Common Pokeweed Management in Field Crops
A Final Report to the Pennsylvania Soybean Board, 2012.
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The following is a final report of the experiments conducted in 2012. Most experiments will be repeated in 2013, and the findings will be submitted to the Board in the next progress report.

<u>Objective 1</u> - Evaluate effectiveness of herbicide options for control in no-till soybean and corn.

During the summer of 2012, herbicide efficacy experiments were conducted in both corn and soybean. Results from this year's corn and soybean studies show that Roundup seems to be a key component in controlling pokeweed. Also, combinations of herbicides seem to work better than individual herbicides alone. Residual herbicides, such as atrazine, may also play an important role, as seedlings were seen coming up into late summer.

Corn herbicides

The herbicide efficacy trial was conducted in a field near Mt. Joy, PA. Nine POST treatments were evaluated: Roundup® (32 fl oz/A), 2,4-D (1 pt/A), Clarity® (1 pt/A), Status® (10 oz/A), Callisto® + atrazine (3 fl oz/A + 1 pt/A), Permit® + Status® (0.67 oz/A + 10 oz/A), Roundup® + Status® (32 fl oz/A + 10 oz/A), Roundup® + Callisto® + atrazine (32 fl oz/A + 3 fl oz/A + 1 pt/A), and Roundup® + Permit® + Status® (32 fl oz/A + 0.67 oz/A + 10 oz/A). Appropriate adjuvants were included in all treatments. Herbicides were applied on May 25 when the pokeweed ranged from seedling to an average of 3 feet tall. The experiment was replicated four times, and plots were visually rated several times throughout the summer. On August 22, three pokeweed plants were collected from each plot and were weighed for both fresh and dry weights. Percent biomass reductions were calculated based on the difference of untreated and treated plant weights. All herbicide treatments provided at least 79% control (Table 1). Although not statistically different from the other treatments, the Callisto + atrazine and Roundup + Permit + Status provided 91% control at the August 22 evaluation. All herbicide treatments also provided at least 87% reduction of dry biomass. Although not significantly different, Status; Callisto + atrazine; and Roundup + Permit + Status all provided above 95% reduction in dry weight.

Table 1. Effect of herbicide treatments on pokeweed control in no-till corn, 2012.

Herbicide	**Rate (per/A)**	**June 6 control (%)**	**June 21 control (%)**	**July 19 control (%)**	**August 22 control (%)**	**Dry weight (kg)**	**Dry weight reduction (%)**
Control	--	0 b	0 d	0 b	0 b	0.345 a	0 b
Roundup	32 fl oz	85 a	91 a	82 a	84 a	0.021 b	94 a
2,4-D	1 pt	81 a	77 c	79 a	89 a	0.027 b	92 a
Clarity	1 pt	81 a	79 bc	80 a	86 a	0.043 b	87 a
Status	10 oz	84 a	79 bc	83 a	88 a	0.013 b	96 a
Callisto plus atrazine	3 fl oz 1 pt	86 a	90 a	97 a	91 a	0.005 b	98 a
Permit plus Status	0.67 oz 10 oz	82 a	76 c	78 a	79 a	0.039 b	89 a
Roundup plus Status	32 fl oz 10 oz	82 a	82 abc	81 a	81 a	0.040 b	88 a
Roundup plus Callisto plus atrazine	32 fl oz 3 fl oz 1 pt	89 a	92 a	85 a	82 a	0.048 b	87 a
Roundup plus Permit plus Status	32 fl oz 0.67 oz 10 oz	84 a	88 ab	90 a	91 a	0.016 b	95 a
LSD (p=0.05) CV Treatment Prob (F)		6.55 5.98 0.0001	7.82 7.16 0.0001	12.11 11.22 0.0001	13.33 11.95 0.0001	0.06 70.53 0.0001	12.5 10.5 0.0001

Means within a column followed by the same letter are not significantly different at the 5% significance level.

Soybean herbicides

The soybean herbicide efficacy study was conducted at the Penn State Rock Springs Research Farm near State College. Eleven POST treatments were evaluated in STS/Roundup Ready soybeans and included: Roundup® at two different rates (22 and 44 fl oz/A), Roundup® at 22 fl oz/A applied twice in the season, Classic® (0.75 oz/A), Harmony® (0.125 oz/A), Synchrony® (0.375 oz/A), Synchrony® (1.125 oz/A), Roundup® + Synchrony® (22 fl oz/A + 0.25 oz/A), Roundup® + Classic® (22 fl oz/A + 0.33 oz/A), Roundup® + FirstRate® (33 fl oz/A + 0.33 oz/A), and Roundup® + Raptor® (22 fl oz/A + 5 fl oz/A). Appropriate adjuvants were included in all treatments. Herbicides were applied on June 28, and the second application of Roundup for the two-pass treatment was applied on July 12. The pokeweed ranged from one to four feet tall. The experiment was replicated four times and plots were rated on July 11 and August 7. Three pokeweed plants were harvested from each plot for biomass on September 4. Yield was taken on November 6. Percent biomass reductions were calculated based on the difference of untreated and treated plant weights. Results show that Roundup provided 75 to 92% control (Table 2). The treatments without Roundup were less effective.

