

Part IV.

Seed Facts

Authored by:

Thomas H. Hardiman, Seed Certification Program Administrator, Virginia Tech

Seed Inoculation

Legumes have the ability to gather available nitrogen from the air and use it for their growth. Grasses growing in association with legumes, or following legumes in rotation, also benefit. Legumes are able to accomplish this through the presence of nitrogen-fixing bacteria that form colonies on the legume roots.

Most soils contain native strains of nitrogen-fixing bacteria (rhizobia), but they are often not efficient in fixing nitrogen. When a legume is seeded – especially in soil where that legume has not been grown in the previous two or three years – commercial strains of bacteria should be included with the seed to “inoculate” the soil and the plant roots. This ensures that bacteria of a productive strain are present in sufficient quantities to fix nitrogen for the plant.

The rhizobia are usually mixed with black peat that serves as the carrier for the bacteria. This black inoculum is mixed with the seed just prior to seeding. It can be mixed thoroughly with dry seed, but better seed contact is obtained by slightly moistening the seed with sugar water or a commercial sticker before adding the inoculum. Pre-inoculated seed, which is coated with the appropriate rhizobia by the seed company, is also available.

When the seed germinates in the soil, the rhizobia bacteria invade the root hairs of the seedlings and begin to multiply to form nodules. A symbiotic relationship exists between the bacteria in these nodules and the plant. The plant provides food and a supply system for the bacteria. In return, the bacteria convert atmospheric nitrogen into ammonia nitrogen, which the plant uses.

Well-nodulated plants have large nodules that are pink or red inside. Ineffective bacteria produce small nodules that are white, gray, or green inside. Nodules should be present by about four weeks after seed germination. If the plants are not properly nodulated, emergency inoculum can be applied to the soil surface by broadcasting or spraying in rainy weather. Under hot and dry conditions, it is necessary to drill the inoculum into the soil.

There are several different strains of rhizobia. It is important to use the correct strain to inoculate the legume being seeded. Table 1 (page 85) indicates those groups of legumes or individual legumes requiring specific strains.

Table 1. Cross-inoculation of legumes.

	Alfalfa	Black medic	Bur clover	Yellow sweet clover	Alsike clover	Crimson clover	Ladino clover	Red clover	White clover	Austrian winter pea	Canada field pea	Garden pea	Hairy vetch	Birdsfoot trefoil	Crown vetch	Garden bean	Soybean	Cowpea	Kudzu	Lespedeza	Partridge pea	Peanut	
Alfalfa	+*	+	+	+																			
Black medic	+	+	+	+																			
Bur clover	+	+	+	+																			
Yellow sweet clover	+	+	+	+																			
Alsike clover					+	+	+	+	+														
Crimson clover					+	+	+	+	+														
Ladino clover					+	+	+	+	+														
Red clover					+	+	+	+	+														
White clover					+	+	+	+	+														
Austrian winter pea										+	+	+	+										
Canada field pea										+	+	+	+										
Garden pea										+	+	+	+										
Hairy vetch										+	+	+	+										
Woollypod vetch										+	+	+	+										
Birdsfoot trefoil														+									
Crown vetch															+								
Garden bean																+							
Soybean																	+						
Cowpea																		+	+	+	+	+	+
Kudzu																		+	+	+	+	+	+
Lespedeza																		+	+	+	+	+	+
Partridge pea																		+	+	+	+	+	+
Peanut																		+	+	+	+	+	+
Sunnhemp																		+	+	+	+	+	+

* Cross marks indicate which legumes are inoculated by bacteria from other legumes. For example, alfalfa is inoculated by bacteria from bur clover, sweet clover, and black medic.

