Plant Phenology as a Guide in Timing Grasshopper Control Efforts on Montana Rangeland

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Abstract

The flowering of 28 forb species at two locations was correlated with grasshopper development in 1977 and 1978. Indicator plants whose flowering phenology was associated with grasshopper hatching included: *Zygadenus elegans, Allium textile, Delphinium bicolor, Oxytropis sericea, Erysimum asperum, Leucocrinum montanum,* and *Astragalus gilviflorus.* The ideal time for controlling grasshoppers (when most of the population is in the 3rd instar) was associated with the flowering phenology of the following indicator plants: *Yucca glauca, Helinathus petiolaris, Opuntia polyacantha, Sphaeralcea coccinea, Antennaria dimorpha, Tragopogon dubius, Cryptanthe celosioides, Allium textile, Delphinum bicolor, Zygadenus elegans,* and *Erysimum asperum.*

Plant growth and development on the northern Great Plains is governed by environmental variables such as soil temperature, air temperature (heat accumulation), soil fertility, soil moisture, and photoperiod. In addition, site characteristics, such as slope and exposure, may affect growth and time of flowering of some species of prairie plants. Grasshopper hatching and development too are regulated to a large extent by environmental factors. Thus soil temperature and moisture appear to influence grasshopper hatching; air temperature (heat accumulation) has great influence on the rate of grasshopper development (Hewitt 1978, Parker 1930); cool rainy weather prolongs grasshopper development; and hot dry weather causes a reduction in duration of nymphal stages. Thus both plant and grasshopper phenology are regulated to a large degree by seasonal weather patterns in the grasshopper ecosystem. Phenological observations have been applied to agriculture for a variety of purposes (Hyder and Sneva 1955; Caprio 1966): to aid in selecting crops for specific locations, to determine the best time to spray herbicides on big sagebrush *(Artemisia tridentata)*, to determine when alfalfa should be cut for control of the alfalfa weevil *(Hypera postica)*, and to determine the best time to begin spring grazing on native rangeland.

This paper reports on another use of plant phenology which should benefit both ranchers and land managers within State and Federal Governments who make decisions on the timing of grasshopper control programs. The time of grasshopper hatching and the time when controls should be applied are related to the flowering of common forbs on the mixed prairie of Montana.

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The author wishes to express particular thanks to Dr. John H. Rumely, Montana State University, Bozeman, Montana for identifying many of the plant species listed.

No manuscript received March 20, 1979.

Methods and Procedures

Seven observation sites, numbered 1 through 7, were originally chosen to record plant and grasshopper development; however only two sites, numbers 6 and 7, are reported on since grasshoppers didn't develop in significant numbers on five of the sites. Site #6 (elevation—1,058 m) was located 40 km N. of Billings, Mont. The observation area was about 0.5 ha in size and sloped gently to the east. The most abundant plant species were needleandthread *(Stipa comata)* and western wheatgrass *(Agropyron smithii)*. Site #7 (elevation—1,217 m) was located 3.2 km N. of Reedpoint, Mont. The observation area was about 1 ha in size and sloped westward. This site contained many species of forbs and grasses and no one species appeared to be the most abundant. About 36 air km separated the sites.

Phenological observations were made weekly, or sometimes more often, during the spring and summer months in 1977 and 1978 at each site from April 20 to June 20, 1977 and from April 25 to July 7 in 1978. Plant development was recorded as pre-bloom stage, beginning to bloom, peak bloom, last stages of blooming, and post-bloom stage. The ground was carefully scrutinized for newly hatched grasshoppers and collections were made with a sweep net once hatching was observed. The number of individuals within each instar of each species was recorded. Plant phenology was correlated with grasshopper hatching and with the time when most of the predominant species of grasshopper were in the 3rd instar and hatching was mostly completed, that is, with the time recommended for control.

Results and Discussion

The flowering time was recorded for 28 species of forbs, Table 1, only 10 of which were common to both sites. Some forbs such as *Phlox hoodii, Lomatium* spp., and dandelion (*Taraxacum* spp.) were in bloom in early April before any grasshoppers hatched at either location. However, most of the forbs flowered in May and June during the nymphal period of grasshopper development. Hatching began at both sites on May 8 in 1977 and on May 20 in 1978. When hatching began in 1977, one plant species was in bloom at site A and two at site B. In 1978, four plant species were in bloom at site A when hatching began and 11 at site B.

