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Determination of the Benefits of Different Berseem Clover Cultivars and Nitrogen Fertilizer in Forage Corn Intercropping System

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ABSTRACT
In order to determine forage yield, land equivalent ratio (LER), relative yield of crop (R), relative yield total (RYT) and corn organic matter, a study was done at Research Farm, Islamic Azad University, Isfahan Branch. A factorial experiment in randomized complete block design with 3 replications was used. Berseem clover cultivars intercropped with corn SC704 were Karaj, Sacromont and Multicut, and nitrogen levels included were 0, 40 and 60 kg/ha. The nitrogen fertilizer was provided from urea source (46% pure N). The effect of cultivar was significant on total corn fresh and dry yield, R of clover, RYT and LER. Total clover fresh yield, total corn fresh yield, R of clover, RYT and LER were significantly influenced by nitrogen fertilizer. Cultivar and nitrogen interaction had significant effect on total corn fresh and dry yield, R of clover, RYT and LER. The highest total fresh and dry yields of corn were obtained in forage corn intercropped with Sacromont and Multicut, respectively. These two parameter significantly increased from application of 0 kg N/ha to 60 kg N/ha. In all intercropping treatments, land equivalent ratios (LER) were well above one indicating yield advantages for intercropping. The highest LER and RYT observed in intercropping of forage corn with Sacromont. There were no significant differences in corn organic matter between intercropped cultivars and nitrogen treatments. On the basis of the results total and dry yields were significantly increased from application of 0 to 60 kg N/ha. Forage corn intercropped with Multicut also had the highest total dry yield, but the maximum total fresh yield was achieve in forage corn and Sacromont intercropping system. In central of Iran and on the basis of low input farming system, cultivation of berseem clover cultivar intercropped with forage corn can be introduced for development of sustainable food production systems.

***Key words**:* Berseem clover, Forage corn, Intercropping, Nitrogen, Cultivar

INTRODUCTION

With rising populations and the consequent pressure from competing socioeconomic demands for land and other resources (Bamire *et al.*, 2010), it has become imperative to use new agronomical management. Cereal-legume intercropping offers potential benefits in low-input cropping systems, where nutrient inputs, in particular nitrogen are limited (Banik *et al.*, 2006; Hauggaard-Nielsen *et al.*, 2009; Thorsted *et al.,* 2006). Sustainability of Iran agriculture may require change from predominant application of high nitrogen fertilizers (Soleymani *et al*., 2011). Berseem clover has been cultivated in Iran for many years (Gharineh *et al*., 2009). Legume cover crops can successfully be used as intercrops in low input farming systems (Akanvou *et al*., 2001).

The land equivalent ration (LER) is defined as the relative land area growing sole crops that is required to produce the yields achieved when growing intercrops (Hauggaard-Nielsen *et al*., 2006). Javanmard *et al*. (2009) also reported that LER is an index that is used for evaluating the effectiveness of all forms of intercropping. Abraham and Singh (1984) noted that LER greater than one was due primarily to the increase in nitrogen absorption. Jaurena *et al*., (2005) reported that organic matter of barley grain, silage of ryegrass and silage of red clover were 919, 814 and 807 g/kg dry matter. Ghaderi *et al*. (2008) demonstrated that the best RYT for alfalfa and wheatgrass intercropping was 1.15 and the maximum R for alfalfa and wheat grass was 1.02 and 0.36, respectively. The objectives of this research were: (i) to assess the potential of forage corn-berseem clover intercrops to enhance forage yield and quality of forage corn when compared with sole crops, (ii) to evaluate the influence of nitrogen fertilizer on forage yield of corn and berseem cultivar, and (iii) to investigate the changes in forage corn yield when intercropped by different berseem cultivars.

