Proactive Management of Pestiferous Grasshopper Habitat

Llewellyn L. Manske PhD
Research Professor of Range Science
North Dakota State University
Dickinson Research Extension Center
Report DREC 14-3065

Large scale grasshopper outbreaks extending throughout the western portion of North America occurred during the 1930's and 1980's and smaller scale regional outbreaks have occurred almost every year someplace in the Northern Plains. It is realistic to predict that grasshopper outbreaks will occur in the near future someplace in the Northern Plains.

Grasshoppers are a natural component of native rangelands and domesticated grasslands of the Northern Plains. Grasshopper population densities ordinarily remain at levels that can be supported by the resources of the ecosystem. All of the pestiferous rangeland grasshopper species of the Northern Plains remain year after year on the land where they hatch. At low densities, grasshoppers are not a problem. However, when favorable conditions decrease mortality rates, increase available food plants, and/or increase access to direct sunlight, pestiferous rangeland grasshopper populations can increase to problem densities.

Pestiferous rangeland grasshopper population densities are regulated by the mortality rates caused by natural enemies, by the availability of nutritious food plants, and by the level of access to direct sunlight throughout the day. Grasshoppers living on rangelands of the Northern Plains have adequate nutritious food plants available even during dry growing seasons but are limited by restricted access to direct sunlight except during growing seasons with high water deficiencies or drought conditions or on heavily grazed, poorly managed, or double used grazinglands with considerable bareground areas and reduced grass plant stature. Beef producers that use the old traditional range management concepts to manage the aboveground perennial grass resources for a single primary use as forage for livestock cause spiraling degradation of the ecosystem that results in reduced grass plant density, increased size and number of bareground areas, and decreased grass herbage biomass production creating habitat favorable for pestiferous grasshoppers. Land managers create their own grasshopper problems with poor land management practices.

On traditionally managed grazinglands in the Northern Plains, grasshopper populations tend to reach high outbreak densities when plant canopy height and ground cover are reduced and herbage production is low. These conditions occur as a result of grazing-management-caused problems or during years with hot temperatures and low precipitation (Onsager 1996, 2000). The grasshopper population outbreaks can occur as the outward expansion of a “hot spot” or as an escalation of low to high numbers across an area (Lockwood, Brewer, and Schell 1996).

Grazing management strategies that repeatedly remove most of the vegetation on grasslands reduce plant density and herbage biomass production. Areas with open vegetation canopy and spots of bare ground are favorable grasshopper habitat. With reduced vegetation canopy cover and enlarged areas of bare ground, the amount of solar radiation that reaches the soil surface increases, as does the airflow over the ground. The reduced vegetation structure results in higher air and soil temperatures and lower humidity in grasshopper habitat.

Grassland habitat with open vegetation canopy and areas of bare ground provides ideal basking sites, where grasshoppers warm themselves in the early morning sun to speed metabolic rates and increase growth rates (Belovsky et al. 2000). Patches of bare ground also are favored egg-laying sites. Higher soil and air temperatures accelerate grasshopper egg development, growth and maturation of young insects, and egg production of adult females. In addition, habitat with intense sunlight and low humidity near the soil discourages the growth of important pathogens that cause grasshopper diseases. As a result, mortality rates of immature grasshoppers decline and greater numbers of the insects survive into adulthood.

Many traditional management practices produce habitat favorable for grasshopper population outbreaks. Common practices that help grasshopper populations increase to problem levels include beginning grazing before plants have reached the third-leaf stage; grazing spring and summer pastures or haylands during the fall; and management treatments such as seasonlong, deferred, and repeat seasonal grazing that leave little residual vegetation following defoliation periods.

Proactive management of grasshopper habitat must reduce the grasshoppers strengths and exploit the grasshoppers weaknesses. Grasshoppers have a major survival strength that relegates proactive management of grasshopper habitat to a neverending annual challenge. Grasshoppers have high fecundity potential, each adult female can produce 100 to 200 viable eggs. Because of this remarkable inherent ability, grasshoppers can increase the population density multifold from one growing season to the next. A one year lapse in land management diligence can lead to a major grasshopper outbreak.

Fortunately, grasshoppers have two major weaknesses that render grasshopper population numbers vulnerable to proactive management of the residuum vegetation structure of their habitat. The first weakness is that grasshoppers are cold blooded and are unable to regulate their body temperature metabolically. Grasshoppers need to bask on open bareground areas to collect direct incident solar radiation to raise their body temperatures to the preferred optimal high levels above 95° F (35° C). When grasshoppers can not achieve the optimal body temperature during most of the day, their growth and development rates slow, the length of time nymphs are at each instar stage increases, nymph mortality increases, the number of nymphs reaching the adult stage decreases, maturation time after adults fledge increases, the quantity of viable eggs produced by each adult female greatly decreases, and the resident grasshopper population remains low.

