Vegetation management system for the conversion of degenerated grasslands to Alfalfa Pastures in Inner Mongolia , China

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Introduction Converting degenerated Inner Mongolian grasslands to pastures by planting appropriate species of native plants is the most reliable method for improving their productivity . However , the extreme weather conditions of northern Inner Mongolia where the grass-growing period is short and severe winter chilling occurs limit the number of species for planting in this region . Some selections of alfalfa (*Medicago* spp .) are known to have adapted to these regions because of their cold hardiness and good productivity , but their early growth is very slow . Therefore , suppression of vegetation other than alfalfa , i .e . , species regarded as weeds , is critical until the alfalfa plants are established . In order to select the best weed management program for the conversion of grasslands to alfalfa pastures , the effects of several weed control methods on weeds and alfalfa production were studied and compared .

Materials and methods The experiment was conducted in a grassland at Beishan Experiment Station , Hulunbeier (49°20′ N) , in northeast region Inner Mongolia . The land was fairly degenerated by being mowed every autumn and lightly exposed to trampling . The vegetation mainly comprised perennial species of grasses , *Artemisia* spp . and *Potentilla* spp . The grassland was subjected to the following treatments : 5 land preparations before planting , 4 post-plant selective weed control , and an untreated check (Table 1) . Three randomly arranged 10 m^2 plots were used . Alfalfa (*Medicago varia* Martin . cv . Caoyuan No . 3) was seeded in every plot at the rate of 6 g/m^2 in 60-cm wide rows on June 15 , 2005 , and grown without fertilizer treatment . To determine alfalfa yield and weed control efficacy , a 1 m^2 stand in the middle of each plot was harvested by cutting back at the soil surface on approximately 20 August every year through 2005 to 2007 . Since slight weed emergence was observed at the start of the 2nd growing season in some treatment plots , all the plots were left untreated during the 2nd and 3rd years of the trial .

Table 1 *Treatments and abbreviations*

Treatment	Herbicide rate (kg/ha a .i .)	Abbrev .
Pre-plant vegetation control		
Tillage , in previous autumn		PT
Glyphosate , in the previous autumn*	2 .000	PGLY
Trifluralin , in the previous autumn	0 .333	PTF
Tillage , at planting**		T
Glyphosate , at planting***	2 .000	GLY
Post-plant selective weed control**		
Trifluralin , preemergence*** , incorporated	0 .333	TF
Trifluralin+Alachlor , preemergence***	0 .667+1 .290	TF+AC
Fluazifop-butyl , postemergence****	0 .520	FH
Asulam , postemergence****	1 .850	AS
Untreated check		CONT

* 270days before seeding ; ** tilled at 2 days before seeding .
*** 1 day after seeding ; **** 40 days after seeding , at 2-3 leaf stage of alfalfa

Results All the treatments produced a remarkable decrease in the growth of perennial grasses that dominated the original vegetation and instead increased the emergence and growth of annual broad-leaved weeds ; further , the growth of these species rapidly decrease from the 2nd year to the 3rd year (Figure 1) . The most effective control of preplant vegetation was obtained with glyphosate application at the time of planting . Among the selective weed control for growing alfalfa , asulam application at the 2-to 3-leaf stage yielded the highest efficacy . The asulam treatment maintained the number of weeds at the lowest level through the 3 years . All treatments with pre-emergence herbicides and tillage in the previous autumn showed less or little efficacy . Alfalfa yield increased in most of the treated plots from the 1st year to the 3rd year as the plants aged , while almost no yield was obtained in the untreated plots (Figure 2) .The asulam treatment that achieved the best weed control in the 1st year produced the highest yield of alfalfa for all the 3 years .

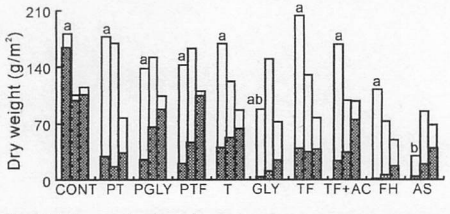

Figure 1 *Effect of weed control treatments on amounts of weed growth in 3 years . Three bars in each treatment are for 2005 (left) , 2006 (middle) and 2007 (right) . The bars with the same letter are not significantly different at the 5% level in 2005 (Tukey HSD test) .*

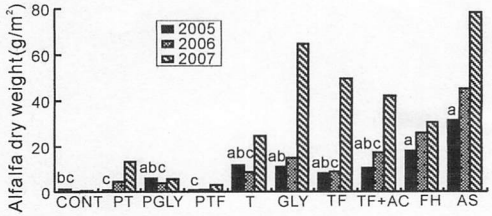

Figure 2 *Effect of weed control treatments on alfalfa yields in 3 years . The bars with the same letter are not significantly different at the 5% level in 2005 (Tukey HSD test) .*

Conclusions For the successful conversion of degenerated grasslands of northern Inner Mongolia to alfalfa pastures , it is essential to practice the pre-plant control of perennial grass vegetation followed by the protection of young alfalfa seedlings from competition with annual broad-leaved weeds that emerge rapidly and replace the grasses . The sequential application of preemergence glyphosate and postemergence asulam is recommended as the most promising weed management program . Weed control for alfalfa is essential only during the planting year because the decreased weed levels are maintained well into the later years of plant growth ; further , increased early alfalfa growth provides an advantage during their later competition with weeds .