first 6 weeks following dry bean planting should allow you to obtain maximum bean yield if other yield limiting factors are met.

Selective herbicides for dry beans.

Farmers generally rely heavily on tillage and herbicides for weed control, and the eleven herbicides registered for use on dry beans and their toxicity to common annual weeds are given in Table 1. Thus, you should select the herbicide(s) to use on a given field based upon the major weeds that are present in that field. A good weed management method is to observe each year what weed species were missed as you combine your dry beans. Then, change your weed management method during the subsequent year so you control those missed weed species or they will increase rapidly.

Weed control methods

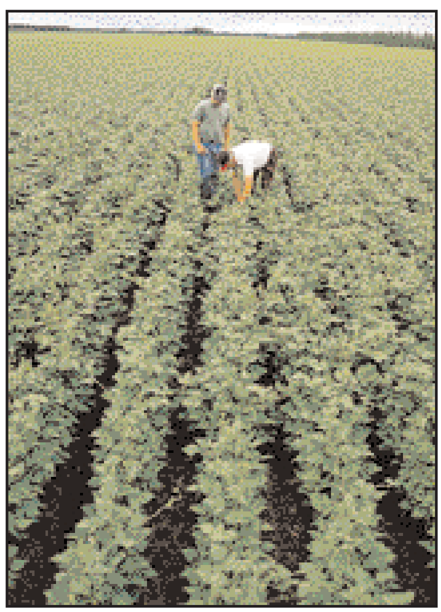
As you plan your weed management program for dry bean production fields, remember that you have many weed control methods in your arsenal. The more of these weed management methods you employ, the more dependable and effective will be your weed control over years and in different dry bean fields.

Weed management methods can be grouped into preventive, cultural, mechanical, biological, chemical, and integrated control methods.

Preventive control methods means to avoid the introduction of any or all of our 1,500 weed species onto your farm. Cultural controls range from crop rotations to weed competitive varieties. Mechanical control mean anything from a weed-free seedbed to row cultivation. Biological control can be insects or other organisms that attack weeds, chemical controls range from preplant incorporated to postemergence herbicides. Integrated control means to use as many of the various weed management methods as are economically feasible.

Thus, a dry bean grower should think of weed management during the entire crop rotation period rather than just during the year that dry beans are grown.

Effective plant disease management often means that dry beans are grown on an individual field only once every four years. Therefore, plan during the entire crop rotation your weed management program for the dry bean production year.



Some things not to do.

A short-sighted approach to controlling such tenacious weeds as ragweeds and nightshades in dry beans would be to delay implementing your control program until the dry bean production year or worst yet until the weeds appear in your dry beans. Then you might be forced into relying solely onto a herbicide solution which is not always available or feasible. Instead, you should be planning your weed control strategy for dry beans during the entire four-year crop rotation.

Weeds such as the ragweeds and nightshades can be controlled effectively and economically with 2,4-D, dicamba, and other herbicides in rotational crops such as small grains and corn.

As atrazine use and application rates in corn have been reduced, ragweeds and nightshades may emerge late in the growing season in corn fields and produce a seed crop for the following year.

Ragweeds and nightshade often come up in small grain stubble and produce seeds before the fields are tilled even though the weeds never get over 6 inches tall.

Field cultivation or tandem discing soon after combining small grains effectively prevents this weed seed production. Then as you approach the dry bean production year you do so without a heavy seed population in the soil of ragweeds and nightshades to deal with.

Thus, problems with ragweeds and nightshades can be effectively and economically controlled in the years prior to growing dry beans.

Narrow-row dry beans.

Research was initiated to determine both the feasibility and economics of narrow row dry production due to its effect on weed management, disease control, and bean yields. A replicated split-plot experimental design was used with four main plots (Untreated, all grass weeds controlled, all broadleaf weeds controlled, and all grass plus broadleaf weeds controlled). Weeds were controlled with appropriate herbicide and cultural weed management treatments. Subplot were six row widths of 6, 12, 18, 24, 30, and 36 inches of Montcalm kidney bean seed planted in late May at 80,000 seeds per acre in all row spacings.

Results during 1996 (research was not repeated in 1997 due to financial constraints) at Staples, MN showed white mold infection of 44% when weeds were not controlled but only 11% when all weeds were controlled.

Dry beans yields were 56% higher on the weed-free versus weedy plots. White mold infection was not significantly different on any of the row spacings from 6 to 36 inches wide because dry bean population was constant over row spacings.

However, dry bean yields were similar on row spacings from 18 to 36 inches wide, but 12 inch row spacings showed a 30% yield increase and 6 inch rows showed a 63% yield increase. Thus, there was a significant yield advantage of solid-seeded dry bean production, but this technology needs further research before it is adopted.

Summary

As you prepare to plant dry beans be sure to plant them into a weed-free seedbed. There are effective preplant or preemergence herbicide to control both black and hairy nightshade. The rotary hoe operated at 8 to 10 mph when weed seedlings are in the white stage can give 80% or more control of annual weeds.

Row planted dry beans can be cultivated about 3 to

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