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ORIGINAL ARTICLE

Evaluation of Intercropping Forage Sorghum with Pearl Millet at Different Row Proportion and Plant Densities in Semi-arid Areas.

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Amir Mahdi Khalatbari, Muhammad Bagher Hosseini, Amir Ali Khalatbari, Omid Reza Zandvakili, Amir Hossein Eslampour: Evaluation of Intercropping Forage Sorghum with Pearl Millet at Different Row Proportion and Plant Densities in Semi-arid Areas: *Am.-Eurasian J. Sustain. Agric., 3(1): 15-20, 2009*

ABSTRACT

In order to study the effects of intercropping forage Sorghum(KFS2) with Pearl Millet at different row proportion and plant densities in semi-arid areas an experiment was conducted at the research farm of Tehran University in the year of 2005.the design was in split plot arrangement with three replications. The main factor consisted of three different densities: 200000, 270000 and 340000 plants per hectare. The second factor consisted of seven different planting proportions: pure stand of Sorghum, pure stand of Pearl Millet, 75% Sorghum+25%Millet, 75% Millet+25% Sorghum, 50% Sorghum+50% Millet, 100% Sorghum+20% Millet and finally 100% Millet+20% Sorghum. To take into consideration the evaluation of fodder yield production on dry matter basis per unit area; the pure stand of Sorghum had the highest yield in first harvest. Whereas the second harvest, the highest dry weight of fodder went to pure stand of Pearl Millet. Evaluation of yield in each plant in the first and second harvests resulted in efficiency of intercropping of these plants which in combination 75% Sorghum+25%Millet was obtained as the highest one for both Sorghum and Pearl Millet. The different row proportion of fodder Sorghum intercropped with Pearl Millet significantly affects forage quality. The combination of 75% sorghum+25% millet obtained the highest percentage of Digestive Dry Matter (DMD) and carbohydrate. The highest percentage of Crude Protein (CP) was belonged to pure stand of sorghum. Evaluation of Land Equivalent Ratio (LER) indicated that the highest one is obtained by the combination of 75% Millet +25 % Sorghum (LER=1.43).

Key words: Intercropping, Fodder Sorghum, Pearl Millet, forage dry weight yield and Land Equivalent Ratio.

Introduction

Total forage production of an intercropping system is dependent on the enhancement or suppression of each species. Interspecies competition for growth resources, such as water and light, can result in suppression of growth and biomass accumulation in the less competitive species. Report in the literature show contradictory intercropping effect on total forage yield [2].

The efficiency of intercropping system can be evaluated by the land equivalent ratio (LER), defined as the total area required under sole cropping to produce the equivalent yields obtained under intercropping.

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LER = La + Lb = (Ya / Sa) + (Yb / Sb)

Where Sa and Sb are sole crop yields of the component crop a and b, and Ya and Yb are the yields of component a and b in the intercrops. A total LER value greater than 1.0 indicates advantages from intercropping in terms of the use of environmental resources for plant growth. Value La and Lb greater than 0.5 indicate advantage for an individual species in intercropping system over the sole cropping.

In an intercrop system, different row proportion and densities alter the amount of light transmission to lower layers of the crops and affect the competition of species for light, water, and nutrients. Compared with corresponding sole crop, yield advantages have been recorded in many intercropping systems, including maize/soybean[10,6], sorghum/soybean[3]. In maize/soybean strip intercropping, West and Griffith [10] observed a 26% increase in maize yield. Ghafarzadeh *et al.* [6] found that strip intercropping had 20-24% greater maize yields.

Improved crude protein content of forage has been found in cereals intercropped with field pea (*Pisum sativum L.*) compared with sole cropped[2].

Cereal forage was also found to have lower neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents in intercropping systems[2].

The objectives of this study were to determine yield advantage and forage quality of the intercropping system in sorghum intercropped with pearl millet in semi-arid areas and also effect of different proportions and densities on forage yield, crude protein, (DMD), carbohydrate and finally LER of sorghum-pearl millet intercropping system.

No serious incidence of insects or diseases was observed. The crop was hand-weeded once one and half month after sowing to keep the field weed-free.