Table 2. Effect of herbicide treatments on pokeweed control in no-till soybean, 2012.

Herbicide	**Rate (per/A)**	**July 11 control (%)**	**August 7 control (%)**	**Sept. 4 control (%)**	**Dry weight (kg)**	**Dry weight reduction (%)**	**Soybean yield (bu/A)**
Control	--	0 d	0 e	0 d	0.327 a	0 c	24 b
Roundup®	22 fl oz	77 ab	75 ab	82 a	0.027 c	92 a	38 ab
Roundup®	44 fl oz	93 a	92 a	92 a	0.026 c	92 a	45 a
Roundup® followed by Roundup®	22 fl oz 22 fl oz	81 a	90 a	95 a	0.029 c	91 a	42 ab
Classic®	0.75 oz	58 c	23 d	33 c	0.168 b	49 b	29 ab
Harmony®	0.125 oz	60 c	54 c	53 b	0.147 bc	55 ab	27 ab
Synchrony®	0.375 oz	66 bc	46 c	48 bc	0.091 bc	72 ab	41 ab
Synchrony®	1.125 oz	64 bc	63 bc	60 b	0.0688 bc	79 ab	37 ab
Roundup® plus Synchrony®	22 fl oz 0.25 oz	91 a	90 a	91 b	0.038 c	88 a	42 ab
Roundup® plus Classic®	22 fl oz 0.33 oz	90 a	94 ab	91 a	0.032 c	90 a	43 ab
Roundup® plus FirstRate®	22 fl oz 0.33 oz	89 a	83 ab	86 a	0.039 c	73 ab	31 ab
Roundup® plus Raptor®	22 fl oz 5 fl oz	90 a	84 ab	96 a	0.040 c	88 a	40 ab
LSD (p=0.05) CV Treatment Prob (F)		11.33 10.98 0.0001	15.89 16.9 0.0001	15.59 15.72 0.0001	0.08 65.15 0.0001	22.9 21.8 0.0001	11.71 22.28 0.008

Means within a column followed by the same letter are not significantly different at the 5% significance level.

Glyphosate rate, timing, spray volume, and spray tip experiments
Several studies were conducted looking at glyphosate rate, timing, spray volume, and nozzle selection at the Penn State Rock Springs Research Farm.

Rate. Three different rates of Roundup (22, 32, and 44 oz/A) were each applied to twelve individual perennial pokeweed plants on June 20. On August 16, a visual percent control rating was given to each plant and all plants were harvested for fresh and dry weights. All three rates reduced the amount of biomass, but the 22 oz/A and 32 oz/A rates had half the amount of biomass as the 44 oz/A rate (Table 3).

Table 3. Effect of glyphosate rate on pokeweed control, 2012.

Rate (fl. oz/A)	**Control (%)**	**Dry Weight (kg)**
0	0	0.914
22	84	0.045
32	94	0.040
44	95	0.080

Timing. Six individual perennial pokeweed plants were selected, tagged, and treated with a standard rate of glyphosate starting in mid-May and ending in late September. Different plants were treated every 2 to 4 weeks during this time period. Eight weeks after application, a visual percent control rating was conducted and above ground plant material was harvested for fresh and dry biomass. Untreated plants were also harvested at the same time. Percent biomass reductions were calculated based on the difference between untreated and treated plants. Preliminary results showed that applications made after mid-June provided at least 80% control, with peak control of 99% by mid-July (Figure 1). Maximum fresh weight reduction was also achieved in mid-July (Table 4). These results suggest that application prior to July may not achieve maximum pokeweed control.

