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# Growing organic black beans in Veneta, Oregon

(17 miles west of Eugene, Southern Willamette Valley)  October, 2009

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1. planting date:  May 1-31, (typically May 12-20).  Early plantings have longer growing season, potentially higher yield, less irrigation required, more weeds and greater risk of frost damage.  Late plantings allow more weeds to emerge and be tilled prior to planting, but shorter growing season.
2. crop rotation:
    - summer bean > winter cover crop > summer bean > winter cover crop = bean year after year, with a winter cover crop to break the disease cycle.  The cover crop can not be beans but vetch, fava and peas are acceptable (Steve Temple, UC Davis extension agronomist, personal communication).  Six consecutive years of summer beans and winter cover crop, followed by fallow, wheat and 4 consecutive years of summer beans and winter cover crop showed no buildup of diseases in Veneta.
    - A possible rotation of 5 years of bean followed by wheat; repeat 5 years of bean followed by wheat.  A shorter rotation of bean, wheat, bean, wheat, does not work very well.  Weed (mustard, radish) mature and shatter in the wheat stand before wheat is harvested, resulting in higher weed population in the following bean crop.  Also, wheat with no fertilizer input, grown on a 6 consecutive year bean field has higher yield and heavier test-weight (density) than grown on a 1 year cycle bean>wheat>bean>wheat.
    - overseeding bean with a winter cover crop on the last cultivation in late July allows early establishment of cover crop.  Cover crops of clover (alsike, crimson, Persian, red and yellow), fava, vetch and wheat were established and grew to 4-12 inches tall at harvest time (September 15).  The cover crops did not interfere with bean harvest.  Overseeding with fava resulted in a poor stand because the large seeds were not adequately planted into the soil during the last cultivation.  Overseeding with winter wheat resulted in a poor wheat stand, possible reasons are rodents and birds ate the wheat seeds or unfavorable condition to germinate in July.
3. Fertilizer input: lime, potassium, phosphorus, sulfur and boron.  Suspected boron deficiency symptoms were observed (Figure 1 and 2).  "Root growth greatly retarded with dark colored, corky areas" (Pscheidt, J W, Ocamb, CM. Key to Nutrient Deficiencies in Vegetable Crops, in 2008 Pacific Northwest Plant Disease Management Handbook).  As a

consequence of poor root development, lack of secondary roots and absence of rhizobia inoculation, boron deficiency appears as yellowing of older leaves (similar to nitrogen deficiency) or irregular shaped leaves with wide midribs (similar to boron deficiency on apple).

4. Major weeds encountered at Veneta:
    - nightshades (Solonaceae solanum) : nightshade berries interfere with seed cleaning; berry size and density are similar to black bean, until the berries dry, then they winnow out easily. Wet nightshade berries take 2+ months to air-dry. Nightshade plant emerges in June- July; can be removed with flex tine cultivator, until ~July 1 when the flex tine cultivator damages 6-10 inches tall bean plants. The flex tine cultivator will suppress nightshade weeds but does not completely eliminate it.
    - wild mustard and radish (Brassicaceae Brassica and Raphanus) : the 1-2 inch thick radish head can jamb the combine draper belt/ feed system; wet seed pods are difficult to winnow during the seed cleaning process but small, dryer pods (5-15 days of air drying) winnow out readily. Wet pods in the drying bin can rot and contaminate adjacent beans. Wild mustard and radish emerges through out the growing season, from March to September. They are controlled but not eliminated with flex tine cultivator in conjunction with rotary hoe and sweeps, especially during the early part of the growing season (May – July 10). Later emerging mustards and radishes will not develop mature seeds when beans are harvested, thus will not produce a weed crop for the next year.
    - wild buckwheat (Polygonaceae Polygonum): the vines tangle with the beans and interfere with combining. flex tine cultivator and rotary hoe remove young shallow rooted weeds, but does not remove well rooted weeds.
    - smart weed (Polygonaceae Polygonum) : compete for nutrient, light and water. It is removed with flex tine cultivator in conjunction with rotary hoe; rotary hoe is more effective.
    - lambs quarter (Chenopodiaceae Chenopodium) competes for sunlight and nutrient. Small amount of lambs quarter is beneficial when direct combining at harvest; it provide physical support for beans that otherwise would lodge; lodging increases with each rain at harvest time.
    - Canada thistle (Asteraceae Cirsium) tough perennial competitor; no means of control by mechanical cultivation (yet?)
5. Weed control: flex tine cultivator, Figure 4 (design available at http://efn.org/~itech/), rotary hoe (Figure 5) and sweeps (Figure 6) are synergistic. The flex tine cultivator and rotary hoe remove weeds in the plant row and between the plant row when bean plants are short, <6 inches. Sweeps remove everything in its path but can not be used in the plant row. Variations of the following mechanical cultivation procedure