Materials and methods

In order to study the effects of intercropping forage Sorghum(KFS2) with Pearl Millet at different row proportion and plant densities in semi-arid areas an experiment was conducted at the research farm of Tehran University in the year of 2005.the design was in split plot arrangement with three replications. The main factor consisted of three different densities: 200000, 270000 and 340000 plants per hectare. The second factor consisted of seven different planting proportions: pure stand of Sorghum, pure stand of Pearl Millet, 75% Sorghum+25%Millet, 75% Millet+25% Sorghum, 50% Sorghum+50% Millet, 100% Sorghum+20% Millet and finally 100% Millet+20% Sorghum.

This experiment was designed as a randomized complete block with a split plot arrangement of treatments.

This experiment was conducted at the research farm of Tehran University (51 degree E lat; 35 degree E, 47 degree N long; 1312 m elevation). The 38-yr average annual precipitation is 265 mm (as semi-arid area) and the annual average temperature is 13 degree C.

The sample of field soil is clay Loam and pH=7.9. Each plot is consist of 6 rows with 50 cm distance between lines and the length is 5 cm, distance between seedlings on each line is 10cm. To omit marginal effects, first and sixth seedlings are eliminated. Chemical fertilizer, phosphate 250 kg per ha before cultivation, 150 kg split urine per ha were considered.

Sorghum cultivar was (KFS2) which is local cultivar.

Traits are as follows: fodder yield production on dry matter basis per unit area, fodder yield production in each plant, percentage of digestive dry matter (DMD), crude protein (CP), carbohydrate and finally land equivalent ratio (LER).

To evaluate the quality traits, NIR device (Near Infra Red) was used. The design was in split plot arrangement with three replications.

Statistical evaluations are estimated by MSTSTC, and SPSS.

Results and discussion

Results of variance analysis in first harvest and second harvests showed that row proportion had significant effects on yield production on dry matter basis per unit area and yield in each plant for both sorghum and pearl millet ($P < 0.01$).

Analysis of variance (ANOVA) for split plot based on RCB design was performed to determine density and intercropping pattern effect on sorghum and pearl millet dry matter yield , yield in each plant, crude protein, (DMD), carbohydrate and LER.

There was significant dry matter yield and yield in each plant advantage of sorghum/pear millet intercropping. The dry matter yield and yield in each plant were increased regardless of plant density. It indicates that yield advantage of intercropping was affected by different proportions of intercropping.

The pure stand of Sorghum had the highest dry yield in first harvest. Whereas the second harvest, the highest dry weight of fodder went to pure stand of Pearl Millet (fig 1). Evaluation of yield in each plant in the first and second harvests resulted in efficiency of intercropping of these plants which in combination 75% Sorghum+25%Millet was obtained as the highest one for both Sorghum and Pearl Millet (fig 2).

Table 1: ANOVA based on randomized complete block designed (RCBD) for dry matter yield and yield in each plant of Sorghum and Pear Millet (first harvest)

SOV	df	dry matter yield	yield in each plant
Block	2	170/0	397/4
Factor A	2	n.s 851/1	n.s778/2
Error A	4	360/0	825/12
Factor B	6	8/8**	9/27796**
A*B	12	062/0 n.s	130/1 n.s
Factor B	36	095/0	183/2
Total	62		

**: Significant at 1% level, ns: not significant.

Table 2: ANOVA based on randomized complete block designed (RCBD) for dry matter yield and yield in each plant of Sorghum and Pear Millet (second harvest)

SOV	df	dry matter yield	yield in each plant
Block	2	006/0	476/1
Factor A	2	012/0 n.s	857/1 n.s
Error A	4	015/0	476/5
Factor B	6	4/32**	2/31590**
A*B	12	003/0 n.s	450/1 n.s
Factor B	36	003/0	661/1
Total	62		

**: Significant at 1% level, ns: not significant.

Table 3: LER of Dry matter yield for Sorghum and Pear Millet at different Intercropping patterns

Treatments	Land Equivalent Ratio(LER)		
	Sorghum	Pearl Millet	Total
T3	81/0	56/0	37/1
T4	66/0	77/0	43/1
T5	71/0	71/0	42/1
T6	67/0	56/0	23/1
T7	53/0	68/0	21/1