MATERIAL AND METHODS

In order to evaluate the benefit of forage corn (SC 704) and berseem clover cultivars, in different levels of nitrogen fertilizer, a study was conducted in 2010, at Research Farm, Faculty of Agriculture, Islamic Azad University, Isfahan Branch (latitude $32^{o}\ 40^{/}$ N, longitude $51^{o}\ 58^{/}$ E, and 1570 m elevation). A factorial experiment in randomized complete block design with 3 replications was used. Berseem clover cultivars were Karaj, Sacromont and Multicut, and nitrogen levels included were 0, 40 and 60 kg/ha. The nitrogen fertilizer was provided from urea source (46% pure N). The soil preparation consisted of mouldboard ploughing (20-25 cm) followed by discing and smoothing with a land leveler. Ditches were prepared separately for each replication. Soil texture at two depths (0-30 and 30-60 cm) was clay (Table 1). The qualitative characteristics of water is shown in Table 2. SAR of water was 5.8 (Table 2). The distance between rows of forage corn was 100 cm and clover cultivars were planted on the basis of 20 kg seed per ha. Clover cultivars were planted between forage corn rows. Plantation was done on 15 June by hand. The first irrigation was done after plantation, the second irrigation for better seedling establishment was done four days after the first irrigation. Other irrigation intervals were 8 days apart. Weeds were controlled by hand weeding. Clover cultivars were harvested at 15% flowering stage. The second cut was used as green manure. Forage corn sampling was done at dough seed stage. Dry matter yield of crops considered for comparison of yield production of the treatments. The land equivalent ration (LER) gives the exact estimation of the greater biological efficiency of the intercropping situation and was calculated as equation (1) (Xu *et al*., 2008), in which LER_a and LER_b are the partial LER of forage corn and berseem clover, respectively. Y_{aa} and Y_{bb} denote yields of forage corn and berseem clover in sole cropping and Y_{ab} and Y_{ba} are the corresponding yields in intercropping. The relative yield of the crop (R) was calculated as equation (2).

$$LER= (LER_a + LER_b) = \{(Y_{ab}/ Y_{aa}) + (Y_{ba}/Y_{bb})\} \quad (1)$$

$$R = (\text{Yield of individual crops in mixture}/ \text{Yield of individual crops in sole cropping}) \quad (2)$$

The relative yield total (RYT) was used when both crops have planted on the basis of the same plant density, and it can directly shows the benefits of intercropping system.

Analysis of variance was carried out with MSTAT-C. The means were compared by Duncan ’s multiple range method using MSTAT-C software program.

Table 1. Soil analysis of the experimental site at two depths (0-30 cm and 30-60 cm)

Depth (cm)	EC (ds/m)	pH	$caco_3$ (%)	OC (%)	P (ppm)	K (ppm)	Sand (%)	Silt (%)	Clay (%)	Soil texture
0-30	2.89	8.1	40	1	57.3	414	19	37	44	Clay
30-60	2.23	8.3	41	0.9	55.8	409	19	33	48	Clay

Table 2. Analysis of irrigation water

EC (ds/m)	pH	Na^+ (meq/lit)	$Ca^{+2}+Mg^{+2}$ (meq/lit)	SO_4^{-2} (meq/lit)	Cl^- (meq/lit)	HCO_3^- (meq/lit)	CO_3^{-2} (meq/lit)	SAR
2	7.4	11.8	8.4	5.6	10.8	2.4	0	5.8

RESULTS AND DISCUSSION

Cultivar had significant influence on total corn fresh and dry yields, R of clover, RYT and LER. Total clover fresh yield, total corn fresh yield, total corn dry yield, R of clover, RYT and LER were significantly influenced by nitrogen treatments. Cultivar and nitrogen interaction also had significant effect on total corn fresh and dry yield, R of clover, RYT and LER (Table 3). There were no differences in total clover fresh and dry yield between berseem cultivars, but application of 60 kg N/ha had the maximum values for these traits. The highest total corn fresh yield was obtained in intercropping with Sacromont cultivar. There was no significant differences in total corn dry yield, when intercropped by these three cultivars. There was no significant difference in corn organic matter intercropped with different cultivars. Corn organic matter was increased from application of 0 to 60 kg N/ha, but it was not statistically significant (Table 4).

LER in all intercropping of forage corn with different cultivars of berseem clover was higher than one, that means a larger area of land is needed to produce the same yield of sole crop of each component than intercropped (Javanmard *et al*., 2009). The highest and lowest LER was obtained in cultivation of forage corn intercropped by Sacromont and Multicut, respectively, but there was no significant difference between Karaj and Multicut (Table 4). Higher LER in intercropping treatments indicated yield advantage over monocropping due to better land utilization (Nasrollahzadeh *et al*., 2009). Results also indicated that LER was higher than one in all of the mixtures with application of nitrogen fertilizers. Land equivalent ratio ranged from 1.62 to 2.32 (Table 4). Therefore, 62 to 132% more land should be used in sole cropping to obtain the same yield of intercropping, which indicates the superiority of the intercrops in using environmental resources (Javanmard *et al*., 2009). Many scientists reported that LER was greater than one in cereal and legume intercrops (Ghosh, 2004; Yilmaz *et al*., 2008). The maximum LER was related to no application of nitrogen fertilizer. The finding that the LER value decreases with increasing fertilization has been confirmed by a number of reports (Akanvou *et al*., 2001; Bilalis *et al*., 2005). Yildirim and Guvenc (2005) noted that, LER values were always more than one in their intercropping systems. There was no significant difference in R of corn between cultivars, but the maximum R of clover was obtained in cultivation with Sacromont. The highest R of corn and clover was related to no application of nitrogen fertilizer (Table 4). In this experiment RYT had changed from 1.02 to 1.26 between cultivars. The maximum RYT was related to cultivation of forage corn with Sacromont. RYT significantly decreased from application of 0 to 60 kg N/ha (Table 4). Ghaderi *et al*. (2008) concluded that the highest RYT shows the advantages of intercropping over sole cropping. In their experiment, RYT had changed from 1.05 to 1.15.