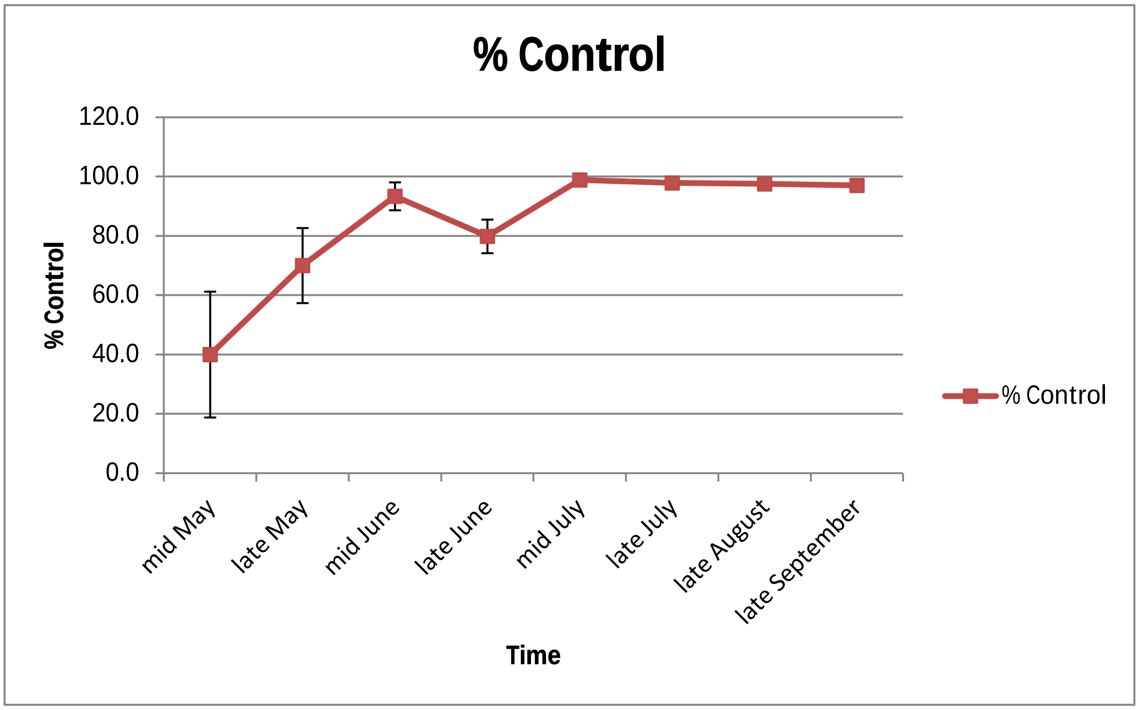

Figure 1. Effect of glyphosate application timing on pokeweed control, 2012.

Table 4. Effect of glyphosate application timing on pokeweed fresh weight, 2012.

Application time	**Fresh weight per plant (kg)**	**% Fresh weight reduction**
mid May	0.825	52
late May	0.46	82
mid June	0.129	96
early July	0.284	91
mid July	0.090	98
early August	0.171	95
late August	0.664	73
late September	2.253	9

Spray Volume. Roundup was applied at a standard rate at three different spray volumes in water (10, 20, and 40 gallons per acre) to twelve individual pokeweed plants (per volume) on June 20, 2012. On August 17, a visual percent control rating was given to each plant and all plants were harvested for fresh and dry weights. Preliminary results showed a trend for improved pokeweed control at the lowest volume (Table 5). This is somewhat contradictory to what we expected assuming that spray coverage might be important. However, previous research also has shown that glyphosate performance improves as spray volume decreases.

Table 5. Effect of spray volume on pokeweed control, 2012.

Volume (gpa)	**Control (%)**	**Fresh weight (kg)**	**Dry weight (kg)**
0	0	4.775	0.914
10	83.9	0.27	0.06
20	74.6	0.45	0.07
40	65.7	0.62	0.10

Nozzle Selection. Roundup was applied at a standard rate using two different nozzle types: Tee-Jet standard flat fan (FF) and a Tee-Jet air induction (AI) tip to twelve individual pokeweed plants (per nozzle type) on June 20. On August 20, a visual percent control rating was given to each plant and all plants were harvested for fresh and dry weights. Both nozzle types reduced biomass compared to untreated plants; however, the FF nozzles had a higher visual percent control rating, but smaller biomass (Table 6). This suggests that spray coverage and nozzle selection can impact control.

Table 6. Effect of nozzle type on pokeweed control, 2012.

Nozzle Type	**Control (%)**	**Fresh weight (kg)**	**Dry weight (kg)**
Untreated	0	2.200	0.458
FF	79	0.317	0.059
AI	69	0.657	0.108

Objective 2 – Increase our understanding of common pokeweed biology and ecology to develop improved management tactics.

Seed Longevity

On November 8, 2011, pokeweed seeds were buried at two different depths (1 and 6 inches) in mesh bags. This experiment was replicated eight times. Each bag contained 20 berries, or approximately 200 seeds. Six, twelve, and eighteen months later, the bags are exhumed and the seeds are tested for viability. The six-month bags were exhumed on May 8, 2012, and the 12-month bags were exhumed on November 9, 2012. The eighteen-month bags will be exhumed on May 8, 2013. Results of the six- and twelve-month bags show variable results, although there appears to be a trend for increased viability the longer and deeper the seed is buried (Table 7).

