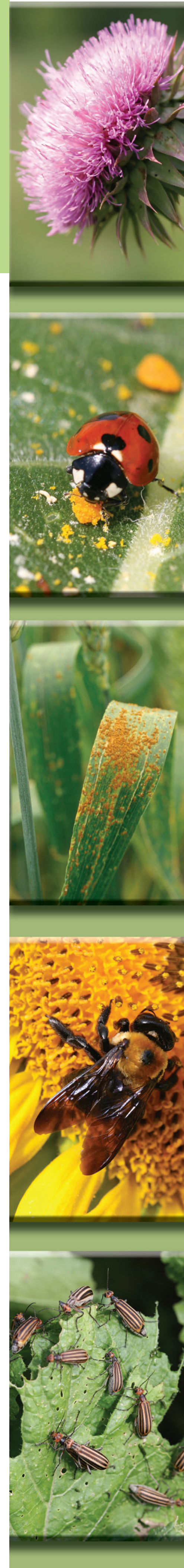
Integrated & Crop Pest Management



Arrested Development in the Soybean Field

Part 2: Seed Development

By Bill Wiebold

As I wrote in Part 1, the two primary yield components for grain crops are seed number and seed size. And, seed number is the more important of the two yield components. Understanding how soybean plants regulate seed number and how this yield component responds to stresses and crop management are helpful in understanding soybean yield production.

Soybean seed number is determined by the number of flowers produced, the number of pods retained on the plant, and the number of seeds per pod. In Part 1, I briefly discussed flower number, and focused on the number of pods retained. In Part 2, I will discuss adjustments in seed number per pod.

Because soybean is a member of the legume family, its fruits are called pods. Pods are mature ovaries and the seeds inside are mature ovules. Soybean ovaries contain two to four ovules before fertilization. There can be no more seeds in a pod than there were ovules. It is highly unlikely that pods in Missouri soybean fields will contain more than four seeds.

Almost immediately after fertilization of the ovules in the ovary, the pod wall begins to expand. Pod expansion in nearly complete before seed filling begins (Figure 1). When pod wall growth is finished, developing seeds have obtained only about 5% of their final dry weight. In a normal pod with normally developing seeds, the seeds at stage R6 will almost completely fill the pod cavity and cause the pod wall to bulge outward at each seed position (Figure 2)

Soybean pods at harvest contain one to four seeds (Figure 3). The number of seeds in a pod is determined by number of ovules in the ovary, number of those ovules fertilized, and number of seeds that continue development until maturity. Somewhat surprising, the ovule near the tip of the ovary (furthest from raceme rachis or position 1 (Figure 2) is fertilized first and its seed begins development one or two days before the other seeds.

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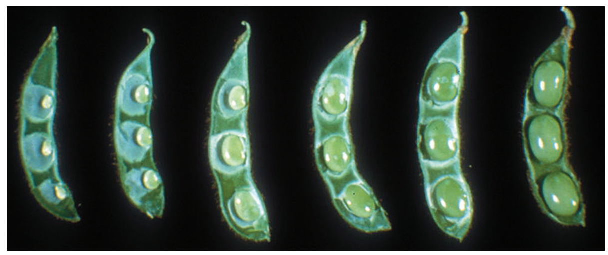

Figure 1: Soybean seed and pod development during growth stage R5. Picture from Iowa State University.

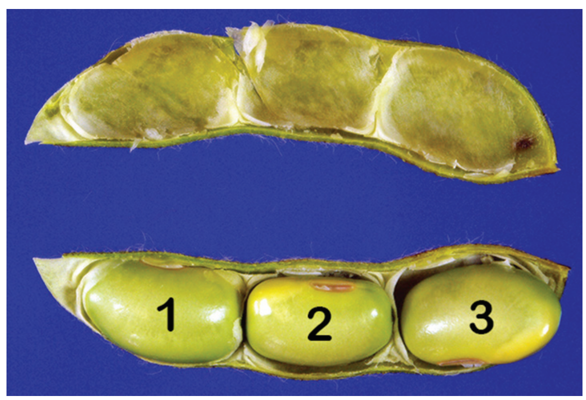

Figure 2: Open soybean pod with seeds. Stage of development is late R6. Seed positions within the pod are labeled with 1 closest to raceme rachis.