Precautions and Tips in Utilizing Inoculum

1. Buy the inoculant with the proper strain of bacteria for the legumes you will inoculate. Refer to table 1 for information about legume species in the same cross-inoculation group.
2. Use the inoculant before the expiration date for optimum results.
3. Powder inoculants are the most common, reliable, available for all types of legumes, and the least expensive to use. However, powder inoculants require more handling, and good contact with the seed is more difficult to achieve without the use of a sticker agent.
4. If legumes seed become too wet during the inoculation process, allow the seeds to dry in a place with good ventilation and away from direct sunlight.
5. Inoculants are made of living organisms, so they must be treated with care. The main reasons affecting bacterial survival on seed are desiccation, toxicity originated from soluble seed coat exudates, and inappropriate temperatures during long-term storage. Inoculants can be stored in refrigerators at temperatures around 40°F, in places with good ventilation and away from direct sunlight. Avoid cool, dry places when not in use. Do not allow seed to contact caustic lime or soluble fertilizers before inoculating the seed.
6. When preparing the inoculation mix, do not use acidic or alkaline water with a high chlorine level. Choose an inoculant that will tolerate the level of chlorine in your water. Ideally, water should meet the standards for drinkable water (less than 1 ppm chlorine).
7. Use an insulated cooler with ice packs to transport the inoculation mix from preparation place to the field.
8. Application equipment should be clean, thoroughly rinsed, and properly calibrated. Leftover from any chemical product can be detrimental for bacteria survival.
9. If applied with fungicide and/or insecticides, check the pesticide label to ensure that the particular strain of bacteria used as inoculum is compatible with the product being applied.
10. Select inoculants that contain stability enhancers that will let them remain stable for a longer time following hydration.
11. Keep packaging closed until future use. Limit the amount of oxygen inside the package to the very minimum level.
12. Plant inoculated seeds within no more than three to four hours after seeds were inoculated. A proper soil moisture and good seed to soil contact is indispensable to maximize chances of bacteria survival.

Certified Seed

The use of viable seed of adapted varieties is an essential part of successful crop production. Like livestock, seed are living bodies subject to the influences of weather, disease, and breeding. It is not enough that the seed produce a plant; it must also contain the genes that will enable the plant to resist disease, produce high yields, and utilize high levels of soil fertility.

Certifying Agency

The Virginia Crop Improvement Association has been designated as the official seed-certifying agency in Virginia by the State Certified Seed Board. The association is an incorporated nonprofit organization of seed growers. It works in cooperation with seed growers, seedsmen, research, Extension, and teaching divisions of Virginia Tech, the Virginia Department of Agriculture and Consumer Services, and the U.S. Department of Agriculture.

Purpose of Certification

The purpose of certification is to reproduce – and make available to the public – high-quality seed and propagating material of superior plant varieties grown and distributed as to ensure genetic purity and a minimum of seed-borne diseases. “Seed” includes all propagating material that could be certified.

Classes and Sources of Certified Seed

Four classes of seed shall be recognized in seed certification; namely, (a) Breeder, (b) Foundation, (c) Registered, (d) Certified.

Breeder seed is seed or vegetative propagating material directly controlled by the originating or sponsoring plant breeder or institution that provides the source for the initial increase of foundation seed. Breeder seed is not available for commercial distribution.

Foundation seed is the progeny of breeder or foundation seed stock that is handled so as to most nearly maintain specific genetic identity and purity. Production must be carefully supervised and approved by the certifying agency or the agricultural research station.

Registered seed is the progeny of breeder, foundation, or registered seed that is handled so as to maintain satisfactory genetic identity and purity and a minimum of seed-borne diseases, and that has been approved and certified by an official certifying agency.

Certified seed is normally the progeny of breeder, foundation, or registered seed. However, when foundation or registered classes of a variety are not available, certified seed can be produced from certified seed that was grown under the supervision of the certifying agency and handled so as to maintain genetic identity, purity, and a minimum of seed-borne diseases.

Application for Certification

Application for inspection of a crop for certification can be made on an official association application blank that can be obtained from Extension agents, vocational teachers, or by writing to the Association office. The application must be properly filled out and mailed to the Virginia Crop Improvement Association, 9225 Atlee Branch Lane, Mechanicsville, VA 23116; 804-746-4884; www.virginiacrop.org.

Field Inspection

At least one field inspection is made at a time most appropriate to determine compliance with certification requirements. All inspections are performed by individuals who have been trained for the job.

Sampling of Seed

Before sampling, seed lots should be cleaned and ready for sale, except for labeling. A representative sample should be taken from the entire lot. Following are sample sizes required for some common seed types.

2 ounces – Kentucky bluegrass, redtop, white clover, alsike clover, bentgrass, and other types of seed of similar size.

5 ounces – Orchardgrass, red clover, crimson clover, alfalfa, fescues, lespedezas, ryegrasses, foxtail millet, grass mixtures, and other types of seed of similar size.

2 pounds – Small grains, vetches, corn, peanut, soybean, sorghum, sudangrass, sunflower, and other types of seed of similar size. For a seed count, a sample must be submitted in a moisture-proof container.

Send samples to: State Seed Testing Laboratory, 600 N. 5th Street, Room 232, Richmond, VA 23219.

