Grasshopper IPM Program: A Retrospective

Grasshopper populations increased during the 1930's to devastating numbers that infested millions of acres of federal and private lands in 17 western states. The grasshopper outbreaks overwhelmed local control efforts. The United States Congress charged the United States Department of Agriculture in 1934 with the control of grasshoppers on federal land. With authorization from several congressional acts, grasshopper control on federal lands and leadership of large scale regional grasshopper control programs became one of the duties of the USDA Animal and Plant Health Inspection Services (APHIS) (Foster 1996a).

Cooperative control programs for rangeland grasshoppers were undertaken by APHIS during almost every proceeding year in affected parts of the Great Plains and Intermountain West. The standard pest control treatment used was liquid insecticide chemicals. Grasshopper populations increased to devastating numbers again during the 1980's that heavily infested 55 million acres of land in western United States. Following standard pest control treatment guidelines was continued and liquid insecticides were aerially applied in blocks of 10,000 acres or larger resulting in a total of more than 20 million acres treated during 1985-1986 (Foster et al. 2000). These large-scale insecticide treatments generated serious concerns about the effects on nontarget organisms, the environment, and the ecosystems.

The development of the Grasshopper Integrated Pest Management Project was described by Cunningham (2000) which has been summarized for this report. In 1987, APHIS initiated the Grasshopper Integrated Pest Management (GHIPM) Project to develop and demonstrate new integrated pest management (IPM) technologies that included prescribed biological, chemical, and cultural methods to control pest grasshopper populations that were above economic thresholds, refinement of grasshopper phenology information, modeling population dynamics, and development of an integrated expert system for grasshopper management. The overall purpose of the GHIPM Project was to develop tools that would help in predicting outbreaks and to develop a combination of preventive tactics that would reduce reliance upon chemical insecticides for control. The comprehensive research and development component was conducted from 1987 to 1994 at two demonstration sites that were established in northwestern North Dakota and in south central Idaho. The Idaho demonstration site lacked high grasshopper populations during 1988 to 1994, making this site less suitable for demonstrating new IPM control technologies. The results from numerous individual research projects were written in a nonscientific format, compiled over a period from 1995 to 2000, and issued during the summer of 2000 as the Grasshopper Integrated Pest Management User Handbook, USDA, APHIS, Technical Bulletin No. 1809.

The grasshopper control studies conducted at the North Dakota Grasshopper IPM Demonstration Project Site during 1987 to 1993 were described by Quinn et al. (2000) which have been summarized for this report. The results from the protozoan pathogen *Nosema*-bran bait study suggested that this biological control field treatment had little, if any, effects on grasshoppers. The results from the 2% carbaryl-bran bait studies showed short-term reductions in total grasshopper populations at an average of 44.5%. Two applications of carbaryl-bran bait were needed when initial grasshopper populations were at very high densities. These moderate levels of control from carbaryl-bran baits resulted because only some grasshopper species consume litter. The grasshopper species that do not consume litter, do not consume bran bait, and are thus not affected by the insecticide. The aerial and ground applications of malathion sprays and carbaryl sprays were the most efficacious treatments with reductions in total grasshopper populations at an average from 84% to 99%.

The grasshopper IPM studies in North Dakota developed more intensive management methods that conduct thorough grasshopper surveys for adults during late summer and for nymphs during spring to more accurately define areas of grasshopper infestations and treat these grasshopper hotspots with carefully timed applications of either malathion or carbaryl insecticidal sprays. The expected outcome from implementation of the grasshopper control techniques developed during the IPM project was great reductions in the costs of grasshopper control treatments and in the amounts of insecticides applied to rangelands compared to the standard treatment of large-scale aerial application of insecticidal sprays to regional grasshopper outbreaks. The conclusion of this report (Quinn et al. 2000) was that the grasshopper control technologies developed during the North Dakota demonstration project should be incorporated into the national grasshopper IPM programs.

A few changes have been made since the printing of Technical Bulletin No. 1809. During the Grasshopper IPM Project, carbaryl bran baits were found not to be particularly effective against high densities of diverse grasshopper assemblages (Foster and Onsager 1996a). Since then, commercial bait products containing carbaryl have no longer been registered for use on rangeland.