Table 4: Forage quality of Sorghum at different row proportion

different row proportion	carbohydrate	Crude Protein (CP)	Digestive Dry Matter (DMD)
T1	5/15b	7/15a	7/66b
T3	7/17a	5/12d	3/70a
T4	5/13d	3/13 c	4/65b
T5	7/14 c	2/11 e	3/58 c
T6	3/13d	3/12d	9/58 c
T7	09/13d	2/14b	1/58 c

Table 5: Forage quality of Pear Millet at different row proportion

different row proportion	carbohydrate	Crude Protein (CP)	Digestive Dry Matter (DMD)
T2	7/12b	7/14b	7/64b
T3	06/14a	4/13 c	05/64 c
T4	6/14a	2/15a	8/65a
T5	3/12b	8/13 c	7/64b
T6	6/11 c	2/11d	7/61d
T7	8/11 c	06/11d	6/61d

Pure stand of Sorghum=T1
Pure stand of Pearl Millet=T2
75% Sorghum+25%Millet=T3
75% Millet+25% Sorghum=T4
50% Sorghum+50% Millet=T5
100% Sorghum+20% Millet =T6
100% Millet +20% Sorghum=T7

Table 6: ANOVA based on randomized complete block designed (RCBD) for forage quality of Sorghum intercropped with Pear Millet

SOV	df	carbohydrate	Crude Protein (CP)	Digestive Dry Matter (DMD)
Block	2	045/0	179/0	029/0
Factor A	2	011/0 n.s	037/0 n.s	073 /0 n.s
Error A	4	072/0	033/0	934/0
Factor B	6	09/301**	4/245**	2/5310**
A*B	12	018/0 n.s	009/0 n.s	353/0 n.s
Factor B	36	022/0	020/0	544/0
Total	62			

: **: Significant at 1% level, ns: not significant.

Table 7: ANOVA based on randomized complete block designed (RCBD) for forage quality of Pear Millet intercropped with Sorghum

SOV	df	carbohydrate	Crude Protein (CP)	Digestive Dry Matter (DMD)
Block	2	009/0	017/0	036/0
Factor A	2	005/0 n.s	014/0 n.s	16/0 n.s
Error A	4	010/0	017/0	031/0
Factor B	6	08/225**	8/249**	9/5256**
A*B	12	012/0 n.s	008/0 n.s	18/0 n.s
Factor B	36			
Total	62			

: **: Significant at 1% level, ns: not significant.

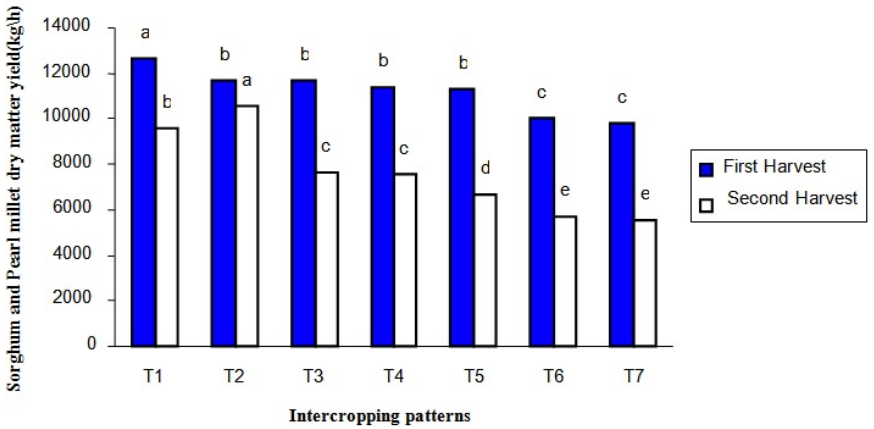

Fig. 1: Dry matter yield of Sorghum and Pear Millet (first and second harvest) at different Intercropping patterns

