

KNOWING WHEN TO LOOK FOR WHAT: WEED EMERGENCE AND FLOWERING SEQUENCES IN WISCONSIN

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Knowing the sequence of weed emergence is useful weed management information. It can help producers and ag professionals estimate when certain weeds may appear, particularly after the early emerging species arrive. Such weed emergence sequences have been reported for primarily annual species by several Midwestern states. Many of you have seen the Iowa State (2000) flyer that presents the emergence sequence of 16 common annual weeds for the upper Midwest. An earlier extension bulletin from Iowa State (Buhler et al. 1997) reported on the emergence patterns of 35 annual and 13 perennial weed species

What has not been done routinely is to monitor the time when perennial and biennial species begin to regrow in the spring. Nor has information on the flowering sequence of a wide array of species at one location been observed and reported. Flowering information for perennial species is important to be able to synchronize tillage, cultivation and systemic herbicide application with the onset of flowering for maximum effectiveness. It is important information for both biennials and perennials in pastures, roadsides, CRP fields and other non-disturbed sites that will be mowed so that this operation is done before weeds produce viable seeds (usually 10 to 15 days after pollination). This paper provides information on the emergence and flowering times and sequences of 82 weed species in a range of life cycles for a three-year period in southern Wisconsin.

Methods

From 1998 to 2000, we monitored and recorded the sequence of emergence and flowering of annual, biennial and perennial species in the Wisconsin Weed Garden at the Arlington Agricultural Research Station. The Garden was established at its present location in 1995 and contains self-perpetuating populations of more than 100 weeds common in Wisconsin fields and other habitats (gardens, roadsides, fence rows, etc.). Biennial and perennial species were considered as “growing” when 2 inches of new growth was present. The date of annual broadleaf emergence was recorded when they reached the cotyledon stage; annual grasses were considered as emerged when they were 0.5 inch tall. Dates of emergence for annuals are only of the first cohort as subsequent germination events were not recorded. We continued observing each species once or twice weekly until all reached anthesis (pollen production).

Data were summarized for the three years and analyzed in several ways. First, we placed the species into seven emergence and flowering groups. We did this because Iowa State used seven groups to report their emergence observations (Iowa State University, 1997). For weed emergence, the seven groups fell into 10-day intervals from March 20 to May 31; for the start of flowering, the species fell into seven groups using a 20-day interval, from April 20 to September 20. The exact dates for each grouping system are found in Table 1.

Table 1. The dates of the intervals used to categorize weed emergence and flowering into seven groups.

Group	Emergence Dates	Flowering Dates
1	Mar. 20-31	Apr. 20-May 10
2	Apr. 1-10	May 11-31
3	Apr. 11-20	June 1-20
4	Apr. 21-30	June 21-July 10
5	May 1-10	July 11-31

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6 May 11-20
7 May 21-31

Aug. 1-20
Aug. 21-Sept. 20

I also calculated the variation in emergence and flowering times over the three years to determine how consistent or variable weeds were in this regard. These data and that of emergence and flowering times were assessed for each of four plant groups: perennials, biennials, annual grasses and annual dicots.

Results

The three-year average of the growth/emergence data found that among the 28 perennial species, quackgrass (Mar. 23), leafy spurge (Mar. 24), dandelion (Mar. 29) and white cockle (Mar. 30) resumed growth the earliest (Table 2). Yellow nutsedge (May 12) and horsenettle (May 26) were the last perennials to appear. Four perennials emerged early April; five in mid-April and seven in late April. Purple loosestrife, hedge bindweed, common milkweed, smooth groundcherry and wild four o'clock appeared in early May. The time interval between the appearance of the first and last perennial weed was 64 days.

In sharp contrast, all six biennial species resumed growth between April 2 and 7, a spread of only six days. This has several explanations. First, compared to the perennials, there were relatively few biennials in the Weed Garden. There may well be biennials that resume growth earlier or later than those observed. Also, five of the six biennials are in one plant family (Asteraceae) while the perennials are from 17 different plant families. Morphologically, biennial plants are similar in that growth resumes from the crown which is at the soil surface. In contrast, perennials regrow from buds on the roots, rhizomes or tubers, or from crown buds. These structures may be at different depths and may also have different heat unit requirements for resuming growth between species.