In This Issue

Arrested Development In The Soybean Field: Part 2: Seed Development

Successful fertilization of an ovule does not mean that the resulting seed will continue development through maturity. Arrested development, often called abortion, may occur to any of the growing seeds in the pod. From 10 to 20% of fertilized seeds abort. Positions within a pod differ for abortion probability. Again somewhat surprising, the seed in position 1 aborts nearly twice as often as seeds further from the raceme rachis.

Successful fertilization of an ovule does not mean that the resulting seed will continue development through maturity. Arrested development, often called abortion, may occur to any of the growing seeds in the pod. From 10 to 20% of fertilized seeds abort. Positions within a pod differ for abortion probability. Again somewhat surprising, the seed in position 1 aborts nearly twice as often as seeds further from the raceme rachis.

Seed abortion can occur at any stage of development, but more than 90% of the abortion incidences occur before 30 days after fertilization.

The 3-seeded pod in figure 4 possesses two seeds with arrested development. Abortion at position 1 probably occurred 7 to 12 days after fertilization. Abortion at position 2 occurred later, maybe 20 to 24 days after fertilization. Abortion that happens late in seed-filling often results in a seed with a wrinkled appearance (Figure 5).

The most common seed number per pod in Missouri soybean fields is 3. Figure 6 illustrates that seed abortion can occur at any position, and that more than one seed may abort.

Sometimes pods are "flat" at harvest and appear to contain no seeds (Figure 7). Flowers that produce flat pods were fertilized because pod growth does not happen unless the flower is fertilized. So, at some time during development, all of the fertilized ovules underwent arrested development. Before maturity, flat pods may appear "normal" with normal pod length and clearly visible chambers where seeds should be (Figure 8). These "flat pods" might contain partially developed seeds (Figure 9).

The causes of seed abortion are similar to the causes of pod abscission. To continue development, seeds require a steady flow of water, carbohydrates, and mineral nutrients. Stresses that reduce any of these requirements may increase seed abortion. Because developing seeds are most vulnerable to abortion early in their development, stress during growth stage R4 is more likely to reduce seed number per pod than stresses that occur earlier or later in the growing season.

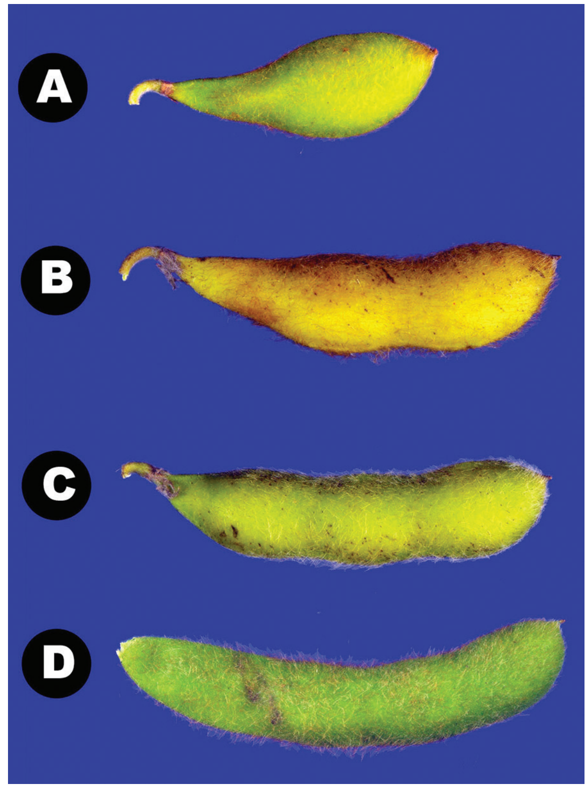

Figure 3: Soybean pods with one (A), two (B), three (C), and 4 (D) seeds.

Figure 4: 3-seeded soybean pod with two aborted seeds at positions 1 and 2. Seeds aborted at different stages of development.

Figure 5: 3-seeded soybean pod with one aborted seed at position 2. Seed aborted late in development .