Table 7. Effect of Burial Depth and Time on Pokeweed Seeds, 2011.

Length of Time Buried (months)	Depth Buried (cm)	% Dead	% Viable
6	2.5	53 ab	47 c
6	15	45 bc	55 abc
12	2.5	50 ab	50 bc
12	15	27 c	73 a

Means within a column followed by the same letter are not significantly different at the 5% significance level.

Seedling Emergence Periodicity

In the fall of 2011, 50 berries, or about 500 seeds, were placed in each of 40 plots. Starting in the spring of 2012, the number of pokeweed seedlings which had emerged was counted every two weeks starting in mid-April and ending in early October. Figure 2 shows the emergence timing during the summer with peak emergence in mid-May. If herbicides are applied after mid-May, then these seedlings would likely be controlled. Ninety-eight percent of the seedlings counted in 2012 had emerged by late June. The total number of seedlings counted in this first season only accounted for about 20 percent of the total number of seeds planted the previous fall; the other 80 percent may have died, not yet germinated, or fallen prey to predators or diseases.

After counting the seedlings, most were removed from the plots so they would not interfere with later emerging cohorts. However, at most dates, a few pokeweed plants were allowed to continue to grow to determine the effect of emergence time on above- and below-ground biomass and reproduction. Both above and below ground plant material was removed and weighed in late September prior to a killing frost. The results showed that the later a seedling emerges, the smaller the plants both above and below ground and the fewer berries and seeds a seedling is able to produce (Table 8, Figures 3 and 4). Plants emerging beyond mid June did not reach reproductive maturity in the first year.

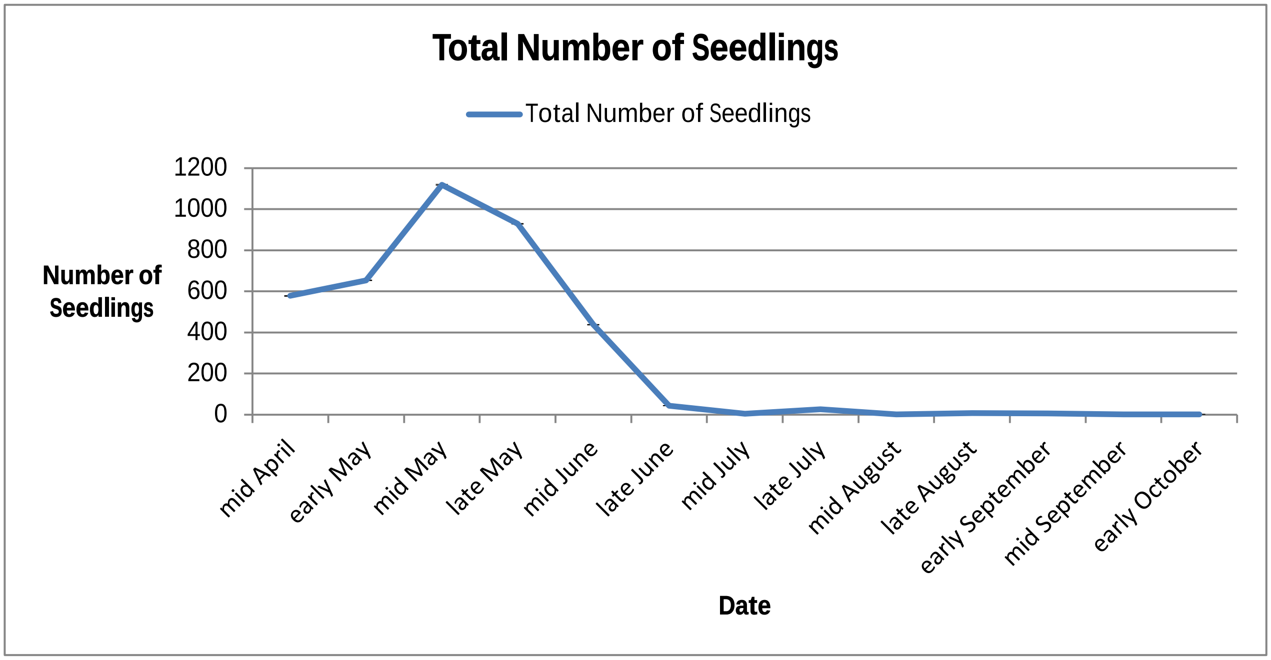

Figure 2. Emergence timing for seedling pokeweed, 2012.