The second vulnerable weakness is that grasshopper eggs require a total of 500 to 600 DD day-degrees of heat from direct incident solar radiation for complete development of the embryo; this includes about 400 DD of heat during the first summer and an additional 150 DD of heat during the following spring to complete embryonic development and hatching. All except one of the pestiferous rangeland grasshoppers deposit their egg pods below the soil surface in bareground patches. Bareground egg pod sites accumulate heat units rapidly and increase the rates of embryonic development. Shading of the soil surface at the egg laying sites from grass canopy cover reduces the quantity of incident solar radiation that decreases the accumulation of heat units, reduces the rate of embryo development delaying egg hatch, and reduces the number of hatchlings produced.

A joint research project was conducted in western North Dakota by Dr. Lee Manske, NDSU, Dickinson Research Extension Center, Dickinson, ND, and Dr. Jerry Onsager, retired research entomologist, USDA-Agricultural Research Service, Sidney, MT, to evaluate and compare the grassland habitat conditions and grasshopper population numbers on a seasonlong grazing treatment and a twice-over rotation treatment (Manske and Onsager 1996, Stelljes 1996).

The twice-over rotation grazing treatment had denser basal cover, less bare ground, and greater herbage biomass than the seasonlong treatment. The grass basal cover on the twice-over rotation treatment was 25.2% greater than that on the seasonlong treatment (Manske 1995, 1996). The average percent of ground not covered by vegetation was lowest on the twice-over rotation treatment, followed by the seasonlong treatment, and greatest on the nongrazed treatment. The twice-over rotation treatment had 31% less open area in the vegetation canopy than the seasonlong treatment (Manske 1995). Herbage production was greater on the twice-over rotation treatment than on the seasonlong treatment. The twice-over rotation treatment produced an average of 33% to 45% more herbage during each growing-season month than did the seasonlong treatment (Manske 1995, 1996).

Onsager (2000) followed grasshopper numbers for five growing seasons on native rangeland areas managed with a seasonlong treatment or the twice-over rotation treatment. The average number of grasshopper days per square meter was 748 on the seasonlong treatment, considerably greater than the average of 229 on the twice-over rotation treatment. During the last two years of the study, a local grasshopper outbreak (figure 1) with an average density of 22.6 adult grasshoppers per square meter occurred on the seasonlong treatment. This population outbreak did not occur on the twice-over rotation treatment, which maintained an average of only 3.9 adult grasshoppers per square meter.

The seasonlong treatment decreased the vegetation cover and promoted grasshopper population increases. The twice-over rotation treatment enhanced the vegetation cover and suppressed grasshopper population increases.

Rangelands are complex ecosystems consisting of numerous interactive biotic (living) and abiotic (nonliving) components. The biotic components are the plants, soil microorganisms, and large grazing graminivores that have biological and physiological requirements. The abiotic components include the major and minor essential elements that have transformable characteristics between organic and inorganic forms. The major essential elements are carbon, hydrogen, nitrogen, and oxygen and the minor essential elements consist of seven macrominerals and ten microminerals. The abiotic components also include radiant energy from the sun. Numerous biological, geological, chemical, and atmospheric pathways transfer the major essential elements into and out of an ecosystem and numerous pathways transfer the minor essential elements out of an ecosystem. Rangeland ecosystems are functioning units of coacting biotic organisms interacting with the abiotic components and the environment. The complex of mechanisms and processes connected with these extensive interactions are the defoliation resistance mechanisms within and around grass plants and the biogeochemical processes within an ecosystem.

Grass plants, soil microorganisms, and large grazing graminivores coevolved and develop extensive interactions that permit grassland ecosystems to function effectively. The defoliation resistance mechanisms that developed within grass plants provide important biological and physiological processes so grass plants can produce greater herbage biomass that replaces lost leaf material, restore disrupted vital processes, and vegetatively reproduce secondary tillers from axillary buds that increase grass tiller density and reduce bareground areas. The soil microorganisms in the rhizosphere and the biogeochemical processes cycle large quantities of plant available essential elements between the organic and inorganic forms. Activation of the defoliation resistance mechanisms and the biogeochemical processes requires partial defoliation by grazing that removes about 25% to 33% of the aboveground leaf material of grass lead tillers between the 3.5 new leaf stage and the flower stage and results in greatly increased ecosystem productivity that is favorable for livestock production. Proactive management of the residuum vegetation structure of grasshopper habitat uses the ecosystem mechanisms and processes to increase aboveground herbage biomass, increase grass plant basal cover, and decrease bareground area creating habitat conditions unfavorable for pest grasshopper production.

The twice-over rotation system is effective in grasshopper management because the grazing treatment properly times defoliation to lead to greater plant density and herbage production and fewer open areas in the vegetation canopy cover. These plant community characteristics develop because the biologically effective twice-over rotation system coordinates grazing with grass growth stages and removes a small amount of leaf material from grass plants between the 3.5 new leaf stage and the flower stage. This timed defoliation stimulates plant processes and soil organism activity that enhance plant growth, and the resulting greater herbage biomass production leads to grassland habitat conditions unfavorable for grasshopper population increases.

