Dry Bean Production Guide

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Introduction

Dry edible bean (*Phaseolus vulgaris*) is a human food high in protein, phosphorus, iron, vitamin B_1, fiber, with no cholesterol. Dry bean is an imported staple in many areas of the world, especially Central and South American and Africa. Different cultures have developed a multitude of end products made with dry edible bean.

Dry bean is a relatively new crop to the North Dakota-Minnesota region. They have been grown on a large scale since the 1970s. Two classes of dry bean (navy and pinto) encompass the major commercial acreage. In addition, black turtle, red kidney, cranberry, pinks, and small red bean classes are also grown on limited acres. Dry bean are generally grown under contract with a processing firm. These firms are located throughout the eastern half of North Dakota and west central Minnesota counties.

The North Dakota Dry Edible Bean Council, the Minnesota Dry Bean Council and the Northarvest Bean Growers Association are organizations which promote and assist in marketing of dry bean. The North Dakota Dry Edible Bean Seed Association is organized to grow and promote dry-bean seed for planting.

Dry bean is a crop that requires special cultural management and attention by the producer. Proper management is essential from field selection and planting through harvest and marketing for maximum profitability.

The primary objective of this guide is to help dry bean growers and related industry personnel to be proficient and successful.

Variety Descriptions

Class and Cultivar	Mat[3]	Plant Type[2]	-- Blight -- Common	Halo	-- BCMV -- Type	NY15	Fusarium Root Rot	White Mold	Rust[1]
PINTO									
Agassiz	E	B	S	—	R	R	—	S	S
Apache	M	V	—	—	—	—	—	S	R
Arapaho	M	V	S	—	R	R	—	S	S
Aztec	E	UV	S	—	S	S	—	S	S
Bill-Z	M	V	S	—	R	R	—	S	MR
Chase	L	V	R	R	S	S	—	T	R
Elizabeth	M	V	—	—	—	—	—	S	R
Fargo	E	V	—	—	—	—	—	—	S-MS
Fiesta	E	V	S	T	R	R	S	S	S
Focus	M	UV	S	—	—	—	—	—	R
Hatton	E	V	S	—	R	R	—	S	S-MR
Maverick	ME	V	S	—	S	S	—	—	R
Othello	E	V	S	T	R	R	—	S	S
Remington	M	UV	—	—	—	—	—	—	R
RS-101	E	USV	—	—	—	—	—	S	S
Topaz	E	V	—	T	R	R	—	S	S-MS
Winchester	ME	UV	—	—	—	—	—	—	R
NAVY									
Agri-1	M	B	S	T	R	R	—	S	S-MR
Aspen	M	USV	—	—	R	R	—	—	R
Avanti	M	USV	—	—	R	R	—	—	R-MS
Envoy	M	B	—	—	R	R	—	S	R
Fleetwood	L	B	S	T	R	R	S	S	S-MR