Table 8. Effect of seedling emergence date on number of berry clusters, berries per plant, and seeds per plant after one season's growth, 2012.

Time of emergence	**Number of berry clusters per plant**	**Number of mature berries per plant**	**Approx. number of seeds per plant**
mid April	29	274	2,740
early May	30	203	2,033
mid May	14	194	1,935
late May	10	94	943
mid June	2	0	0
late June	0	0	0
late July	0.3	0	0

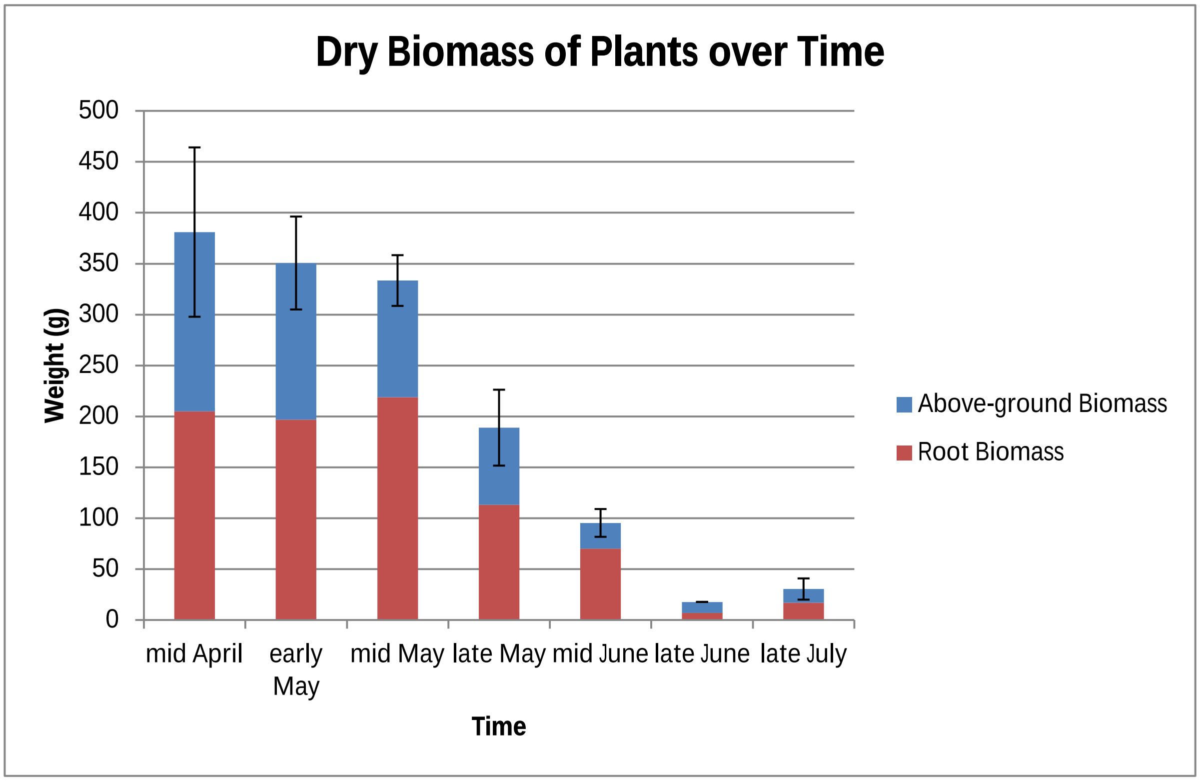

Figure 3. Effect of emergence date on pokeweed biomass after one season's growth, 2012.

Figure 4. A comparison of roots from the earliest emerged seedling (mid April) on the left, and the latest emerged seedling (late July) on the right, 2012.

Mechanical Disturbance - Mowing

During the summer of 2012, individual pokeweed plants were subjected to a mowing regime to evaluate a potential mechanical control tactic. Plants were mowed zero to three times over three months (July through September). At each mowing time, heights of the plants were recorded. On October 9, approximately one month after the last mowing, all plants were harvested for fresh and dry weights. Percent biomass reductions were calculated based on weight differences between untreated and treated plants. The greatest reduction in biomass was seen at later mowing times, regardless of the previous number of mowings (Table 9). Plant regrowth will be assessed in 2013.

Table 9. Effect of mowing timings on pokeweed height and regrowth.

Treatment	**Height (in)**	**% Biomass reduction**
Untreated	57	0
J	45	21
A	5	92
S	0	100
J, A	10	82
J, A, S	12	79
J, S	0.1	100

*J = July, A = August, S = September