Downy brome is a winter annual grass species. Seeds of this weed germinated the previous summer and plants resumed growth on Mar. 26. Among the 13 summer annual grasses, giant foxtail emerged first (Apr. 27) and stinkgrass last (May 28), a spread of 32 days. Woolly cupgrass emerged at the same time as yellow foxtail (Apr. 30). The three panicum species (fall panicum, witchgrass and wild proso millet) essentially emerged at the

Table 2. Emergence dates, flowering dates, and days from emergence to flowering for 82 weed species in the Wisconsin Weed Garden for 1998, 1999 and 2000.

28 Perennial Species	Emergence dates, range and group			Flowering dates, range and group			Time emer-flower (days)
	Date	Range (days)	group	Date	Range (days)	group	
Blackseed plantain	Apr. 6	5	2	June 30	2	4	85
Canada thistle	Apr. 16	15	3	June 24	4	4	69
Chicory	Apr. 7	2	2	June 26	5	4	80
Comfrey	Apr. 17	6	3	May 22	6	2	35
Curly dock	Apr. 10	24	2	June 9	17	3	60
Dandelion	Mar. 29	6	1	Apr. 29	6	1	31
Field bindweed	Apr. 26	4	4	June 25	21	4	50
Field Horsetail	Apr. 28	7	4	--	--	--	--
Giant chickweed	Apr. 12	3*	3	June 12	19	3	61
Grey goldenrod	Apr. 10	5	2	Aug. 18	12	6	130

Hedge bindweed	May 6	12	5	June 22	--	4	47
Hemp dogbane	Apr. 28	1	4	June 18	7	3	50
Hoary alyssum	Apr. 2	3*	2	June 2	2*	3	61
Horsenettle	May 26	23	7	June 28	13	4	33
Jerusalem artichoke	Apr. 28	17	4	Sept. 20	16	7	144
Leafy spurge	Mar. 24	25	1	May 16	8	2	53
Milkweed	May 6	5	5	June 26	5	4	52
Perennial sowthistle	Apr. 30	21	4	July 10	10	4	71
Purple loosestrife	May 1	2	5	June 24	10	4	54
Quackgrass	Mar. 23	24	1	June 13	16	3	82
Smooth groundcherry	May 6	4	5	July 1	9	4	56
Stinging nettle	Mar. 30	13	1	June 22	1	4	84
Swamp smartweed	Apr. 26	11	4	July 29	13	5	94
White cockle	Mar. 30	12	1	May 25	8	2	56
Wild 4 o'clock	May 8	5	5	June 9	10	3	32
Wirestem muhly	Apr. 22	11	4	Aug. 10	10	6	110
Yellow nutsedge	May 12	3	6	July 9	15	4	58
Yellow rocket	Apr. 2	12	2	May 8	4	1	36

6 Biennial Species	Emergence dates, range and group			Flowering dates, range and group			Time emer-flower
	Date	Range (days)	group	Date	Range (days)	group	(days)
Bull thistle	Apr. 5	24	2	Aug. 1	11	6	118
Burdock	Apr. 4	15*	2	July 15	--	5	102
Musk thistle	Apr. 2	25	2	June 16	10	3	75
Plumeless thistle	Apr. 7	7	2	June 25	15	4	79
Spotted knapweed	Apr. 2	11	2	July 12	12	5	101
Wild Carrot	Apr. 7	12	2	June 26	7	4	80

14 Annual Grass Species

Barnyardgrass	May 3	8	5	July 12	32	5	60
Downy brome	Mar. 26	5	1	May 19	2	2	54
Fall panicum	May 5	6	5	Aug. 6	3	6	93
Giant foxtail	Apr. 27	2	4	Aug. 3	7	6	98
Green foxtail	May 3	3	5	July 12	17	5	70
Large crabgrass	May 14	9	6	July 21	27	5	68
Sandbur	May 12	12	6	July 29	26	5	78
Shattercane	May 13	10*	6	July 29	5*	5	77
Smooth crabgrass	May 16	4	6	July 28	23	5	72
Stinkgrass	May 28	4	7	July 10	11	4	43
Wild proso millet	May 7	4	5	July 3	13	4	57
Witchgrass	May 5	13	5	Aug. 10	12	6	97
Woolly cupgrass	Apr. 30	6	4	Aug. 2	17	6	94
Yellow foxtail	Apr. 30	7	4	July 15	18	5	76

34 Annual Broadleaf Species

Buffalobur	May 10	15	5	June 30	22	4	51
Bur cucumber	Apr. 29	5	4	Aug. 14	3	6	107
Carpetweed	May 26	30	7	June 20	23	3	25
Catchweed bedstraw	Mar. 31	10	1	May 14	5	2	44