Table 3. Analysis of variance of studied characters

S.O.V.	d.f	Total clover fresh yield	Total clover dry yield	Total corn fresh yield	Total corn dry yield	R of corn	R of clover	RYT	LER	Corn organic matter
Replication	2	1.24^{ns}	0.046^{ns}	5.02**	2.18**	0.027^{ns}	0.001	0.019^{ns}	0.020^{ns}	42.97^{ns}
Cultivar	2	0.16	0.021	55.4**	5.66**	0.010^{ns}	0.158**	0.111**	0.109**	57.68^{ns}
Nitrogen	2	6.33**	0.090^{ns}	77.6**	6.11**	0.024^{ns}	0.865**	1.154**	1.153**	35.22
Cultivar×Nitrogen	4	0.51	0.001	9.61**	0.35**	0.001	0.083**	0.074**	0.073**	20.22
Error	16	0.75	0.038	0.626	0.33	0.009	0.001	0.015	0.015	41.76

* and :**significant at 0.05 and 0.001 probability levels,: ^{ns} non significant

Table 4. Mean comparisons for total clover fresh yield (ton/ha), total clover dry yield (ton/ha), total corn fresh yield (ton/ha), total corn yield (ton/ha), LER, R of corn, R of clover and corn organic matter (%)

Treatment	Total clover fresh yield	Total clover dry yield	Total corn fresh yield	Total corn dry yield	R of corn	R of clover	RYT	LER	Corn organic matter
Cultivar									
Karaj(C1)	11.65a	1.483a	33.83b	11.56a	0.86a	1.01b	1.02b	1.88b	64.76a
Sacromont(C2)	11.62a	1.387a	37.69a	11.53a	0.79a	1.26a	1.26a	2.06a	60.33a
Multicut(C3)	11.87a	1.440a	33.06b	11.96a	0.81a	1.04b	1.05b	1.86b	64.68a
Nitrogen (kg/ha)									
0(N1)	10.82b	1.344a	31.72c	9.34c	0.87a	1.45a	1.45a	2.32a	61.78a
40(N2)	11.83a	1.422a	35.31b	12.09b	0.82ab	1.02b	1.03b	1.86b	62.49a
60(N3)	12.49a	1.543a	37.54a	13.61a	0.77b	0.84c	0.85c	1.62c	65.50a
Cultivar×Nitrogen									
C1N1	10.65bc	1.34e	31.33f	8.20f	0.90a	1.27d	1.18b	2.18b	60.58a
C1N2	11.44abc	1.42cd	34.63cd	11.67c	0.88a	0.85f	0.74c	1.74c	65.33a
C1N3	12.87a	1.54ab	35.53c	14.80a	0.80a	0.92e	0.73c	1.73c	68.37a
C2N1	10.52c	1.06f	32.80e	9.46e	0.86a	1.60a	1.47a	2.47a	62.07a
C2N2	12.07abc	1.46c	37.63b	12.17c	0.78a	1.34c	1.13b	2.13b	57.74a
C2N3	12.27ab	1.61a	42.63a	12.97b	0.75a	0.83fg	1.59c	1.59c	61.20a
C3N1	11.30abc	1.30e	31.03f	10.3d	0.85a	1.47b	1.33ab	2.33ab	62.69a
C3N2	11.97abc	1.36de	33.67de	12.4bc	0.81a	0.87ef	0.70c	1.70c	64.39a
C3N3	12.33a	1.49bc	34.47cd	13.07b	0.76a	0.79g	0.55c	1.55c	66.94a

Means with a common letters within each column do not differ significantly based on Duncan’s test at 0.05% probability level

CONCLUSIONS

Intercropping of legumes with cereals such as forage corn shows many benefits. On the basis of the results, forage corn-berseem clover intercrops produced greater dry matter yield than sole cropping. Also, RYT and LER were greater in intercropping, that was mainly due to a greater ability to capture resources. A higher land equivalent ratio (LER) value leads to a crop yield advantage (Ghosh, 2004). It can be concluded that corn-legumes intercropping could significantly increase forage quality and quantity (Javanmard *et al*., 2009).

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