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Aboveground biomass production of switchgrass and sainfoin on Loess Plateau of China

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Key words: actual yield loss (AYL), aggressiveness (A), land equivalent ratio (LER), sainfoin, switchgrass

Introduction In the semiarid, hilly-gully region in the Loess Plateau of China, it is critical to find sustainable, rational cropping patterns for various grass species. Intercropping has long been used as one dryland farming practice in China, particularly in rainfed areas. While most of the plants used in mixtures have been annual crops, the objective of this study was to investigate biomass production of a perennial introduced grass (switchgrass, *Panicum virgatum* L.) and a perennial legume (sainfoin, *Onobrychis viciaefolia* L.) under a 2:1 row-replacement intercropping system compared to a monoculture.

Materials and methods Field experiments were conducted in five consecutive years from 2001 to 2005 at Ansai Research Station, Chinese Academy of Science, Shaanxi Province, (36°51′30"N; 109°19′23"E; elev. 1,068m), which has a mean annual rainfall of 540 mm. The loess soil was characterized as silt loam with low available N and P, and high available K. Treatments were: 1) pure switchgrass, 2) pure sainfoin and 3) mixed switchgrass and sainfoin in 2:1 row-replacement. Each treatment was replicated four times and arranged in a randomized complete block design. Aboveground biomass was sampled at the end of each growing season. Three competitive indices (AYL, A and LER) were used to evaluate intercropping. Data were analyzed by standard ANOVA at $P=0.05$.

Results Intercropping reduced the aboveground biomass of sainfoin significantly compared to growth in a pure stand (Table 1). Partial AYLa of sainfoin during 2001-2004 gave positive values, indicating yield gain, while partial AYLb of switchgrass was negative in 2002 and 2005, showing yield loss (Table 2). The higher value of AYLa than AYLb during 2001-2004 was consistent with the positive Aab. This revealed that sainfoin was the dominant species whereas switchgrass was the dominant species before 2003. LER>1.0 during 2001-2004. The aggressiveness of sainfoin compared to switchgrass (Aab) decreased gradually in subsequent years.

Table 1 *Yearly biomass production (g m^{-2}) of switchgrass and sainfoin in monocultures and mixtures (Values within a row followed by different letters without a bracket are significantly different, and values within a column followed by different letters within a bracket are significantly different.)*

Year	2001	2002	2003	2004	2005	Mean±S.E.
Sole switchgrass	305.7 d (b)	1655.4 a (a)	1252.4 c (a)	1342.5 c (a)	1460.3 b (a)	1203.3±18.6 (a)
Sole sainfoin	332.8 d (a)	1368.4 a (b)	874.9 b (b)	923.6 b (b)	745.1 c (b)	848.9±7.2 (b)
Switchgrass+ sainfoin (2:1)	323.7 d (a)	848.6 c (c)	920.8 b (b)	958.5 a (b)	626.8 b (c)	735.7±7.4 (c)

Table 2 *Competition indices of sainfoin (crop a) and switchgrass (crop b) based on yearly biomass in mixture.*

Year	2001	2002	2003	2004	2005	Mean(S.E.)
AYLa	+3.55	+0.60	+0.84	+0.29	-0.76	+0.90(0.04)
AYLb	+0.15	-0.17	+0.33	+0.39	-0.07	+0.13(0.03)
AYL	+3.70	+0.41	+1.17	+0.67	-0.82	+1.03(0.07)
LER	+2.29	+1.08	+1.51	+1.35	+0.70	+1.38(0.03)
Aab	3.41	0.76	0.50	-0.10	-0.69	+0.77(0.02)

Conclusions Intercropping of switchgrass and sainfoin in a 2:1 row replacement system reduced biomass production of switchgrass. Which considerable biomass, especially during years four or five. The morphological and physiological causes for the differences between monocultures and mixtures need further investigation.