were applied on 14 acres of black beans for 5 years, 2005 to 2009, and successfully suppressed weeds, but not a complete elimination.

- First cultivation: pre emergence cultivation with flex tines; 2 passes at 6 mph ground speed, 2-5 days after planting (bean emerges 7-14 days after planting, depending on weather). The flex tine cultivator scratches the surface creating channels ~3/4 to 1 inch deep and removes weeds at the white root stage in direct path of the tines (blind cultivation, weed have not yet emerged from the soil surface).
- Post emergence cultivation: rotary hoe 4-6 days after bean plant emergence, 1 or 2 passes on the same day; ground speed 8-12 mph. The rotary hoe creates pits ~1 ½ inches deep, 2 ½ x 3 ½ inch spacing. This lifts shallow rooted weeds, breaks the soil-water capillary conductivity, desiccates shallow rooted weeds not lifted out of the soil and disrupts the channels created by the flex tine cultivator. The rotary hoe penetrates deeper but has less coverage of the soil surface, compared to the flex tine cultivator.
- Second post emergence cultivation: flex tine 4-8 days after rotary hoe disrupt the channels created by the first flex tine pass.
- Subsequent cultivations, alternate between flex tine, rotary hoe and sweeps
- Last rotary hoe cultivation, 4 inch tall beans ~June 10 at ~6 mph ground speed; last flex tine cultivation, 8 inch tall beans ~July 1 at ~3 mph ground speed; last sweep cultivation, ~85% canopy in late July - August 1.
- Alternative (and less effective) cultivation procedure using flex tine and sweeps; without using rotary hoe. Reconfigure the flex tine cultivator so that the tine positions (and the channels on the soil surface created by the tines) are asymmetrical. In Figure 5 shown below, the flex tine cultivator has two 5 feet wide sections; tines are spaced 8 inches apart in both sections. In an asymmetrical cultivator, the tine spacing on one of the section is 8 inches apart; and a combination of 7 and 9 inch spacing on the other section. The spacing of soil surface channels created by the section with 8 inch tine spacing will be different from the spacing of channels created by the section with 7 and 9 inch tine spacing. Drive the cultivator in both directions so that channels created by 8 inch tine spacing will disrupt channels created by 7 and 9 inch tine spacing when driving in the 180 degrees opposite direction.

6. Irrigation: first irrigation is in late June; no irrigation needed to germinate beans.
7. Harvest: Allis Chalmers All-Crop combine can harvest the beans directly off the plants, without knifing and windrowing the beans prior to combining. Minimize bean splits during combining with low combine cylinder speed (~400-500 rpm) and use 1 concave bar (remove the second concave bar). Beans have indeterminate flowering, some pods

are ready to harvest while late flowering pods are green. Depending on weather, there is a 10-20% loss from lodging, pod shattering, bean splits; additional loss from inclement weather.