Sources of Seed

The Virginia Crop Improvement Association distributes spring and fall certified seed directories that list sources of registered and certified seed grown in Virginia. The Foundation Seed Farm, located at 4200 Cople Highway, Montross, VA 22520, is responsible for increasing seed of new varieties and maintaining commercially important varieties that have been developed by public institutions.

Seed Protection

Plant variety protection ensures intellectual property protection to breeders of new varieties of plants. There are four types of intellectual property protection that breeders can obtain (**table 2, page 89**).

1970 Plant Variety Protection Act – Legislation enacted to promote the development of new varieties by allowing the variety owner to determine who may sell seed of the variety. Farmers may save seed for their own planting need and sell that amount to a neighbor if plans for that variety change. All seed sales must comply with state seed laws. Applies to all varieties protected prior to April 4, 1995.

1994 Amended PVPA – Amendment to the Plant Variety Protection Act that prohibits the sale of any farmer-saved seed without the permission of the variety owner. It also extends protection to tuber-reproduced plants, varieties essentially derived from variety, and harvested material of the variety. Seed protected under the 1994 PVPA must be sold by variety name (except for turf, forage, alfalfa, and clover). Length of protection was increased to 20 years for most kinds of plants, and 25 years for trees, shrubs, and vines. Applies to all varieties protected after April 4, 1995.

Title V – An option for protected varieties that allows for the sale of the seed by variety name only as a class of certified seed. Noncertified sales are prohibited. Seed may be called "certified" only after meeting all requirements and standards of an official seed certifying agency.

Utility and plant patents – A means of protection for certain varieties, especially those developed through genetic engineering or biotechnology. Farmers cannot save, clean/condition, or sell any seed protected under a utility/plant patent.

Table 2. Plant variety protection type and allowable uses.

	1970 PVPA	1994 PVPA	TITLE V	PATENT
Farmer				
Allowed to sell seed	YES*	YES*	YES*	NO
Allowed to sell seed (no advertising) to neighbor if in compliance with state law	YES*	NO	'70 PVPA ONLY	NO
Conditioner				
Condition varieties for farmers	YES*	YES*	YES*	NO
Store seed for farmers	YES*	YES*	YES*	NO
Clean or stock as step in marketing variety	NO	NO	NO	NO
Deliver or load seed to a third party	NO	NO	NO	NO
Advertise farmer-saved seed	NO	NO	NO	NO
Sell or act as broker for farmer-saved seed	NO	NO	NO	NO

* Limited to the amount of seed needed to plant a farmer's own holdings (land owned, leased, or rented).

A quick method for estimating the pounds of seeds broadcast per acre

After planting, place a sheet of 8 1/2" x 11" paper over the planted area and make an outline in the soil. Remove the paper and count the seeds in the marked area. In the first column of **table 3**, find the number of seeds counted. The other columns show pounds of seed per acre. Measure several different areas and take an average. This method could be modified by placing a large cover on the ground before planting to make the small seed more visible.

Table 3. Estimate of seeding rate based on seed count under one sheet of paper.					
Seeds per lb for each species	223,500	275,000	1,400,000	540,000	14,500
No. of seeds counted under 8 1/2" x 11" paper	Alfalfa fescue (tall)	Red clover	Kentucky bluegrass	Orchard-grass	Wheat barley
Pounds of seed broadcast per acre					
1	0.29	0.24	0.05	0.12	4.51
2	0.60	0.49	0.10	0.25	9.25
4	1.20	0.98	0.19	0.50	18.51
6	1.80	1.46	0.29	0.75	27.76
8	2.40	1.95	0.38	0.99	37.01
10	3.00	2.44	0.48	1.24	46.27
12	3.60	2.93	0.58	1.49	55.52
14	4.20	3.42	0.67	1.74	64.77
16	4.80	3.90	0.77	1.99	74.03
18	5.40	4.39	0.86	2.24	83.28
20	6.00	4.88	0.96	2.48	92.53
25	7.50	6.10	1.20	3.11	115.67
30	9.01	7.32	1.44	3.73	138.80
40	12.01	9.76	1.92	4.97	185.07
50	15.01	12.20	2.40	6.21	231.34
60	18.01	14.64	2.88	7.45	277.60
70	21.01	17.08	3.35	8.70	323.87
80	24.01	19.52	3.83	9.94	370.14
90	27.02	21.96	4.31	11.18	416.41
100	30.02	24.40	4.79	12.42	462.67

Table 4 allows estimate of seeding rate (seeds per acre) based on the row spacing and distance between seeds in a row.