Huron	M	USV	—	—	R	R	—	T	R
Mayflower	ML	USV	—	T	R	R	T	T	R
Navigator	M	USV	—	—	R	R	—	T	R
Newport	E	B	—	—	R	R	—	S	R
Norstar	ME	USV	S	T	R	R	—	T	R
Prize	M	B	—	—	R	R	—	—	R
Schooner	ML	USV	—	—	R	R	—	S	R
Seafarer	E	B	S	T	R	R	S	S	S
Snowbunting	E	B	S	T	R	S	S	S	S
Upland	ME	B	S	T	R	S	S	S	S-MR
Vista	ML	USV	—	—	R	R	—	T	R
Voyager	ME	V	—	—	R	R	—	S	S-MS
CRANBERRY									
Cran-09	M	B	—	—	R	R	S	S	R
Mich. Imp	L	V	—	—	—	—	—	S	R
Taylor Hort	E	B	—	—	—	—	S	S	R
UI-50	M	B	—	—	R	R	—	—	—
UI—686	M	V	—	—	R	R	—	—	R
SMALL RED									
Cajun	E	UV	—	—	—	—	—	—	MR
Garnet	M	V	—	—	R	R	—	S	S
NW59	ML	V	S	T	R	R	T	S	S
NW63	ML	V	S	T	R	R	T	S	S
UI-239	ME	V	—	—	—	—	—	S	S
BLACK									
Blackhawk	L	USV	S	T	R	R	T	T	R
Blackjack	ML	USV	—	—	R	R	—	—	R
Black Magic	L	USV	S	T	R	R	T	T	R
Domino	L	USV	S	T	R	R	T	T	R
Midnight	L	USV	S	S	R	R	T	T	R
Panther	M	USV	—	—	R	R	—	T	R
Raven	ME	—	—	—	R	R	—	S	R
Shadow	ME	USV	—	—	R	R	—	T	R
T-39	M	USV	S	T	R	R	T	T	R
UI-911	M	V	—	—	R	R	—	—	R
PINK									
Flamingo	E	V	—	—	—	—	—	S	S
UI537	E	V	—	—	R	R	—	S	S
Viva	M	V	—	—	—	—	R	S	S
LT. RED KIDNEY									
California Early	E	B	S	S	—	—	S	—	S
Chinook	M	B	—	T	R	R	—	—	R
Foxfire	ME	B	T	R	R	R	T	T	R
Sacramento	E	B	S	S	S	S	S	S	S
DK. RED KIDNEY									
Drake	M	B	S	S	R	R	S	T	R
Isles	M	B	—	T	R	R	T	T	R
Montcalm	ML	B	S	T	R	R	S	T	R
GREAT NORTHERN									
Alpine	M	UV	S	T	R	R	—	S	R
Beryl	M	V	—	—	—	—	—	S	—

Starlight	ME	V	T	T	T	T	—	—	MR

Some cultivar disease reactions adapted from North Central Regional Extension Publication 198.

[1] Reaction based upon field observation of rust obtained in North Dakota, 1995-1996 and field collections, 1996

S = Susceptible; MS = Moderately Susceptible;
T = Tolerant; MR = Moderately Resistant.
R = Resistant;

[2] V = Vine; UV = Upright Vine;
B = Bush; USV = Upright Short Vine.

[3] RM = Relative Maturity; E = Early;
M = Medium; ME = Medium Early;
ML = Medium Late; L = Late.

Seed Certification

The purpose of seed certification is to maintain and make available to the public high quality seed of crop varieties that are produced, conditioned, and distributed as to insure proper identity and genetic purity. This process of maintaining genetic purity is done through a nationally recognized seed certification system. Each state has an authorized agency that establishes minimum standards for genetic purity and other seed quality factors for each class of certified seed. These minimum standards must meet or exceed the standards set by the Association of Official Seed Certifying Agencies.

In the case of dry edible beans other seed quality factors like seed borne diseases are as important as genetic purity. When seed is label as certified, a buyer can be assured that the seed has been produced and lab tested to maintain varietal purity, low levels of disease, noxious weeds, inert matter and other crop seeds. Each seed lot is conditioned and handled as seed and must meet minimum standards for germination. Seed can not be sold as certified seed until it has passed field inspection and laboratory testing.

All seed sold as certified seed must bear a certified seed tag on the bag. Those tags will come in three colors. A white tag that represents Foundation class seed, a purple tag that represents Registered class seed and a blue tag represents Certified class seed. These are the only color of tags that are recognized by the Association of Official Seed Certifying Agencies.

The Idaho Department of Agriculture provides a windrow field inspection service to monitor bean fields for blight symptoms. All seed that passes their windrow inspection is given a Green tag. No varietal purity check are made during these inspections, nor are there any laboratory tests for seed borne blight organisms conducted on such seed lots by the Idaho

Ag Department.

Plant Variety Protection PVP

Plant variety protection provides owners of a novel variety control over who can produce and market the variety that they develop. A Certificate of Plant Variety Protection can be issued either with a requirement that the variety be certified by an official certifying agency (Title V option) or the certificate of protection can be issued which gives the owner of the variety or his designee the exclusive right to produce and market the variety as seed.