8. Weather (rain) is a limiting factor in growing dry beans in western Oregon affecting planting, early weed control, harvest and post harvest drying. Mature bean pods can tolerate 4-8 days of light rain; however the plant sags lower to the ground, making it difficult to harvest, increases diseases as well as weed re-growth. It almost always rain at least once during a 10 day harvest period in Veneta, Oregon. Equipments must be in good condition, ready to go and be ready to dodge the rain. Preventative maintenance is better than emergency repair; if it is not broken, fix it anyway.
9. Post harvest drying. It almost always rain at least once during post harvest drying. Assume that fog will form at night during part of the drying period. Moisture condensation on beans in the drying bins (Figure 6 and 7) can occur if the blower circulates cold nighttime air, chills the bean temperature down then blow warm daytime humid air on cold beans. Wet beans and weeds will mold. Do not circulate cold air through the drying bin at night in high humidity conditions.
10. Seed cleaning: Screens are a 21/64 inch diameter round hole at the top to remove large pods and dirt; an intermediate screen with 11/64 x ¾ inch slotted (oval) holes; bottom screen is 10/64 x ¾ inch slotted (oval) holes to remove split beans, small stems etc. Beans are winnowed following screen cleaning (winnower design available at http://efn.org/~itech/)
11. Black beans will cross pollinate with pinto, kidney and other common beans (Ashworth, S 1991. Seed to Seed. Seed Savers Exchange, Decorah, Iowa). Experience from Veneta: seeds from cross pollinated black and pinto bean produce black speckled beans with tan background color; cross pollinated black and kidney bean is intermediate color, size and shaped bean. Pinto bean has higher yield because of its vine growth habit, but more difficult to harvest directly off the vine (not a problem if bean plants are knifed and windrowed before combining). Kidney bean is easier to clean because its large size is significantly different from weed seeds and pods. Soybean is the easier to grow because its strong upright stalk will support pods off the ground and shed rain better than common beans.

**Suspected boron deficiency**

Figure 1.  Left: Healthy bean roots, white internal flesh and secondary root growth.  Right: suspected boron deficiency: internal brown cork and lack secondary root growth.

Figure 2. Close up of suspected boron deficient roots with internal brown corks and lesions.

**Mechanical cultivators**

Figure 3. Flex tine cultivator

Figure 4. Rotary hoe

Figure 5. Sweeps and mini disks

**Post harvest drying**

Figure 6. Grain drying bins using  4ft x 4 ft totes, connected to a blower.

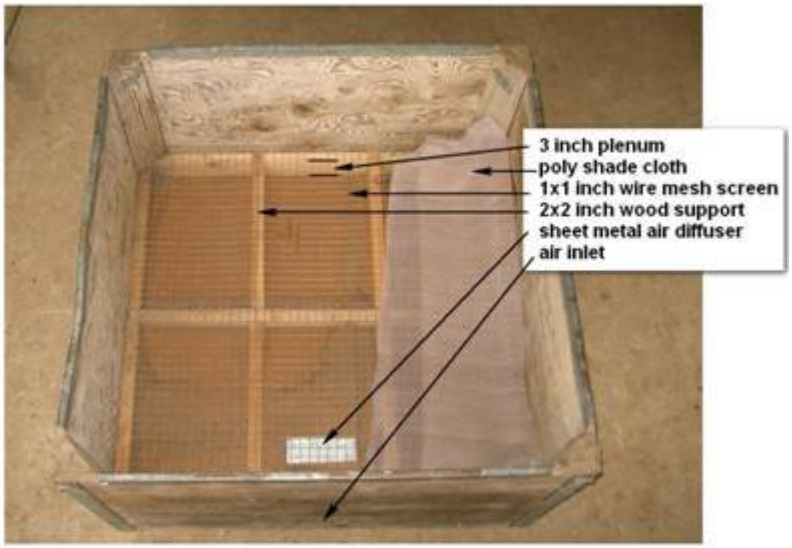


Figure 7. Top view of grain drying bin, showing poly shade cloth (partly removed), 1 x 1 inch wire mesh screen, 2 x 2 inch wood support for wire screen and sheet metal air diffuser.