Fourteen indicator plants, that is, those whose flowering coincides with the time of grasshopper hatching or the recommended time of control, were selected on the basis of three criteria: (1) they were abundant and widespread throughout the mixed prairie of Montana; (2) at least some species were familiar to ranchers, extension personnel, and land managers who make decisions about grasshopper control; and (3) flowering during both years at each site

Table 1. Observations on plant phenology at two sites in central Montana, 1977-1978.[1,2]

Plant species	Site No. 6						Site No. 7					
	1977			1978			1977			1978		
	Beg. bloom	End of bloom	No. of days in bloom	Beg. bloom	End of bloom	No. of days in bloom	Beg. bloom	End of bloom	No. of days in bloom	Beg. bloom	End of bloom	No. of days in bloom
Asteraceae (=Compositae)												
**Antennaria dimorpha* (Nutt.) T.& G.							5/13	—	34 +	5/25	7/3	40
Aster canescens Pursh				6/8	6/17	10						
Erigeron ochroleucus Nutt.							5/20	6/5	17	6/7	—	30
**Helianthus petiolaris* Nutt.	6/4	—	11 +	6/16	—	9 +						
Hymenoxys acaulis (Pursh) Parker										6/8	—	30
Microseris cuspidata (Pursh) Schultz-Bix										5/18	6/8	22
Senecio canus Hook.										6/18	6/27	20
**Tragopogon dubius*	5/28	6/8	12	6/1	6/24	24	6/5	6/11	7	6/1	6/27	27
Boraginaceae												
**Cryptanthe celosioides* (Eastw.) Payson							5/13	6/5	24	5/18	6/27	41
Cactaceae												
**Opuntia polycantha* Haw.	6/4	6/15	12	6/16	—	9 +				6/25	—	13
Cruciferae												
**Erysimum asperum* (Nutt.) DC.	5/4	6/8	36	5/10	6/13	35				5/18	6/8	22
Lesquerella alpina (Nutt.) Wats.										5/18	6/8	22
Sisymbrium altissimum L.				5/18	6/8	22				5/18	5/28	11
Fabaceae (=Leguminosae)												
**Astragalus gilviflorus* Sheld.							5/1	5/6	6	4/29	5/18	20
Astragalus missouriensis Nutt.				5/6	6/16	42				5/18	6/8	22
Oxytropis sericea Nutt.							5/1	5/13	13	5/18	6/8	22
Psoralea esculenta Pursh										6/18	6/16	9
Vicia americana Muhl.										5/28	6/8	12
Liliaceae												
**Allium textile* Nels. & Macbr.										5/14	6/17	35
Calochortus nuttallii Torr.										6/17	7/3	17
**Leucocrinum montanum* Nutt.	4/20	5/6	17	4/29	5/22	24	4/22	5/13	22	4/25	5/21	27
**Yucca glauca* Nutt.	6/4	—	11+	6/24	7/2	9	6/11	6/19	9	6/25	—	13
**Zygadenus elegans* Pursh				5/28	6/9	13	5/10	5/28	19	5/25	6/8	15
Linacea												
Linum perenne L.							6/5	6/11	7	5/28	6/17	21
Malvaceae												
**Sphaeralcea coccinea* (Pursh) Rydb.	5/20	—	27+	6/8	—	17+				6/8	6/27	20
Ranunculacea												
**Delphinium bicolor* Nutt.										5/18	6/27	41
Scrophulariaceae												
Penstemon albidus Nutt.				6/1	6/16	16	6/2	—	13+	6/1	7/3	33
Violaceae												
Viola nuttallii Pursh							5/1	5/6	6	4/29	5/28	30

[1]A + indicates plant was in bloom when last observation was made.

[2]An * indicates an indicator species.

correlated with hatching or control time. Seven of the indicator plants were common to both sites.

Indicator plants associated with hatching were:

1. Mountain death camas *(Zygadenus elegans).* This plant was in full bud, but flowers were not yet visible.
2. Onion *(Allium textile)* and low larkspur *(Delphinium bicolor).* These plants were just beginning to bloom.
3. White pointloco *(Oxytropis sericea)* and plains wallflower *(Erysimum asperum).* These plants were in peak bloom.
4. Mountain star lily *(Leucocrinum montanum)* and threeleaved milkvetch *(Astragalus gilviflorus).* These plants were in the last stages of bloom.