Table 4. Seed population at planting																	
	Row spacing (inches)																
	4	6	8	10	14	16	18	20	22	24	26	28	30	32	34	36	38
Seeds/acre	Inches between seeds																
4,000	392	261	196	157	112	98	87	78	71	65	60	56	52	49	46	44	41
6,000	261	174	131	105	75	65	58	52	48	44	40	37	35	33	31	29	28
8,000	196	131	98	78	56	49	44	39	36	33	30	28	26	25	23	22	21
10,000	157	105	78	63	45	39	35	31	29	26	24	22	21	20	18	17	17
12,000	131	87	65	52	37	33	29	26	24	22	20	19	17	16	15	15	14
14,000	112	75	56	45	32	28	25	22	20	19	17	16	15	14	13	12	12
16,000	98	65	49	39	28	25	22	20	18	16	15	14	13	12	12	11	10
18,000	87	58	44	35	25	22	19	17	16	15	13	12	12	11	10	9.7	9.2
20,000	78	52	39	31	22	20	17	16	14	13	12	11	10.5	9.8	9.2	8.7	8.3
22,000	71	48	36	29	20	18	16	14	13	12	11	10	9.5	8.9	8.4	7.9	7.5
24,000	65	44	33	26	19	16	15	13	12	11	10	9.3	8.7	8.2	7.7	7.3	6.9
26,000	60	40	30	24	17	15	13	12	11	10	9.3	8.6	8.0	7.5	7.1	6.7	6.3
28,000	56	37	28	22	16	14	12	11	10	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9
30,000	52	35	26	21	15	13	12	10.5	9.5	8.7	8.0	7.5	7.0	6.5	6.1	5.8	5.5
35,000	45	30	22	18	13	11	10	9.0	8.1	7.5	6.9	6.4	6.0	5.6	5.3	5.0	4.7
40,000	39	26	20	16	11	9.8	8.7	7.8	7.1	6.5	6.0	5.6	5.2	4.9	4.6	4.4	4.1
50,000	31	21	16	13	9.0	7.8	7.0	6.3	5.7	5.2	4.8	4.5	4.2	3.9	3.7	3.5	3.3

Table 4. Seed population at planting (cont.)

	Row spacing (inches)																
	4	6	8	10	14	16	18	20	22	24	26	28	30	32	34	36	38
Seeds/acre	Inches between seeds																
60,000	26	17	13	10	7.5	6.5	5.8	5.2	4.8	4.4	4.0	3.7	3.5	3.3	3.1	2.9	2.8
70,000	22	15	11	9.0	6.4	5.6	5.0	4.5	4.1	3.7	3.4	3.2	3.0	2.8	2.6	2.5	2.4
80,000	20	13	10	7.8	5.6	4.9	4.4	3.9	3.6	3.3	3.0	2.8	2.6	2.5	2.3	2.2	2.06
90,000	17	12	8.7	7.0	5.0	4.4	3.9	3.5	3.2	2.9	2.7	2.5	2.3	2.2	2.0	1.94	1.83
100,000	16	10.5	7.8	6.3	4.5	3.9	3.5	3.1	2.9	2.6	2.4	2.2	2.1	2.0	1.84	1.74	1.65
125,000	13	8.4	6.3	5.0	3.6	3.1	2.8	2.5	2.3	2.1	1.9	1.8	1.7	1.57	1.48	1.39	1.32
150,000	10	7.0	5.2	4.2	3.0	2.6	2.3	2.1	1.9	1.7	1.6	1.5	1.4	1.31	1.23	1.16	1.10
200,000	7.8	5.2	3.9	3.1	2.2	2.0	1.7	1.6	1.4	1.3	1.2	1.1	1.0	0.98	0.92	0.87	0.83
250,000	6.3	4.2	3.1	2.5	1.8	1.6	1.4	1.3	1.1	1.05	0.97	0.90	0.84	0.78	0.74	0.70	0.66
300,000	5.2	3.5	2.6	2.1	1.5	1.3	1.2	1.05	0.95	0.87	0.80	0.75	0.70	0.65	0.61	0.58	0.55
500,000	3.1	2.1	1.6	1.3	0.9	0.8	0.7	0.63	0.57	0.52	0.48	0.45	0.42	0.39	0.37	0.35	0.33
1,000,000	1.6	1.0	0.8	0.6	0.45	0.39	0.35	0.31	0.29	0.26	0.24	0.22	0.21	0.20	0.18	0.17	0.17
1,500,000	1.0	0.7	0.5	0.4	0.30	0.26	0.23	0.21	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11