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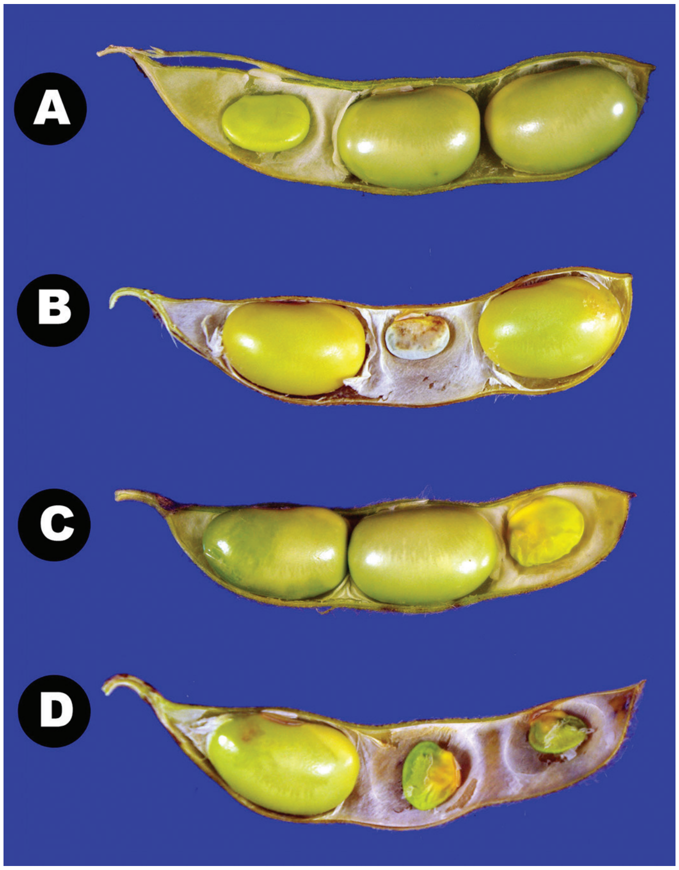

Figure 6: 3-seeded soybean pods with one aborted seed at position 1 (A), one aborted seed at position 2 (B), one aborted seed at position 3 (C), and two aborted seeds at positions 2 and 3.

Figure 7: Soybean raceme with "flat" pod. Stage of development is R7.

Figure 8: Surfaces of two "flat" soybean pods. Stage of development is late R6.

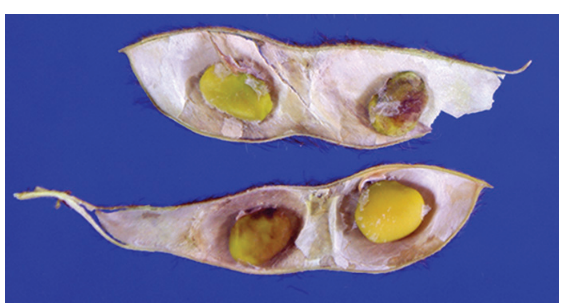

Figure 9: Insides of two "flat" pods illustrating that some "flat pods" contain visible aborted seeds. Stage of development is late R6.

Myers is new State Cereal Crops Extension Specialist

Dr. Brent Myers will join the College of Agriculture, Food and Natural Resources in the Division of Plant Sciences as Assistant Professor effective December 1, 2012. Brent will serve as State Extension Specialist for Cereal Crops with a 75% Extension / 25% Research appointment. Brent will perform needs analyses and develop focused extension and applied research programs to address those needs. He will have primary responsibility for Extension education programming on the production of corn, wheat, and other cereal crops in Missouri with emphasis on sustainability and profitability of production systems, cultural practices, stress management, and grain quality and use, and other areas. In addition, Brent will develop active relationships with other faculty, regional Extension specialists, cereal grain producers, and industry and participate in appropriate interdisciplinary programs and projects.