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34 Annual Broadleaf Species	Emergence dates, range and group			Flowering dates, range and group			Time emer-flower
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	Date	Range (days)	group	Date	Range (days)	group	(days)
Cocklebur	May 3	4	5	Aug. 24	3	7	113
Common mallow	Apr. 23	8	4	June 28	4*	4	66
Common ragweed	Apr. 2	17	2	Aug. 19	11	6	139
Corn spurry	Apr. 18	15	3	June 3	9	3	46
E. black nightshade	Apr. 30	16	4	July 8	19	4	73
Erect knotweed	Mar. 27	23	1	June 28	25	4	93
Flixweed	Mar. 30	4*	1	May 28	10	2	59
Galinsoga	May 2	4	5	June 16	6	3	45
Giant ragweed	Apr. 2	17	2	Aug. 8	28	6	128
Hairy nightshade	May 1	3	5	June 21	16	4	51
Henbit	Apr. 3	14	2	May 9	19	1	36
Jimsonweed	May 2	4	5	June 25	8	4	54
Kochia	Mar. 25	25	1	July 13	16	5	109
Lady's thumb smtwd	Apr. 22	9	4	June 18	7	3	57
Lambsquarters	Apr. 8	21	2	June 28	17	4	81
Pennsylvania smtwd	Apr. 16	19	3	June 29	25	4	66
Pennycress	Mar. 31	12	1	Apr. 30	10	1	30
Prostrate knotweed	Mar. 23	32	1	July 4	7	4	103
Prostrate pigweed	May 1	5	5	July 4	28	4	64
Purslane	May 25	26	7	July 21	11	5	57
Redroot pigweed	May 9	2	5	July 5	15	4	57
Shepherd's purse	Mar. 31	38	1	Apr. 24	21	1	24
Smooth pigweed	May 3	6	5	June 20	20	3	48
Velvetleaf	Apr. 28	5	4	July 23	14*	5	85
Venice mallow	May 3	16	5	July 6	16	4	64
Waterhemp	May 5	1	5	July 25	16	5	85
Wild buckwheat	Mar. 31	27	1	June 24	9	4	85
Wild cucumber	Apr. 16	10	3	July 15	2*	5	90
Wild mustard	Apr. 2	16	2	May 25	4	2	53
Wild radish	Apr. 12	18	3	May 31	6	2	50

* this range includes only two years of observations

same time (May 5 to 7). It was surprising to see fall panicum emerge this early and this is in contrast to the observation in Iowa where this species emerged considerably later than the foxtails, woolly cupgrass and wild proso millet. Sandbur, shattercane and both crabgrass species germinated in mid-May.

The 34 annual broadleaf weeds emerged over a 64-day interval: the exact period and dates (Mar. 23 to May 26) as observed for the perennials. From Mar. 23 to Mar. 31, prostrate knotweed, kochia, erect knotweed, flixweed, catchweed bedstraw, pennycress, shepherd's purse and wild buckwheat emerged. Three of these species are in the buckwheat family and three are mustards. Common ragweed, giant ragweed, wild mustard, henbit and lambsquarters appeared in early April. Wild radish, Pennsylvania smartweed, wild cucumber, corn spurry, ladythumb smartweed, common mallow, velvetleaf, bur cucumber and eastern black nightshade emerged in mid to late April. From May 2 to 10, jimsonweed, cocklebur, smooth pigweed, venice mallow, waterhemp, redroot pigweed and buffalobur emerged. The last annual species to appear was carpetweed.

The time between new growth initiation and flowering for perennials varied from 31 days for dandelion to 144 days for Jerusalem artichoke: a range of 113 days (Table 2). Horsenettle was the last perennial to appear (May 26) but flowered in 33 days (June 28). Yellow nutsedge flowered 58 days after resuming growth, quackgrass in 82 days and wirestem muhly in 110 days. Many perennial broadleaves flowered 45 to 70 days after resuming growth. As expected, Cruciferae species flowered in comparatively short times. The range of flowering times for biennials was 43 days (musk thistle 75 days and bull thistle 118 days). For annual grasses the range was 55 days (43 days for stinkgrass, the latest emerging annual grass, and 98 for giant foxtail, the earliest emerging annual grass). The range for annual broadleaves was 115 days (24 days for shepherd's purse and 139 for common ragweed). Kochia emerged first but took more than 100 days to flower.

