ASSESSING THE LAND EQUIVALENT RATIO (LER) OF TWO CORN [ZEA MAYS L.] VARIETIES INTERCROPPING AT VARIOUS NITROGEN LEVELS IN KARAJ, IRAN

Mazaheri Dariush, Madani Ahad, Oveysi Meysam

College of Agriculture of Tehran University

Islamic Azad University of Ramhormoz, Khosestan, Iran

Manuscript received: December 22, 2005; Reviewed: May 7, 2006; Accepted for publication: August 13, 2006

ABSTRACT

The experiment was carried out to study effect of two corn varieties intercropping combinations (75%SC704:25%SC604, 50%SC704:50%SC604, 25%SC704:75%SC604) on land use efficiency at various nitrogen levels (150, 200, and 250 kg ha^{-1}) using the Land Equivalent Ratio (LER). Intercropping combinations had significant ($p<0.01$) effect on LER for grain and biological yield. Maximum LERs of 1.066 and 1.039 for grain and biological yield were attained by 50%SC704:50%SC604 intercropping combination indicates that the area planted to monocultures would need to be 6.6% and 3.9% greater than the area planted to the intercrop for the two to produce the same combined grain and biological yield, respectively. At all of nitrogen levels, 50%SC704:50%SC604 combination showed yield advantage (Total LER > 1.0) compared monoculture in equal land area. Nitrogen levels had no significant effect on LER for grain and biological yield. How ever, maximum LERs of 1.032% and 1.022% for grain and biological yield were attained by middle (200 kg ha^{-1}) nitrogen level.

Keywords: Land equivalent Ratio, LER, Corn, Nitrogen, Yield

INTRODUCTION

Managing the complexity of interactions that are possible when more of the elements of diversity are present in the farm system is key part of reducing the need for external inputs and moving toward sustainability [2-5]. Increasing diversity often allows better resources use efficiency in agro ecosystem because with higher diversity, there is greater microhabitat differentiation, allowing the components species and varieties of the system to grow in an environment ideally suited to its unique requirements [11, 8-12].

A primary and direct way of increasing diversity of an agro ecosystem is intercropping system that allows interaction between the individuals of the different crops and varieties [11, 12, 10]. Intercropping can add temporal diversity through the sequential planting of different crops during the same season [12-3].An important tool for the study and evaluation of intercropping systems is the Land Equivalent Ratio (LER). LER providing that all other things being equal measure of the yield advantage obtained by growing two or more crops or varieties as an intercrop compared to growing the same crops or varieties as a collection of separate monocultures [2,12]. LER thus allows us to go beyond a description of the pattern of diversity into an analysis of the advantages of intercropping [5,9,6]. The LER is calculated using the formula LER= ∑ (Ypi/Ymi), where Yp is the yield of each crop or variety in the intercrop or polyculture, and Ym is the yield of each crop or variety in the sole crop or monoculture. For each crop (i) a ratio is calculated to determine the partial LER for that crop, then the partial LERs are summed to give the total LER for the intercrop (Table1).

An LER value of 1.0, indicating no difference in yield between the intercrop and the collection of monocultures [8,1,6]. Any Value greater than 1.0 indicates a yield advantage for intercrop. A LER of 1.2 for example, indicates that the area planted to monocultures would need to be 20% greater than the area planted to intercrop for the two to produce the same combined yields [5,7]. In a sense, the LER measures the levels of intercrop interference going on in the cropping system [12, 6]. Theoretically, if the agro ecological characteristics of each crop in a mixture are exactly the same, the total LER should be 1.0 and the partial lERs should be 0.5 for each [10, 1]. A total LER of higher that 1.0 indicates the presence of positive interferences among the varieties or crops components of the mixture, and also mean that any negative interspecific interference that exists in the mixture is not as intensive as the intraspecific interference that exists in the monocultures [2, 10, and 6]. Avoidance of competition or partitioning of resources is probably occurring in the mixture [11, 12].