Prior to joining Plant Sciences, Brent earned MS and PhD Degrees in Soil, Environmental, and Atmospheric Science at the University of Missouri. His dissertation was entitled "Sensor driven methods for soil landscape models". Most recently, Brent has worked as Research Soil Scientist with the USDA-ARS group in Columbia. Before that, he served as postdoctoral research associate at the University of Florida, Gainesville, for two years. Recent research includes mapping continuous depth fluctuations of subsoil potassium, modeling soil electrical conductivity, associations between soil carbon and ecological landscape drivers, and several other topics. Brent has broad expertise in geospatial assessment of corn/soybean yield risk, crop profitability modeling, soil landscape models, digital soil mapping and other areas that bring the power of modern technologies to application in Missouri's crop production systems.

Please join us in welcoming Brent to the Division of Plant Sciences, CAFNR, and Mizzou. His email is myersdb@missouri.edu.

Weather Data for the Week Ending November 30, 2012

By Pat Guinan

Station	County	Weekly Temperature (ºF)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	October 1-30	Departure from long term avg.	Accumulated Since Apr.1	Departure from long term avg.
Corning	Atchison	52	26	66	11	40	+5	1.10	-0.96	3863	+411
St. Joseph	Buchanan	52	31	64	14	42	+5	1.87	-0.05	4142	+700
Brunswick	Carroll	54	28	65	12	42	+5	1.41	-1.39	4022	+529
Albany	Gentry	50	24	62	8	37	+1	1.71	-0.33	3910	+559
Auxvasse	Audrain	57	33	73	14	44	+5	1.33	-1.93	4134	+573
Vandalia	Audrain	56	31	71	14	43	+4	0.85	-2.31	4093	+598
Columbia-Bradford Research and Extension Center	Boone	57	31	72	14	44	+4	1.22	-1.98	4090	+424
Columbia-Capen Park	Boone	59	27	74	14	42	+2	1.42	-1.82	3952	+153
Columbia-Jefferson Farm and Gardens	Boone	57	34	72	14	45	+5	1.28	-1.91	4260	+581
Columbia-Sanborn Field	Boone	58	35	72	18	46	+6	1.44	-1.84	4491	+682
Columbia-South Farms	Boone	57	33	71	15	45	+5	1.32	-1.89	4253	+582
Williamsburg	Callaway	58	33	73	16	45	+6	0.71	-2.89	4147	+651
Novelty	Knox	51	29	61	13	40	+2	1.47	-1.42	3806	+391
Linneus	Linn	51	29	61	11	41	+4	1.72	-0.76	3956	+599
Monroe City	Monroe	54	30	67	14	42	+4	1.38	-1.78	3970	+493
Versailles	Morgan	60	35	72	15	48	+7	0.89	-2.66	4477	+696
Green Ridge	Pettis	57	33	68	15	45	+6	1.59	-1.63	4272	+735
Lamar	Barton	59	36	72	20	47	+6	1.57	-2.28	4466	+509
Cook Station	Crawford	60	35	73	17	46	+4	1.87	-2.45	3993	+233
Round Spring	Shannon	60	30	74	17	42	+2	1.69	-2.68	3824	+227
Mountain Grove	Wright	58	36	71	20	46	+6	1.84	-2.74	4064	+485
Delta	Cape Girardeau	55	34	66	23	44	+1	1.76	-3.08	4301	+124
Cardwell	Dunklin	58	37	70	24	47	+2	2.29	-2.43	4645	+79
Clarkton	Dunklin	57	36	69	25	46	+2	1.80	-2.63	4647	+156
Glennonville	Dunklin	57	39	68	26	47	+3	1.80	-2.61	4668	+211
Charleston	Mississippi	56	38	67	26	46	+2	2.77	-1.45	4599	+375
Portageville-Delta Center	Pemiscot	58	40	70	28	48	+3	2.31	-2.08	4902	+363
Portageville-Lee Farm	Pemiscot	59	40	70	25	48	+3	2.19	-2.21	4845	+342
Steele	Pemiscot	59	38	71	25	48	+3	2.32	-2.46	4936	+384

‡Growing degree days are calculated by subtracting a 50 degree (Fahrenheit) base temperature from the average daily temperature. Thus, if the average temperature for the day is 75 degrees, then 25 growing degree days will have been accumulated.

Weather Data provided by Pat Guinan
GuinanP@missouri.edu
(573) 882-5908

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Editor: Kate Riley (rileyka@missouri.edu).