Abstract

Skeletonleaf bursage is a good candidate for precision herbicide application (PHA), because it is a perennial and grows in dense patches. Net present value was positive for most combinations of field size and infestation rates. Higher net present values were observed with larger fields and lower infestation rates.

Precision Application of Herbicide for Control of Skeletonleaf Bursage in Winter Wheat

By Matthew R. Fleming, David A. Claypool, Stephen D. Miller, and Larry J. Held

Matthew R. Fleming is a former graduate research assistant at the University of Wyoming. He received his B.S. degree in agriculture business from the University Wyoming (2003); and his M.S from the University of Wyoming (2005).

David A. Claypool is a Master Technician, Precision Agriculture in the Plant Sciences Department at the University of Wyoming. He received his B.S. degree (1983) in Agronomy at the Ohio State University and M.S. degree (1990) from North Dakota State University in Soil Fertility. His academic interests are in precision agriculture and sustainable cropping systems.

Stephen D. Miller is professor of weed science and director of experiment stations at the University of Wyoming. He received his B.S. degree (1968) from Colorado State University; and his M.S. degree (1970) and Ph.D. degree (1972) from North Dakota State University. His academic interests are development of biologically, ecologically and economically sound weed management programs.

Larry J. Held is professor of agricultural and applied economics at the University of Wyoming. He received his B.S. degree (1971) and M.S degree (1973) from North Dakota State University; and his Ph.D. degree from the University of Nebraska (1977). His academic interests are in farm and ranch management, with emphasis on economics of sustainable farming systems.

Introduction

The University of Wyoming Department of Plant Sciences and Department of Agricultural and Applied Economics conducted field studies from 2001 to 2003 exploring the use of precision herbicide application (PHA) technology to control skeletonleaf bursage (SB, *Ambrosia tomentosa* Nutt.) in southeast Wyoming. PHA means that only infested areas of the field are sprayed instead of a blanket application across the entire field which is referred to as whole-field application (WFA). Skeletonleaf bursage is a good candidate for PHA because it is a perennial and tends to prefer certain soil types and grows in dense patches rather than being randomly distributed. This noxious weed is both difficult and expensive to control beecause it is resistant to many common broadleaf herbicides and effective herbicides are expensive. Because SB emerges later than most annual broadleaf weeds, an additional herbicide application is required for control. Therefore, is it necessary to develop alternative management practices to reduce production costs. Reducing herbicide costs to achieve better profit margins would help winter wheat producers who have this weed problem.

Skeletonleaf Bursage and Precision Agriculture

Skeletonleaf bursage is native to the south central Great Plains and Rocky Mountain states and is found in the prairie and semi-arid regions of Wyoming, New Mexico, Arizona, Colorado, western Kansas, Nebraska, Oklahoma, and Texas. It is considered a noxious weed in several states and is a serious problem in cultivated land. The weed is unpalatable to livestock and produces pollen which will aggravate allergies. Closely related to ragweed, SB is a long-lived perennial that reproduces by seeds and root fragments (Roché). Roots may penetrate the soil up to 6 feet or more and it can spread from a single plant to a 36-foot diameter patch in 3 years (Jeffery and Robison). The depth of its root system makes tillage or cultivation ineffective. These operations may actually spread SB via root fragments from which new plants may grow. Research in a controlled-environment chamber on SB transpiration rates, water use, and interference were conducted at the University of Wyoming. Water use was similar to that of spring wheat and interference of SB reduced spring wheat grain yields by up to 61 percent (Claypool, Delaney, and Miller).

Precision agriculture involves managing inputs such as fertilizer or herbicides based on management zones within a field. Its use offers the opportunity for farmers to gain a renewed understanding of field variability that was lost as the scale of agriculture increased in the 20th century (Lowenberg-DeBoer, Nielsen, and Hawkins). Traditional management techniques have emphasized WFA which may not be the most economical method for controlling SB. The high cost of herbicides required for controlling SB warrants consideration of PHA. It can be economical if herbicide savings are sufficient to pay for the added costs of equipment and maintenance.

Objective

The objective of this article is to examine the profitability associated with adopting PHA for controlling SB in hard red winter wheat.

The scenario is a series of drought years in which there is no yield difference between PHA and WFA. Net Present Value is the method used for economic analysis.

Field Research

Field research was conducted at the Archer Research and Extension Center in Laramie County, Wyoming, in a field naturally infested with SB. Treatments were PHA, WFA, and an unsprayed control. The herbicide applied was Curtail M (Dow AgroSciences) which is a mixture of clopyralid and MCPA. Clopyralid, in combination with other herbicides has been effective in controlling SB in winter wheat with control ratings of 92 and 95 percent for clopyralid plus 2,4-D and MCPA, respectively (Miller). Maps were produced to monitor changes in the SB patches over time using GPS and visual recognition. Serious SB infestations are easily recognized from the tractor seat.

Severe drought persisted during the years of the field study. Because of this, no statistically significant yield differences were measured between the three treatments. Under such circumstances, the economic benefits of PHA are a result of reduced herbicide costs. In this context, we can analyze the cost of adoption and herbicide cost savings of this technology under a "worst-case scenario" in which a farmer adopts the technology and unfavorable weather conditions (several consecutive years of drought) follow. This is not an unusual occurrence in southeast Wyoming where annual precipitation averages 14.5 inches.