Areas with habitat unfavorable to grasshoppers are those on which plant density is increased so that only a few small spots of bare ground occur and on which adequate herbage biomass remains after grazing periods so that the vegetation canopy is nearly closed. The improvement in the vegetation characteristics of rangeland managed with the twice-over rotation system reduces the amount of sunlight reaching the ground, increases the humidity, and lowers the temperature within the grasshopper habitat. In these grassland habitat conditions, grasshopper metabolic rates and growth rates slow and disease increases mortality rates among grasshoppers. These changes negatively affect the growth and survival of immature grasshoppers in the nymphal stages and result in reduced grasshopper numbers and in suppression of local grasshopper population outbreaks (Onsager 2000).

Producers can suppress potential grasshopper population outbreaks by implementing biologically effective grazing management that minimizes habitat favorable to the insects. Three management practices can be used to develop grassland habitat unfavorable for grasshopper outbreaks: (1) delaying the start of grazing until grasses have reached the 3.5 new leaf stage (early May for crested wheatgrass and smooth bromegrass and early June for native rangeland), (2) grazing native rangeland with a twice-over rotation management system that coordinates rotation dates with plant growth stages, and (3) grazing complementary forage types during the fall rather than grazing spring and summer pastures or haylands late in the season.

Implementing improved cultural management practices is not a quick fix to a major problem. Grazing management strategies that produce habitat unfavorable for grasshopper population outbreaks are a long-term solution to grasshopper problems and take three or more years to show substantial results. Pastures that are grazed using traditional management practices and that have had problems with increased grasshopper numbers need a change of management treatments to biologically effective grazing management practices that stimulate plant mechanisms and ecosystem processes to increase plant density and vegetation canopy.

The twice-over rotation system is a biologically effective grazing management treatment that has the three attributes needed to deter grasshopper outbreaks in the Northern Plains. The twice-over rotation grazing system: (1) deliberately varies the time and intensity of defoliation from year to year, (2) controllably enhances vegetation shading canopy during critical portions of grasshopper life cycles, and (3) reduces and almost eliminates bare soil areas.

Pestiferous rangeland grasshopper population numbers in the Northern Plains can be held at tolerable low densities by proactive management of the grasshopper habitat by using the recently discovered grasshopper biology and population dynamics and the technologies for activation of the defoliation resistance mechanisms and the biogeochemical processes.

Acknowledgment

I am grateful to Sheri Schneider for assistance in production of this manuscript.

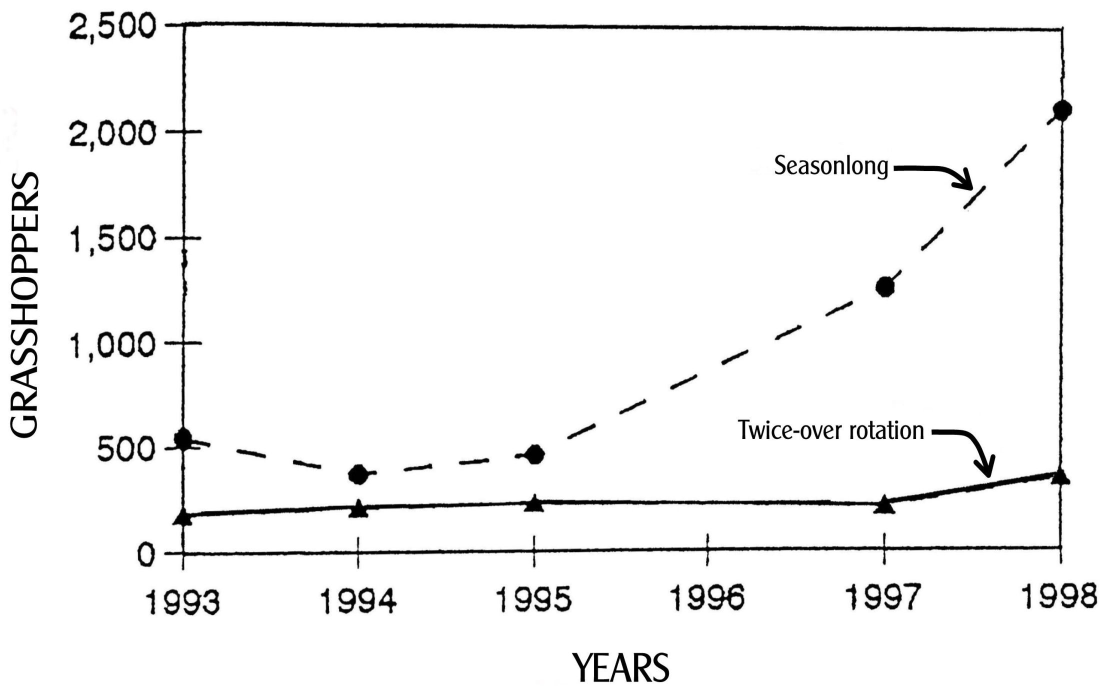

Fig. 1. Grasshopper population outbreak occurring on the seasonlong treatment during 1997 and 1998 but not occurring on the twice-over rotation treatment. Grasshopper abundance reported as grasshopper days per square meter, data from Onsager 2000.

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