Economically damaging grasshopper populations should be controlled before many of the insects develop beyond the 3rd instar because the last two nymphal instars (4th and 5th) and the adult stage cause the most forage loss. On that basis, the ideal time to apply control was estimated as June 1 at site A and June 7 at site B in 1977 and June 20 at both sites in 1978 (Fig. 1). (On these dates most grasshoppers were in the 3rd instar.) The reason for the late date in 1978 at site B was the late hatching of *Melanoplus* ssp. and *Ageneotettix deorum.* The ideal control time may be difficult to determine in some years because of extended hatching that results from local weather patterns.

Indicator plants associated with the ideal time for control were:

1. Yucca *(Yucca glauca).* This plant was in the pre-bloom stage.
2. Prairie sunflower *(Helianthus petiolaris)* and plains pricklypear *(Opuntia polyacantha).* These plants were just beginning to bloom.
3. Scarlet globemallow *(Sphaeralcea coccinea),* low pussytoes *(Antennaria dimorpha),* and salsify *(Tragopogon dubius).* These plants were in peak bloom.
4. Miners candle *(Cryptanthe celosioides),* onion, and low larkspur. These plants were in the last stages of bloom.
5. Mountain death camas and plains wallflower. These were mostly through flowering.

The flowering of the indicator plants should be useful in estimating the best time to control grasshoppers because many people overlook young nymphal grasshoppers. As a reuslt, considerable damage can take place before arrangements for control are made. However, different people might observe and record plant flowering differently. Also flowering dates might vary for the same species if many plants (with greater genetic variability) are observed at one site and only a few plants are present at another site. Too, plants on a north facing slope may flower later than those on an east facing slope (Jackson 1966), and some plants show greater variability in the time of flowering and may be governed by length of daylight (Leopold and Jones 1947). Nevertheless, the indicator plants selected in this study appeared to be fairly consistent in their flowering times at both locations during both years. Therefore, one plant or a

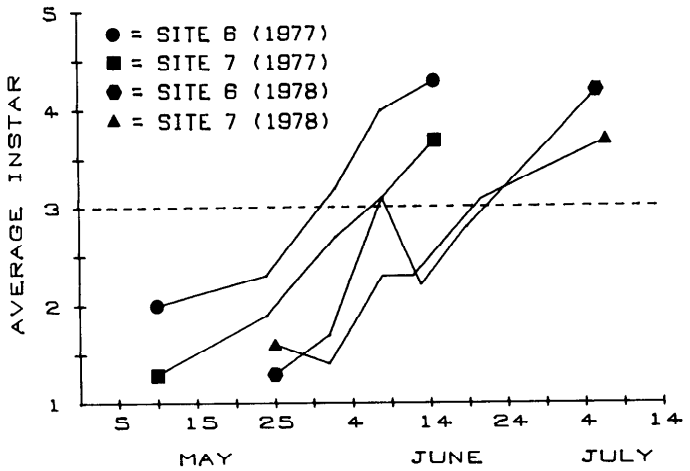

Fig. 1. *Seasonal development, showing ideal control times, of spring-hatching rangeland grasshopper species at two locations, 1977-1978.*

combination of plants could be used to determine the best time for control, depending on the expertise of the landowner or agency personnel in identifying plants. Possibly these and/or other plant species might be useful as indicator plants on different types of rangeland in other areas of the western United States.

It should be pointed out that from the economic point of view, and considering the objectives of those who control grasshoppers (USDA, Animal Plant Health Inspection Service) on large acreages, it is most desirable to control all the grasshoppers in one area at the same time. In the Mountains where elevations and exposure to sunlight and moisture vary, grasshoppers are not likely to reach the 3rd instar stage at the same time. The practical solution to this problem is to wait until all the grasshoppers have hatched, but control them before they lay eggs. In this situation the 3rd instar stage would not be the major guideline to dictate timing of control and major forage losses could occur before control takes place. This means that using indicator plants and grasshopper stage of development as control guidelines will probably be more effective on level lands with homogeneous climatological and weather conditions.

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