The Title V option — essentially allows anyone to handle the variety providing it has met all of the certification requirements.

Marketing of protected varieties that don't have the certification requirement is usually restricted to those that are authorized to handle the variety either through a licensing agreement or through an established dealer network.

Approximately one-half of the dry bean varieties that have a Certificate of Plant Variety Protection are protected with the Title V option that requires certification.

Dry Bean Types and Development Stages

Two basic plant types are found in dry edible bean, determinate (bush) or indeterminate (vining or trailing). Cultivars may be classified according to plant types. For example, navy beans may be either of the bush or vining type. In the determinate type, stem elongation ceases when the terminal flower racemes of the main stem or lateral branches have developed. On indeterminate types, flowering and pod filling will continue simultaneously or alternately as long as temperature and moisture permits growth to occur.

In addition to the distinction between determinate and indeterminate plant types, four plant growth habits have been identified. These are: Type I – Determinate bush; Type II – Upright short vine, narrow plant profile, three to four stems; Type III – Indeterminate, prostrate vine; Type IV – Indeterminate with strong climbing tendencies. These growth habits have become useful in identification and classification of new upright bean cultivars.

Plant development for both determinate and indeterminate plant types has been divided into vegetative (V) and reproductive (R) stages as indicated in Table 1. Vegetative stages are determined by counting the number of nodes on the main stem beginning at the unifoliate leaf node (V1). Reproductive stages are described with pod and seed characters in addition

to nodes. The first pod developing on the plant is described and followed to full size. At the time of first bloom (R), secondary branching begins in the axis of lower nodes which will produce secondary groups of blooms or pods. It is important to follow the main stem, which is readily discernible on both determinate and indeterminate plants. A node is counted when the edges of the leaflets no longer touch.

Table 1. Stages of vegetative and reproductive development in determinate bush (Type I) and indeterminate (Type III) dry bean.

Stage No.	General Description* Vegetative stages	Days from planting**
V1	Completely unfolded leaves at the primary (unifoliolate) leaf node.	10
V2	First node above primary leaf node. Count when leaf edges no longer touch.	19
V3	Three nodes on the main stem including the primary leaf node. Secondary branching begins to show from branch of V1.	29
V(n)	n nodes on the main stem, but with blossom clusters still not visibly opened.	A new node each 3 days
V5	Bush (determinate) plants may begin to exhibit blossom and become stage R1.	50
V8	Vine (indeterminate) plants may begin to exhibit blossom and become stage R1.	40
	Determinate BUSH (Type I) Reproductive Stages	
R1	One blossom open at any node.	50
R2	Pods □ long at first blossom position. Usually node 2 to 3.	53
R3	Pods 1 inch long at first blossom position. Secondary branching at all nodes, so plant is becoming denser but not taller, □ bloom.	56
R4	Pods 3 inches long – seeds not discernible. Bush types may be shorter.	59
R5	Pods 3-4 inches. Seed discernible.	64
R6	Seeds at least □ inch over long axis.	66
R7	Oldest pods have developed seeds. Other parts	72

	of plant will have full length pods with seeds almost as large as first pods. Pods will be developed over the whole plant.	
R8	Leaves yellowing over half of plant very few small pods and these in axils of secondary branches, small pods may be drying. Point of maximum production has been reached.	90
R9	Mature, at least 80% of the pods showing yellow and mostly ripe. Only 40% of leaves still green color.	105

Indeterminate VINING Plant (Type III)
Reproductive stages

R1	One blossom open at any node. Tendril will begin to slow.	40
R1	Pods □ inch long at first blossom position (node 2 to 5 most plants). Blossom would have just sluffed.	43
R3	Pods 1 inch long at first blossom position. Pods are showing at higher nodes when blossom sluffs, □ bloom.	46
R4	Pods 2 inches long at first blossom position.	50
R5	Pods 3 plus inches long, seeds discernible by feel.	56
R6	Pods 4.5 inches long with spurs (maximum length). Seeds at least □ inch long axis.	60
R7	Oldest pods have fully developed green seeds. Other parts of plant will have full length pods with seeds near same size. Pods to the top and blossom on tendril, nodes 10-13.	70
R8	Leaves yellowing over half of plant, very few small new pods/blossom developing, small pods may be drying. Point of maximum production has been reached.	82
R9	Mature, at least 80% of the pods showing yellow and mostly ripe. Only 30% of leaves are still green.	94