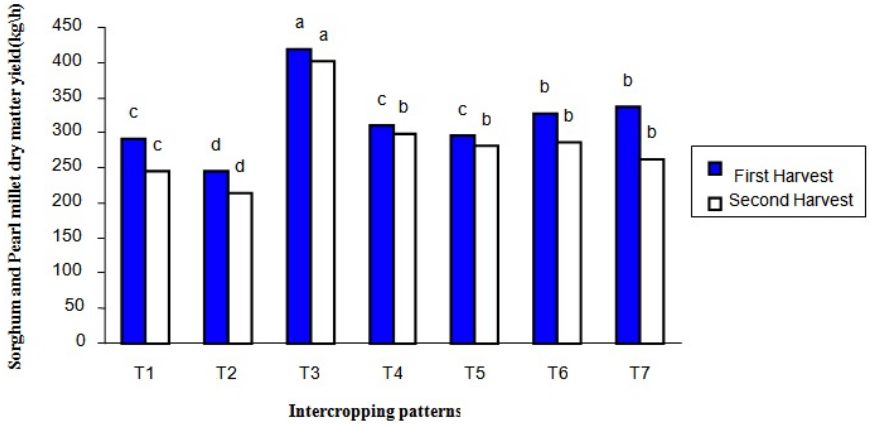

Fig. 2: Dry matter yield of Sorghum and Pear Millet (first and second harvest) in each plant at different Intercropping patterns

The results suggest that sorghum and pear millet benefited from intercropping in terms of yield in each plant. Regarding to results which are obtained, there was no interspecies competition between intercropped sorghum and pear millet during growth stage. Because neither of them was dominated species.

The trade-off between increasing the yield of dominant species has three possible outcomes for intercropping system, i.e. yield advantage (LER>1), yield disadvantage (LER<1) and the intermediate result (LER=1) (vander meer, 1989). The result of present experiment however showed the yields of intercropping sorghum and pear millet were all increased by intercropping.

The different row proportion of fodder Sorghum intercropped with Pearl Millet significantly affects forage quality. The combination of 75% sorghum+25% millet obtained the highest percentage of Digestive Dry Matter (DMD) and carbohydrate. The highest percentage of Crude Protein (CP) was belonged to pure stand of sorghum.

Evaluation of Land Equivalent Ratio (LER) indicated that the highest one is obtained by the combination of 75% Millet +25 % Sorghum LER=1.43 (fig 3).

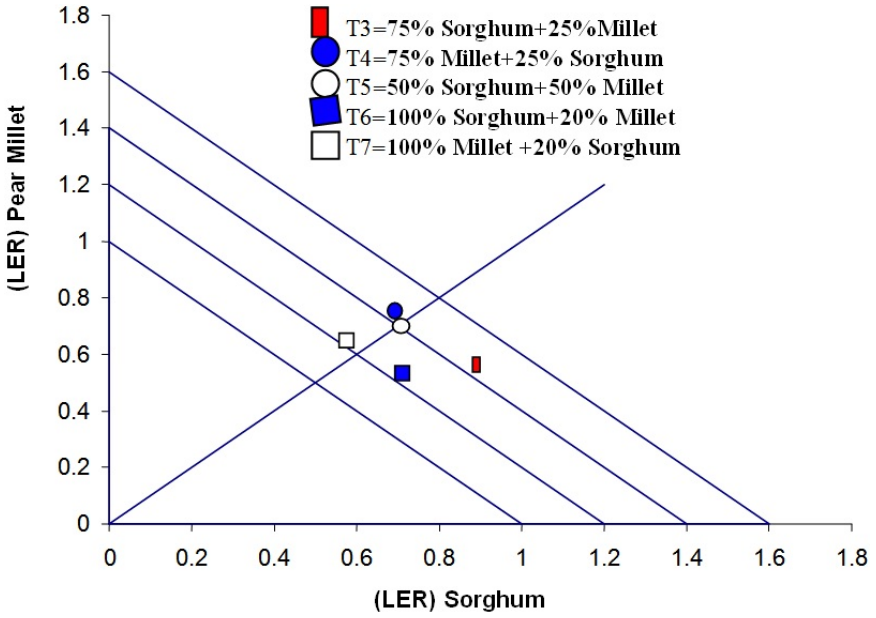

Fig. 3: LER of Dry matter yield for Sorghum and Pear Millet at different Intercropping patterns

Discussion

Yield in each plant advantage of intercropped sorghum and pear millet came from positive effects in the sorghum/pear millet intercropping the former in agreement with the literature. Yield increases in maize/soybean strip intercropping system were primarily due to increase in maize adjacent to soy bean[10]. In canola and soy bean strip intercropping, land equivalent ratios (LERs) were significantly greater than 1.0.

Superiority of green fodder yields of pear millet and sorghum was perhaps due to a higher number of tillers, higher fodder yield obtained due to more rapid dry matter accumulation in sorghum and pear millet.[7].

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