The registration for use of the chemical insecticide acephate on grazed or cut for hay rangeland was not renewed. Between the first year of registration in 1982 and the last year of registration, acephate was rarely used for grasshopper control because of the undesirable mixing (Foster and Onsager 1996b). Acephate is still registered for insect control on noncropland areas not grazed or cut for hay. Both carbaryl bran baits and the chemical insecticide acephate have been removed as treatments used during cooperative rangeland grasshopper control programs (APHIS 2002).

An insect growth regulator, dimilin (diflubenzuron), that inhibits chitin formation in immature insects was registered as a restricted use pesticide (RUP) by the US Environmental Protection Agency (EPA) for rangeland grasshopper control. In order to effectively prevent immature grasshoppers from forming their chitinous exoskeleton, dimilin must be applied early in the season when nymphs compose almost the entire population (Foster and Reuter 1996).

During the Grasshopper IPM Project, reduced rates of chemical insecticide sprays were tested with some results showing enough success to continue the research (Reuter and Foster 1996). During 1995 to 2003, reduced chemical research was conducted by University of Wyoming and USDA scientists on a chemical control method referred to as Reduced Area and Agent Treatments (RAATs) where the insecticide rates were reduced below traditional blanket treatment rates and treated swaths alternated with untreated swaths (Lockwood and Schell 1997, Lockwood et al. 2000, Foster et al. 2000, Lockwood et al. 2001, Lockwood and Latchininsky 2004). Both the insect growth regulator dimilin and the chemical control method Reduced Area and Agent Treatments (RAATs) have been added as treatments used during cooperative rangeland control programs (APHIS 2002).

Cultural control of rangeland grasshoppers by manipulation of habitat by livestock grazing practices was studied at the North Dakota Grasshopper IPM Demonstration Project Site during 1993 and 1994. The research was conducted as a joint project between the Range Research Laboratory at the NDSU, Dickinson Research Extension Center, Dickinson, North Dakota and the Rangeland Insect Laboratory, USDA-ARS, Bozeman, Montana. The range laboratory team was responsible for the grazing management treatments and the vegetation parameter data and the insect laboratory team was responsible for the grasshopper identification and population density data. This study was conducted with the cooperation of the USDA Forest Service and the McKenzie County Grazing Association. From 1995 through 1998, the cultural control study was conducted as two independent projects without funding from APHIS. Preliminary reports were included in USDA/APHIS Project Annual Reports (Manske 1993, 1994a, 1994b). Project reports were included in the Grasshopper IPM User Handbook (Onsager 1996, Manske 1996b). Summary project reports were presented to the National Grasshopper Management Board and included in the proceedings (Manske and Onsager 1996, 1997; Onsager 1998). Manske (1999a) explained the adaptive tolerance mechanisms that had coevolved among the soil organisms, grass plants, and grazing livestock interactions and described how management of grazing livestock can be used to manipulate these mechanisms and change rangeland habitat to be unfavorable for pestiferous rangeland grasshoppers. Onsager (2000) documented the occurrence of a grasshopper outbreak on rangeland managed by seasonlong grazing and the prevention of the grasshopper outbreak on rangeland managed by the twice-over rotation grazing strategy and explained how the grazing system changes in habitat caused differences in grasshopper population dynamics. Unfortunately, the results from these two separate but collaborative projects were not reported jointly. The objective of this report is to explain how cultural management can be used to reduce pestiferous grasshopper outbreaks by connecting the relationships of grasshopper life cycle growth and development biology with the unfavorable habitat changes resulting from grazing manipulation of rangeland ecosystem biogeochemical processes.

Even though research on cultural control of grasshoppers was include among the numerous projects during the Grasshopper IPM Project, cultural management practices will not be included as treatments used during cooperative rangeland grasshopper control programs. APHIS lacks land management authority. The responsibility of APHIS is to directly intervene and suppress grasshopper populations only when requested and only when those grasshopper populations on a large region or on a

hotspot reach levels that can cause economic damage to rangeland forage and/or adjacent cropland (APHIS 2002). Implementation of the actual cultural practices, such as grazing management strategies, that are intended to prevent grasshopper outbreaks are the responsibility of the livestock producers and land managers rather than APHIS. This report will assist in the development and operation of grasshopper cultural management practices.