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* Adapted from: Growth stages according to Marshall J. Lebaron (University of Idaho, College of Agriculture, Current Information Series No. 228, April 1974).

** Approximate number of days. This will vary from season to season and variety to variety.

Plant Description

Visual Aid (6KB b&w image)

1. Hypocotyl
2. Radicle
3. Cotyledon (simple leaf)
4. Colydeonary node
5. Tap root
6. Lateral (branch) root
7. First true leaf (unifoliate)
8. Trifoliate leaflet
9. Terminal bud
10. Axillary buds
11. Hypocotyl arch
12. Nodes (point of leaf attachment)
13. Nodules
14. Root hairs

Planting Rates

Planting rates vary from 35 to 65 pounds per acre, depending on row spacing, bean plant type and percent pure live seed. Navy bean range from 2,200 to 2,500 seeds per pound. Planting rates suggested for navy beans are 35 to 45 pounds per acre of pure live seed. Studies conducted at various plant populations do not indicate any significant advantage to having populations greater than 90,000 plants per acre for Type I navy beans. Slightly higher rates are advised under irrigation.

Pinto beans range from 1,200 to 1,500 seeds per pound. Planting rates suggested for pintos are 50 to 65 pounds per acre of pure live seed. Populations of 70,000 plants per acre for Type III (pinto) beans have been found to be adequate. In some instances, reduced yields were observed when plant populations were below these recommendations. Under irrigation, some lodging has been observed in the Type I cultivars at extremely low plant populations.

Rates should be adjusted for low germination or cool, wet planting conditions. To obtain desired plant populations, overseed live seed by 10 to 15 percent to compensate for losses during emergence. The normal planting depth is about 1□-2□ inches. Seed should not be planted deeper unless the topsoil is dry. Plant seeds in moist soil if possible. Windbreaks of

corn or sunflower can be planted in fields where winds could become a problem at harvest. Growers should test their planter on a hard surface and in the field at normal planting speeds to ensure proper depth and seeding rate.

Growing Requirements

Dry bean are adapted to a wide variety of soils. They are not sensitive to soil type as long as it is reasonably fertile, well drained and free of conditions that interfere with germination and plant emergence, such as saline (salt affected) soils.

Saline soils affect germination, emergence and later plant growth. Plants that emerge on saline soils may become yellow and have stunted growth. The leaf edges of the affected plant will be brown and dead and often accumulations of salt may be seen on the leaf surface (refer to the section on fertility).

Dry bean are a warm season crop and usually are not affected by high temperatures if adequate soil moisture is present. Cool, humid or rainy weather is unfavorable to dry bean, but they are adapted to a fairly wide range of temperature. The optimum average growing temperature for field beans is 65 to 75□F. Dry bean production is more successful in areas where rainfall is light during the latter part of the growing season. It is essential that the crop be grown on a well-drained soil since beans are extremely sensitive to standing water or waterlogged conditions.

Dry bean are not tolerant to frost or to prolonged exposure to near-freezing temperatures at any stage of plant growth.

Hail Damage

The amount of crop damage caused by hail will depend on the intensity, size of hail stones and duration, as well as plant type and stage of development. Determinate (Type I) cultivars are likely to suffer greater losses than the indeterminate (Types II and III) cultivars, because Types II and III can recover and compensate to a greater degree than can the Type I.

Severe hail damage can delay plant maturity. The earlier the stage of development at which the injury occurs, the greater the time available for recovery, resulting in less yield reduction. Hail will not directly affect seed quality unless a strike occurs on the pod.