MATERIALS AND METHODS

The experiment was carried out at the agriculture research farm of Tehran University in Karaj during 2003. The site is located at 35º 25´ N latitude, 71 º 25´ E longitudes and an altitude of 1321 meters above sea level. Karaj is located about 30 km west of Tehran thus has a semi-arid (375mm rainfall yearly) climate. The soil of experimental site was clay loam with a clay type of montmorillionite, low in nitrogen (0.04-0.05%), low in organic matter (0.9-1%) and alkaline in reaction with a PH of 7.8 and Ec=0.44 ds m^{-1}.

The experiment was laid out in two factorial [Intercropping combinations (75%SC704 25%SC604, 50%SC704 50%SC604, and 25%SC704 75%SC604) and Nitrogen levels (150, 200 and 250 Kg/ha)] randomized randomized complete block design have tree replication. A sub plot size of 4.5m × 4m, having 6 rows 4 m long was used. Sowing was done in hills. Normal cultural practice was followed uniformly for all experimental units. The plots were hand weeded in different vegetative stages. Irrigation was applied at weekly interval. Areas of $6m^2$ (2 m from 4 middle rows) were hand harvested from each sub plot to estimate grain and biological yield and partial and total LER calculated. Data were statistically analyzed using analysis of variance technique appropriate for randomize complete block design with plant densities split on planting dates and Duncan ($p<0.05$) test was employed for mean separation when F-values were significant.

Table1: Representative data for calculation of LER

	Yield in polyculture (Yp)	Yield in monoculture (Ym)	Partial LER (Ypi/Ymi)	Total LER for polyculture
Variety A	1000	1200	0.83	∑ (Ypi/Ymi)=1.63
Variety B	800	1000	0.80	

RESULTS AND DISCUSSION

LER for grain yield:

The statistical analysis of data indicates that intercropping combinations had significant effect (P<0.01) on LER for grain yield (table2). Maximum and minimum LERs of 1.066 and 0.974 were attained by 50%SC704: 50%SC604 and 25%SC704: 75%SC604 intercropping combinations, respectively. How ever, no LER difference was observed among 25%SC704:75%SC604 and 75%SC704:25%SC604 combinations (Fig1). Laster (12) reported that soybean and bean intercropping in 1:1 ratio gave the highest monetary return and land equivalent ratio (LER) of 2.00 and the yield advantage was more in intercropping than all sole cropping systems. In other hand, Mazaheri [9] reported that SC604 and SC704 intercropping in 1:1 ratio gave 15.3% and 7.8% greater grain yield compared 1SC704:3SC604 and 3SC604:1SC704 combinations, respectively.

Nitrogen levels had no significant effect on LER however, maximum LER of 1.034 was attained by middle (200 kg ha^{-1}) nitrogen level (table2, 3). At all nitrogen levels, 50%SC704 50%SC604 combination showed yield advantage (total LER > 1.0) compared monoculture in equal land area while, At all nitrogen levels, monoculture obtained greater yield (in equal land area) compared 25%SC704: 75%SC604 combination. Monoculture showed yield advantage (in equal land area) compared 75%SC704:25%SC604 combination only at 250 kg ha^{-1} nitrogen level. At all nitrogen levels, lowest difference between SC704 partial LER and SC604 partial LER was attained by 50%SC704: 50%SC604 combination (partial LER for both of these varieties was noted about 0.5), indicating that competition or partitioning of resources (for example nitrogen) are less than other combinations that cause to greater combined yield. While there is a great difference between partial LERs of SC704 and SC604 varieties at all nitrogen levels. Beets [4] demonstrated that corn and soybean intercropping in 1:1 combination gave maximum monetary return, greater total LER (equal to 1.35), and partial LERs of 0.7 and 0.65 for corn and soybean, respectively. Therefore, it seems that less competition between corn and soybean in 1:1 ratio compared other combinations resulting to equal partial lERs of greater than 0.5 (total LER>1) and graiter mixture yield.