When the species are examined by emergence group (as defined in Table 1), we see that 17 to 24% of the weeds emerged in groups 1, 2, 4 and 5, with less than 10% emerging in groups 3, 6 and 7 (Table 3). A similar assessment of flowering times finds nearly a normal distribution (bell-shaped curve) with most species (36%) flowering in group 4 (June 21 to July 10).

Table 3. Percentage of 82 weed species in each emergence and flowering group.

Group	Emergence	Flowering
	-----%-----	
1	17	6
2	21	10
3	9	15
4	18	36
5	24	19
6	6	12
7	5	3

* See Table 1 for dates of each emergence and flowering group.

Further analysis of the emergence and flowering groups by life cycle reveals some interesting observations. Perennials and annual broadleaf weeds were present in all seven emergence categories and averaged group 3.3 and 3.6, respectively (Table 4). The same is true for the flowering groups and here too, the average flowering group for the perennials and annual dicots is almost identical (3.6 and 3.8, respectively). These were the two life cycles with the most species so perhaps this accounts for their representation in all seven categories. All the biennial species renewed their growth in group 2 but flowered over a range from group 3 to group 6. Interestingly, on average the annual grasses were in group 4.9 for both emergence and flowering. If we exclude the winter annual grass downy brome, the range for emergence and flowering for annual grass species was relatively small.

Table 4. Mean and range of group values for emergence and flowering and by life cycles of the 82 weed

species.

	Perennials mean range		Biennials mean range		Annual grasses mean range		Annual dicots mean range	
	-----group number-----							
Emergence	3.3	1-7	2.0	2	4.9	4-7*	3.6	1-7
Flowering	3.6	1-7	4.5	3-6	4.9	2-6*	3.8	1-7

* Excluding downy brome, range is 4-7 for emergence groups and 4-6 for flowering groups.

It's one thing to know the average dates of weed emergence and flowering but how consistent are these events from year to year? Naturally there will be some variation because the weather is the primary driver of these events and weather is variable. Table 2 gives the range of variation in emergence and flowering over the three-year period for each species. Table 5 summarizes this information by life cycle. On average, annual grasses had the least variation in emergence (6.6 days) of all life cycles but had the greatest variation in flowering times (15.2 days). I see no rationale for this observation. The perennials and annual dicots had similar ranges for the variation in emergence and flowering while the biennials varied more in emergence than flowering times over the three years. A more thorough analysis of the data is needed to see how the emergence and flowering patterns correlate to growing degree days and other environmental parameters.

Table 5. Mean and range in the maximum days of variation in emergence and flowering times between 1998, 1999 and 2000 by life cycles for the 82 weed species.

	Perennials mean range		Biennials mean range		Annual grasses mean range		Annual dicots mean range	
	----- days -----							
Emergence	10.0	3-25	15.7	7-25	6.6	2-13	14.9	1-38
Flowering	9.6	2-21	11.0	7-15	15.2	2-32	14.2	2-28

Interesting Observations

- Species in some families grow and/or emerge similarly (Cruciferae, Chenopodiaceae, Amaranthaceae); some don't (Asteraceae, Poaceae, Polygonaceae, Solanaceae).
- Some close relatives emerge differently: wild cucumber 13 days before bur cucumber.
- Some close relatives emerge similarly: eastern black nightshade and hairy (1 day); common and giant ragweed same day.
- Some close relatives flower differently: musk thistle flowered 9 days before plumeless; plumeless thistle flowered 20 days before bull thistle.
- Fall panicum and witchgrass emerge in the middle the annual grasses but flower later than the rest.
- Woolly cupgrass and giant foxtail are early emerging annual grasses but are the last to flower.
- Giant foxtail was the first annual grass to emerge; stinkgrass the last. Stinkgrass flowered in the least

time (43 days) and giant foxtail took the most (98 days).

- Milky-sapped perennials flower in ~ 50 days; common milkweed 52 days; hemp dogbane 50 days; leafy spurge 53 days.
- Horsenettle was the last weed to appear (May 26) but flowered quickly (33 days).
- Jerusalem artichoke is a short day plant; flowered on Sept. 20, 144 days after emergence.
- Annual dicots broke into two distinct groups regarding variation in emergence dates over years: those in groups 1-3 averaged 20.8 days variation; those in groups 4-7 averaged 9.5 days variation.

References

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