Planting Guide

NAVY BEANS					
Approximate lbs. Live Seed per Acre	Plants per Acre	Row Width — Seed spacings within crop row			
		6"	12"	22"	30"
30	75,000	—	—	3.8	2.8
40	100,000	—	5.2	2.9	2.1
50	125,000	8.4	4.2	2.3	1.7
60	150,000	7.0	3.5	1.9	1.4
70	175,000	6.1	3.0	1.7	—
80	200,000	5.2	2.6	1.5	—

PINTO BEANS		12"	22"	30"
50	62,500	8.4	4.6	3.4
60	75,000	7.0	3.8	2.8
70	87,500	6.3	3.3	2.5
80	100,000	5.2	2.9	2.1

Estimation of Dry Bean Yields

You can estimate dry bean yields by knowing the number of seeds per pod, pods per plant and plants per 1/1000th of an acre. At the time of counting seeds and pods, the maturity status of each should be determined.

If a seed or pod will not mature, it shouldn't be counted. Then count the total plants per 1/1000th acre to complete the data collection.

Length of row equal to 1/1000th acre. An accurate estimate of plant population per acre can be obtained by counting the number of plants in a length of row equal to 1/1000 of an acre. Make at least three counts in separate sections of the field, calculate the average of these samples, then multiply this number by one thousand (1,000).

Row Width	Length of Single Row to Equal 1/1000 of an acre	
(inches)	(feet)	(inches)
6	87	1
10	52	3

15	34	10
22	23	9
30	17	5
36	14	6

Within a representative and uniform plant stand, randomly select five plants each from at least five randomly selected locations in the field.

Keeping all plant data separate, pull and count the pods from each plant and then count the seeds to determine average seeds per pod for all five replications. These data are combined with the average number of plants per 1/1000th acre.

	Average Number of Seeds per Pound
Kidneys	900-1000
Pintos	1400
Great Northerns	1600-1800
Pinks/Small Reds	1600-2000
Navies/Blacks	3000

Seeds per pound can vary 10-20% for different varieties within a bean class. If available, use reported estimates for seed number per pound for your variety.

The accuracy of yield estimate can be improved by counting seeds and pods from at least 10 plants per replication.

Calculations

1. (Average seeds per pod) x (average pods per plant) equals average seeds per plant.
2. (Average seeds per plant) x (plants per 1/1000th of an acre) x (1000) divided by seeds per pound of the variety equals yield in pounds per acre.

Estimates Program

Dry Edible Beans

Consists of acreage and production reports giving total United States and 17 individual state estimates. The 17 states are California, Colorado, Idaho, Kansas, Michigan, Minnesota, Montana, Nebraska, New Mexico, New York, North Dakota, Oregon, Texas, Utah, Washington, Wisconsin and Wyoming.

Reports on acreage and production are released throughout the year. The following gives a summary by individual reports. Estimates are total of all classes, unless otherwise indicated.

- ***Planting Intentions*** released **end of March** each year.
- ***June Planted Acres*** released **end of June** and contains estimates on acres planted and intended for harvest.
- ***Planted Acres by Commercial Class*** are included in the August production forecast, released **around August 12**.
- ***Production Forecasts*** are made as of August 1 and October 1. Production forecasts consist of adjusted acres for harvest, yield per acre and total production. Release dates are **around August 12 and October 12**.
- ***Production Estimate by Commercial Class*** in early December is an estimate of the current year's planted and harvested acres, yield per acre and production, by commercial class. The commercial class acreage, yield and production estimate are released **around December 9**.
- ***North Dakota County Estimates*** contain acres planted, acres harvested, yield per acre and total production by county. County estimates will be available **the middle of March** each year for the previous year's estimates. County data by commercial class is not available.