In other hand, actual partial LER of SC704 in all of intercropping combinations and nitrogen levels are greater than expected partial LER of SC704 (expected partial yield of SC704 at A%SC704:(100-A)%SC604 is A/100). This actual partial LER advantage compared expected partial LER, indicating that SC704 is a winner in the competition with SC604, it may due to that SC704 has a longer growth season and is its height is more than SC604. Oveysi [4] reported that SC704 in 1SC704:1SC604 and 1SC704:3SC604 combinations were 20 cm and 38 cm taller than SC604, resulting to less competition and greater mixture yield in 1:1 ratio.

LER for biological yield:

The statistical analysis of data indicates that intercropping combinations had significant effect (P<0.05) on LER for biological (Table2). Maximum and minimum LERs of 1.039% and 0.991/% were attained by 50%SC704: 50%SC604 and 25%SC704: 75%SC604 intercropping combinations, respectively. How ever, no LER difference was observed among 25%SC704:75%SC604 and 75%SC704:25%SC604 combinations (Fig1). Nitrogen levels had no significant effect on LER however, maximum LER of 1.022 was attained by middle (200 kg/ha) level (table2, 3). At all nitrogen levels, 50%SC704 50%SC604 combination showed yield advantage (Total LER > 1.0) compared monoculture in equal land area.25%SC704: 75%SC604 intercropping combination showed yield advantages compared monoculture only at middle nitrogen level. At lowest and middle nitrogen levels, 75%SC704:25%SC604 combination showed biological yield advantages compared monoculture in equal land area (Total LER>1). For biological yield like grain yield, partial LERs of two varieties at 50%SC704 50%SC604 combination were equal (About 0.5), indicating low negative competition between mixture

Table 2: mean comparison of Total LER (%) as affected by intercropping combinations and nitrogen levels.

Source of variation	d.f	LER for grain yield	LER for biological yield
Replication	2	0.0070325 **	0.0030778 **
Intercropping combination	2	0.0090985	0.0060369
Nitrogen level	2	0.0030112 n.s	0.0010119 n.s
Intercropping × Nitrogen Level	4	0.0020144 n.s	0.0010001 n.s
Error	16	0.0010036	0.0010691

Means of the same category followed by different letters are significantly different at 0.05 % level of probability using Duncan test

Table 3: T otal LER and prtial LERs for grain yield at various intercropping combinations and nitrogen levels.

Nitrogen levels (kg ha^{-1})	Intercropping combinations	Partial LER for SC704	Partial LER for SC604	Total LER	Total LER means for Nitrogen levels
150	75%SC704 25%SC604	0.974 a	0.241	1.035	102.1 a
	50%SC704 50%SC604	0.557	0.469	1.053	
	25%SC704 75%SC604	0.265	0.708	0.973	
200	75%SC704 25%SC604	0.763	0.249	1.012	103.4 a
	50%SC704 50%SC604	0.559	0.556	1.115	
	75%SC704 25%SC604	0.256	0.720	0.976	
250	75%SC704 25%SC604	0.750	0.246	0.996	99.9 ab
	50%SC704 50%SC604	0.544	0.485	1.029	
	25%SC704 75%SC604	0.263	0.710	0.973	

Means of the same category followed by different letters are significantly different at 0.05 % level of probability using Duncan test.

Table 4: Total LER and partial LERs for Biological yield at various intercropping combinations and nitrogen levels

Nitrogen levels (kg ha^{-1})	Intercropping combinations	Partial LER for SC704 (%)	Partial LER for SC604 (%)	Total LER (%)	Total LER means for Nitrogen levels (%)
150	75%SC704 25%SC604	0.780	0.240	1.020	101.1 a
	50%SC704 50%SC604	0.546	0.492	1.038	
	25%SC704 75%SC604	0.267	0.708	0.975	
200	75%SC704 25%SC604	0.766	0.229	1.005	102.0 a
	50%SC704 50%SC604	0.644	0.514	1.058	
	75%SC704 25%SC604	0.256	0.746	1.002	
250	75%SC704 25%SC604	0.769	0.225	0.994	100.5 ab
	50%SC704 50%SC604	0.517	0.505	1.022	
	25%SC704 75%SC604	0.265	0.731	99.9	

* Means of the same category followed by different letters are significantly different at 0.05 % level of probability using Duncan test.