Costs for Economic Analysis

The costs used for economic analysis were those required to convert an existing sprayer to a PHA system. This includes cost of precision application equipment plus extra maintenance required. All costs and benefits for this study are computed on a real 2004 dollar basis. A broad range of field sizes are considered for this study (300 to 1,500 acres) to represent dryland wheat farms in southeast Wyoming (Agee). Common SB infestation rates on an area basis range from 1 to 40 percent although higher rates were included in this analysis to test the sensitivity of Net Present Values to a wider range of infestation rates. No additional cost for mapping SB-infested areas was assumed. The equipment used in the field research is equipped with a global positioning system (GPS) and is capable of creating maps either by recording an actual herbicide application or through the use of manual toggle switches which could be used by the operator to record SB infestations during an application to control other weeds. Mapping of SB for future applications can be conducted during another spraying operation without additional cost.

The additional components used to convert an existing sprayer to a basic PHA system cost $13,428, and included: rate-control console, radar speed sensor, motorized control valve, flow meter, GPS antenna and receiver, light bar, boom controls, field computer, software, and associated cables. According to the equipment supplier, this equipment will have a useful life-span of approximately ten years during which few repairs are expected. Additional maintenance is $281 for approximately 20 hours per year at $14.07 per hour which is equal to a labor rate for farm equipment mechanics in southeast Wyoming (Bureau of Labor Statistics). Curtail M cost $11.19 per acre at the time of the study. Cost savings of PHA compared to WFA would be the herbicide cost of the unsprayed fraction of the field.

Net Present Value Analysis

Net Present Value analysis was chosen for this project because it incorporates the timing and magnitude of cash flows within the analysis. It involves discounting net cash flows over the expected life of the investment (10 years in this case). The following data were used in this analysis: the initial investment cost ($13,428), extra maintenance cost for each of the 10 years ($281), net cash flows (herbicide savings minus maintenance), and an 8 percent discount rate representing a long-term real

(inflation free) rate of 4 percent plus a four percent additive risk premium adjustment for agricultural investments (AAEA, p.2-38). A positive Net Present Value will be realized, if the sum of discounted net cash flows over the ten-year period exceeds the initial investment cost.

Results

Table 1 shows positive Net Present Values from PHA for most combinations of field size and infestation rates. A consistent pattern of increasing Net Present Values for a given infestation rate is observed with larger fields, because more acres reap the benefits of herbicide savings from PHA compared to WFA. Fields within a given size with higher infestation rates are less profitable because herbicide requirements are closer to that of WFA. Table 1 also indicates given all field sizes considered, there would be very little incentive to adopt PHA, if infestation rates equal or exceed 60 percent of field acreage. In that case, field size should be greater than 300 acres to justify adopting PHA for control of SB in winter wheat.

Conclusions

It appears that adoption of a basic PHA system for controlling SB in winter wheat can be an economical choice due to savings in herbicide cost even in a series of drought years. This is especially true if infestation rates are low in combination with large fields. Adopting PHA on smaller fields having very high infestation rates (60 to 80%) would not be economical. Both the size of the field and the scale of a weed problem must be examined when the adoption of precision herbicide weed control technology is being considered. This project was limited to analyzing the adoption of PHA technology to control one weed species. Because the equipment can be used for all herbicide applications, the conversion to this technology may have the potential to be more profitable than shown here.

References

Agee, D. E. "Cost of Producing Winter Wheat, Southeastern Wyoming." Wyoming Extension Bulletin 634. 1975.

American Agricultural Economists Association. *Commodity Costs and Returns Estimation Handbook* p. 2-38. Ames, Iowa: July 20, 1998.

Barry, P., P. Ellinger, J. Hopkin, and C. B. Baker. *Financial Management in Agriculture* 6th edition. Danville, Illinois: Interstate Publishers, 2000.

Claypool, D., R. Delaney, and S. Miller. "Skeletonleaf Bursage Studies: Transpiration Rates, Water Use, and Interference." College of Agriculture: Agricultural Experiment Station Progress Report. University of Wyoming (1998):191-196.

Jeffery, L.S. and L.R. Robison. "Know and Control Woollyleaf bursage and Skeletonleaf bursage." Cooperative Extension Service. University of Nebraska. Bulletin E.C. (1969):69-185.

Lowenberg-DeBoer, J., R. Nielsen, and S. Hawkins. "Management of intra field variability in large scale agriculture: A farming systems perspective." *Proceedings Of The International Symposium On Systems Research In Agriculture And Rural Development*. Center for International Cooperation in Agronomic Research For Development. CIRAD, Montpelier, France. (1994):551-555.

Miller, S.D. "Skeletonleaf Bursage Control in Winter Wheat." Weed Control in Agronomic Crops Progress Report 1991. University of Wyoming Agricultural Experiment Station. p. 86.

Roché, C. "Skeletonleaf Bursage." Pacific Northwest Extension Publication. PNW410. United States Department of Labor. Bureau of Labor Statistics. *State Occupational Employment and Wage Rates*. 2005.

Table 1. Net Present Value of Precision Herbicide Application Associated with Different Field Sizes and Infestation Rates of Skeletonleaf Bursage

SB infestation rates (%)	Field size (acres)				
	300	**600**	**900**	**1,200**	**1,500**
			$ per acre		
10	17	42	51	55	57
20	9	35	43	47	50
30	2	27	36	40	42
40	-6	20	28	32	35
50	-14	12	21	25	27
60	-21	5	13	17	20
70	-29	-3	6	10	12
80	-36	-11	-2	2	5