Minnesota	**North Dakota**
Ag Statistics Service	**Ag Statistics Service**
8 East Fourth St., Suite 500	PO Box 3166
St. Paul, MN 55101	Fargo, ND 58108
Phone: 612-296-2230	Phone: 701-239-5306

Crop Rotation and Disease Management

Several disease-producing bean pathogens are either soil borne or borne on bean crop residue. A three year crop rotation helps reduce carryover of most disease pathogens, including rust, bacterial blights, most root rots and anthracnose. A four year rotation may be needed if white mold is severe in a field. Crop rotation, although it helps to reduce disease carryover, is not a "cure-all" since many pathogens can be air borne and may blow in from nearby fields. This is particularly notable in the case of white mold and rust.

Some bean pathogens attack only beans; these include the bacterial blights, rust and anthracnose. Crop rotation reduces populations of these pathogens. Field selection is also important: if possible, avoid planting next to a field that was severely infected with rust last year.

Other pathogens, such as the Rhizoctonia root rot pathogen and white mold (Sclerotinia), attack several crops (hosts), and crop rotation must take into account all crops that are host of the pathogen. Specific considerations follow.

White mold attacks many broad leaved crops. Dry beans, sunflower and canola are among the most susceptible. Other crops that are slightly less susceptible include soybeans, safflower, mustard, lentils, and chickpeas (garbanzo beans). Crops which are moderately susceptible include alfalfa, field peas, and potatoes. Flax and buckwheat are only slightly susceptible, and produce very few of the survival structures called sclerotia. They are less liable to be severely attacked and less liable to help maintain a white mold population than most other broad leaved crops. Sugarbeets have not been attacked by white mold in Minnesota or North Dakota. Members of the grass family, including small grains, corn and millet are immune to white mold and are good rotational crops for dry bean disease management.

Rhizoctonia causes a root rot of dry beans. The same strains of Rhizoctonia that attack dry beans also cause a severe root rot of sugarbeets, and can cause a root rot of soybeans. Including two of these crops in a rotation is likely to lead to the buildup of Rhizoctonia. One of the Rhizoctonia strains that attack dry beans, sugarbeets and soybeans also attack flax and lentils.

Dry Bean Fertility

Dry bean is responsive to fertilizer when soil levels are inadequate to support yield levels possible with existing soil moisture and growing season climatic conditions. Soil testing is recommended to determine the probability of crop response to fertilizer amendments. If soil levels are less than adequate, dry bean may respond to nitrogen (N), phosphorus (P), potassium (K) and zinc (Zn) in many Northern Plains soils. Soil test cores should be taken at 0-6 inch and 6-24 inch depths. N is analyzed on both core depths, and P,K and Zn are analyzed on the 0-6 inch depth. Salt levels on both depths may be analyzed if there is reason to suspect a salt problem. Soil pH may be determined on the surface depth if iron chlorosis problems are anticipated.

Phosphorus

Phosphorus should be applied as recommended in Table 1. Soil test levels indicating medium levels and lower would be expected to respond to P fertilizer. P fertilizer may be broadcast or banded. Banded rates of P in the very low or low range may be reduced by one-third from table recommendations since the broadcast recommendations also include extra buildup fertilizer useful in long-term fertility programs. Reducing the rates will not result in long-term improvement of soil P fertility but may increase short-term profitability in the current crop year.

Table 1. Phosphorus recommendations for dry bean.

	Soil Test Phosphorus, ppm				
	VL	L	M	H	VH
Bray Pl	0-5	6-10	11-15	16-20	21+
Olsen	0-3	4-7	8-11	12-15	16+
lb/A	lb P_2O_5/Acre				
1200	20	15	10	0	0
1400	25	20	15	0	0
1600	30	25	15	0	0
1800	35	25	15	0	0
2000	45	30	20	10	0
2200	50	35	20	10	0
2400	55	40	25	10	0

Banded P should not be placed in contact with the seed. In fact, **no fertilizer should be placed in contact with the seed.** The fertilizer band should be placed with at least 1 inch of complete separation from the seed. A band 2 inches to the side and 2 inches below the seed is very commonly used.