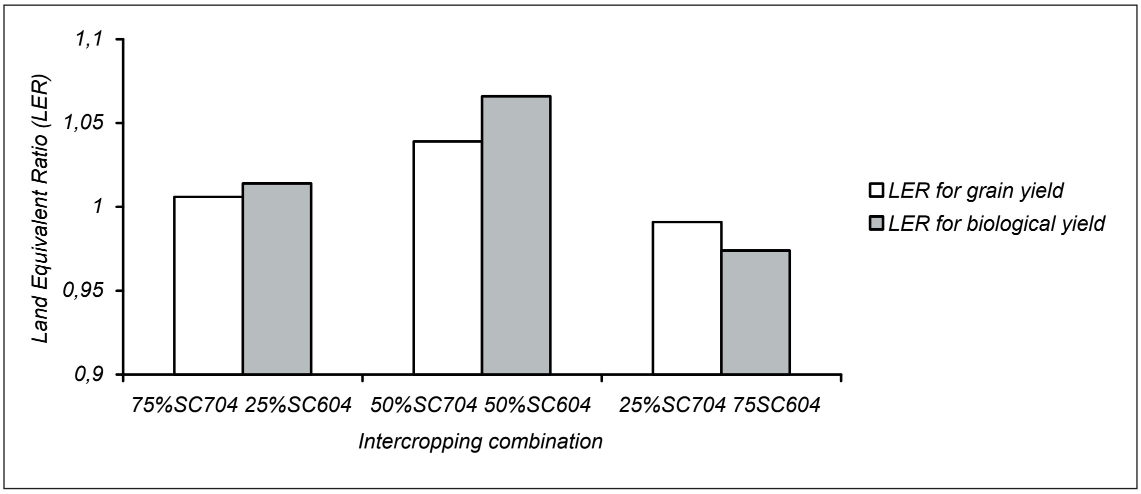

Figure 1: LER for garin and biological yield as affected by intercropping combinations

components, resulting more biological yield compared monoculture.

REFRENCES

[1] Agrawal, R.L., 1995. Emerging trends in cropping system. Indian Farmers Digest., 10: 20-23.

[2] Andrews, D.J. and A.H. Kassam, 1976. The importance of multiple cropping is increasing world food supplies. In multiple cropping. American Society of Agron, 27: 1-10.

[3] Anonymous, 1996-97. Bangladesh Agricultural Research Institute, pp: 16 1.

[4] Beets, W.C., 1994. Multiple cropping of maize and soybean under a high level of crop management. Netherlands J. Agric. Sci., 25: 95-102.

[5] Herrara, W.A.T. and R.R. Harwood, 1974. The effect of plant density and row arrangement on productivity of com rice intercrop. Paper presented at the 5th annual convention of the crop science of Philippines, Nagar City, and pp: 16-18.

[6] Kurata, T., 1986. A study on farming system in USSA. Quarterly J. Agro. Eco., 26: 179-205.

[7] Laster, M.L., and R.E. Furr. 1972. Heliothis populations in cotton-sesame interplantings. Journal of Economic Entomology. Vol. 65,

No. 5. p. 1524–1525

[8] Mazaheri.D, and M.oveysi. 2004.effects of intercropping of two corn varieties at various nitrogen levels. Iranian journal of agronomy. P:71-76

[9] Pathick, D.C. and M.L. Malla, 1979. Study on the performance of crop legume under monoculture and intercrop combination. Sixth annual maize development workshop, Nepal.

[10] Venkatswarlu, J., N.K. Sanghi, U.M.B. Rao and C.H. Rao, 1979. Maximizing production in a sorghum/ pigeon pea system in the semi arid tropics. In: R.W. Willey (eds.), Proc. Inter. Workshop on intercropping .ICRISAT, Hyderabad, India, pp: 30-34.

[11] Willey. R.W. and M.S. Reddy, 1981. A field technique for separating above and below ground interaction for intercropping of expt. With pearl millet/ groundnut. Expt. Agric., 17: 257-264.

[12] Yancey, Cecil Jr. 1994. Covers challenge cotton chemicals. The New Farm. February. p. 20–23.