Effects of Alternate Furrow Irrigation on the Forage Quality of Alfalfa (*Medicago sativa*)

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Introduction

Alfalfa (*Medicago sativa*) is widely used to establish pasture to sustain animal production because of its high nutritional quality for livestock (Bouton, 2012). Therefore improving quality of alfalfa pasture is the main goal for establishing pasture throughout the world. Irrigation is an important approach for achieving high qualities of alfalfa pasture, however, the scarcity of water threatens the sustainability of world alfalfa production, requiring us to force on using water more efficiently (Liu and Guo, 2013). Alternate furrow irrigation has been proved as a water-saving technique to promote fruit quality of tomatoes and grapevines and the seed quality of cotton (Kirda *et al*., 2004, Dos Santos *et al*., 2003, Tang *et al*., 2005). But these studies only focus on harvesting the seed, fruits and tubers, while neglecting the vegetative mass. In this study, we investigated the effects of alternate furrow irrigation with different irrigation volumes on the quality of alfalfa.

Materials and Methods

Experimental design and management: A two-year stand pasture of "Golden Empress" alfalfa cultivar was selected for this experiment. A split-plot design was used with three replicates assigning two irrigation modes as main plots and four irrigation volumes as subplots. Irrigation modes include alternate furrow irrigation (AFI) and conventional irrigation (CI); Irrigation volumes include 65%-I_1, 80%-I_2, 95%-I_3, 110%-I_4 of conventional irrigation volumes, respectively. Five subplots, using randomized complete block design (RCBD), were ploughed with buffer strips 12 m wide by 10 m long (120 m^2) with 0.5 m between adjacent subplots. Alternate furrow irrigation means that one of the two neighboring furrows was alternately irrigated during consecutive watering and received half (50%) the conventional irrigation volume during the experiment period. The depth of each furrow was 0.3 m, and the top and bottom widths of each furrow were approximately 0.3 m and 0.25 m, respectively.

Sampling and measurements: Samples were taken at the flowering stage of alfalfa, and the harvest date was 16 June, 25 July, and 20 September, respectively. Crude protein was measured by Kjeldahl determination, neutral detergent fiber and acid detergent fiber was measured by ANKOM 2000 fiber analysis apparatus.

Statistical analysis: Analysis of variance (ANOVA) was performed using the general linear model-univariate procedure from SPSS17.0 software.

Results and Discussion

This study showed both irrigation modes and irrigation volumes affected the alfalfa forage quality, but no significant effect was found on the interaction of them (Table 1). Alternate furrow irrigation significantly increased crude protein, neutral detergent fiber and acid detergent fiber contents at the first cutting and it increased the neutral detergent fiber and acid detergent fiber contents at the second and the third cutting, respectively. These indicated that alternate furrow irrigation improve the palatability, but reduce the digestibility rate of alfalfa forage for livestock. The crude protein content in shoots increased when the irrigation volumes increased to 80% of conventional irrigation volume at the first and the second cutting time, and then kept stable, whereas the neutral detergent fiber and acid detergent fiber decreased with the increase of irrigation volumes.

Table 1: Effects of alternate furrow irrigation and irrigation volumes on alfalfa (*Medicago sativa*) crude protein, neutral detergent fiber and acid detergent fiber contents (%)

Treatments	Crude protein			Neutral detergent fiber			Acid detergent fiber		
	FC	SC	TC	FC	SC	TC	FC	SC	TC
Irrigation modes									
AFI	17.45a	17.59	16.88	44.85a	42.04a	42.96	34.58a	32.64	35.53a
CI	17.05b	17.66	16.83	42.40b	41.59b	42.51	32.64b	31.99	34.60b
Significance	*	ns	ns	**	*	ns	**	ns	*

Irrigation volumes										
I_1		16.68b	17.15b	17.10	44.14a	43.35a	43.79a	34.05a	32.61a	35.14a
I_2		17.33a	17.91a	16.98	44.41a	42.52b	43.51a	33.37ab	32.07ab	36.20a
I_3		17.70a	18.11a	16.77	42.86b	42.04b	42.65a	33.93ab	31.68b	35.14a
I_4		17.30a	17.62a	16.58	43.09b	39.34c	40.98b	33.08b	31.90b	33.78b
Significance		**	*	ns	**	**	**	*	**	**
Irrigation volumes × Irrigation modes										
I_1	AFI	16.69	17.35	17.35	45.44	43.78	43.99	34.97	32.97	33.88
	CI	16.67	16.95	16.85	42.83	42.92	43.60	33.13	32.24	36.40
I_2	AFI	17.52	17.43	17.07	45.50	43.96	43.53	34.65	30.17	37.26
	CI	17.14	18.39	16.89	43.32	41.08	43.48	32.09	33.19	35.14
I_3	AFI	18.01	17.97	16.86	44.13	41.29	43.35	34.97	32.50	36.68
	CI	17.38	18.26	16.67	41.59	42.80	41.94	32.89	31.64	33.59
I_4	AFI	17.57	17.94	16.24	44.32	39.12	40.95	33.72	31.90	34.28
	CI	17.02	16.80	16.92	41.85	39.56	41.01	32.43	31.89	33.27
Significance		ns	ns	ns	ns	ns	ns	ns	ns	ns

AFI - alternate furrow irrigation; CI - conventional irrigation; FC - the first cutting time; SC - the second cutting time; TC - the third cutting time. *, ** Significant at 0.05 and 0.01 level, respectively; ns - not significant.

Conclusion

This study suggests that alternate furrow irrigation and irrigation volume have direct impact on forage quality of alfalfa. Alternate furrow irrigation increases the palatability but decreases digestibility of alfalfa forage. Irrigation volume improves the forage quality of alfalfa when it increases from 65% to 110% of conventional irrigation volume.

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