Potassium

Potassium is seldom required in most Northern Plains soils; however, a soil test should be analyzed to determine the probability of response. Medium K level or lower may respond to K fertilizer. Lower K levels may sometimes be found on sandy ridges within the region. The rate of K recommended at different K soil test levels is shown in Table 2. K fertilizer may be broadcast or banded. Banded K should not be placed with the seed. At least 1 inch of seed and fertilizer separation is required.

Table 2. Potassium recommendations for dry bean.

	Soil Test Potasium, ppm				
Yield	VL	L	M	H	VH
Goal	0-40	41-80	81-120	121-160	161+
lb/A	lb K_2O/Acre				
1200	35	15	0	0	0
1400	35	15	0	0	0
1600	40	15	0	0	0
1800	45	20	0	0	0
2000	50	20	0	0	0
2200	55	25	0	0	0
2400	60	25	0	0	0

Nitrogen

Inoculation

Many legumes have the ability to fix N from the air without the use of commercial fertilizers if inoculated with a nitrogen-fixing bacteria. The N-fixing bacteria for dry bean is called Rhizobium phaseoli, and it is specific for dry bean. Inoculant used for soybean or pea are different and will not infect dry bean. Unfortunately, the relationship between dry bean and Rhizobium phaseoli is not strong. Dry, hot weather, short periods of soil water saturation, and cold weather, will all result in sloughing off of nodules, so it may be difficult to achieve high dry bean yields consistently using inoculation for an N source.

Dry bean seed is usually inoculated with a chemical used to control bacterial blight. Until recently, many dry bean producers would not use an inoculation treatment because of the fear that the chemical would also kill the Rhizobium bacteria. It was recently shown that at least some newer strains or formulations resisted the seed treatment, and would produce greater nodule numbers when inoculant was applied to seed immediately prior to planting. However, higher rates of soil N at planting decreased the number of nodules on the plant. Therefore, the following guidelines are suggested to determine whether to inoculate or apply fertilizer N instead.

Inoculate when —

> Yields 2,000 lb/acre represent realistic yield goals, and soil nitrate-N levels are 50 lb/acre or less.

Use fertilizer N only when —

> Yields greater than 2,000 lb/acre are consistently desired, or when beginning soil nitrate-N levels are greater than 50 lb/acre.

Commercial N Fertilizer

Because of the inconsistency of inoculation in supplying season long N nutrition, N fertilizer is often recommended. Table 3 shows the amount of N required for selected yield levels. The general formula for these recommended levels is:

> N recommended = Yield Goal X 0.05 less soil test nitrate-N to 2 ft., previous crop credit from other legumes in the rotation and a sampling date adjustment if fall sampled before September 15 of □ lb N/day.

Table 3. N recommendations for dry bean.

Yield Goal	Soil N plus Fertilizer N Required
lb/A	lb/Acre 2'
1200	60
1400	70
1600	80
1800	90
2000	100
2200	110
2400	120

Some producers are reluctant to apply fertilizer N because of fear of white mold caused by enhancing robust early growth. However, studies have indicated that higher susceptibility to white mold is dependent on increased crop growth from either inoculation or N fertilizer. If the crop is healthy enough to achieve a high yield level, it is susceptible to white mold damage if environmental conditions are favorable for the disease, regardless of source of N. Recently developed upright growth varieties, wider rows and crop rotation away from white mold susceptible crops may help to reduce white mold infection and damage. Certainly, being prepared to apply fungicides at the proper time is important in a higher yield environment.

Zinc

Dry bean is one of only a few crops in the region to regularly respond to zinc fertilizer in low zinc soils. Soil test levels below 0.8 ppm may respond to fertilizer zinc application. Zinc deficiency may be seen as bronzing, browning and death of leaf tissue, stunting, and poor vining. Zinc deficiency may be treated by foliar sprays of zinc sulfate, zinc chelate or ammoniated zinc solutions. Zinc deficiency may be prevented with preplant or planter treatments of zinc sulfate, zinc chelates or ammoniated zinc solutions. A treatment of 3-5 lb/acre actual zinc preplant incorporated as zinc sulfate may improve soil availability for several years.

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