Competition Indices of Barseem Clover, Italian Ryegrass Mixtures

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ABSTRACT

This study clarifies the affects of interseeding Italian-ryegrass with barseem clover in mixtures. Seeding ratios influence in yield of species, competition and the economics of mixture growing was also included. Barseem monoculture significantly enjoyed the largest dry forage per square meter in all the studied cutting and as a seasonal total.Whereas, ryegrass monoculture, significantly showed small dry forage yield during the third, fourth cuttings and total seasonal yield. The highest significant total dry yield obtained with increasing the percentage of barseem contribution to binary mixture. In the meantime, ryegrass contribution to the composition of the binary mixture was maximum when mixing ratio was 75:25 barseem: rye approximately in all four cutting. Commonly, the estimated indices showed different correlations. Monetary advantage index (MAI) or Intercropping advantage (IA) which is the economic measure to mixtures profitability, showed strong positive correlation with each of A_{rye} and AYL_{Rye} as a partial IA_{Rye}. Whereas, $IA_{Barseem}$ showed positive significant strong correlation with $CR_{Barseem}$. Actual Yield loss AYL_{Rye} showed positive significant strong correlation with A_{Rye} and CR_{Rye}.Whereas, negative significant strong correlation were obtained for $CR_{Barseem}$ and $A_{Barseem}$.

Key words: Barseem clover, Italian rye grass, competition indices, botanical composition, dry forge yield.

INTRODUCTION

Barseem clover (*Trifolium alexandrinum , L*) is the main forage crop that is well adapted to the whole land of Egypt. Farmers used to grow barseem in monoculture. The long season of production that extend to more than seven months, encounter high palatability, high protein and low energy forage. Early cutting of barseem is almost characterized by high moisture content, which represent a great problem to calves growers.

Barseem-grass mixtures were proposed as a tool to overcome the problems related to quality, productivity and botanical composition (Ibrahim *et al.*, 1978, Ahmed and Nour, 1996 and Ahmed, 1999, Ahmed *et al.*, 2012 and Ahmed *et al.*, 2013). Casler (1988) stated that the effective use of management practices to maintain components of an interspecific mixture is often precluded by differences in physiological growth requirements and differences in growth and regrowth potentialities among the components of mixture. Also, Smith *et al.*, (1986) added that maintaining the components of a mixture at a specific level is another difficulty. More complexity is added when management of the mixture is based on requirement of one component, only (Smith, 1968). Moreoverthe level of competitives shown by a campanion grass species in a binary mixture varies depending on management practices including; fertilization, watering, harvest protocol (Mosso and wedin, 1990).

Productivity and botanical stability of barseem-grass mixtures is fluctuating because of fluctuation in levels of competition between components, through the successive cuttings. Barseem and grass species may compete for irradiance, nutrients and water, when grown in mixture.

Competition for irradiance that is related to plant height and growth habit is often considered critical (Donald, 1961). Although, deeper root system of legumes enables larger area for water absorption, they have limited water use efficiency (Haynes, 1980). In the meanting fibrous roots and low cation-exchange capacity give grasses an advantage in extracting cations from soil. On the other hand, nitrogen is non-competitive to the side of legumes (Haynes, 1980).

Ahmed (1999), used the concept of relative yield total (RYT) set by (De wit, 1960) to characterize the competitive relationships between barseem and each of eight grass forage species. He obtained values of (RYT) greater than unity for barseemand italian ryegrassmixture, through the four cuttings suggesting a synergistic compatibility between barseem and Italian ryegrass. Variable seeding rates for barseem and Italian ryegrass when grown in mixture, might affect the competition and the stabilization of mixture through successive cuttings. Furthermore, competition indices have not been used in barseem-ryegrass mixtures to evaluate the corresponding competition and advantage in using resources.

The objectives of the recent study were ;(i) to evaluate forage yield and botanical composition of barseem –ryegrass mixtures at three seeding rates.(ii) Evaluate the different competition indices that were applied to intercropping systems, to determine the most useful index related to both yield and botanical composition characters.

MATERIALS AND METHODS

Helalli barseem clover (*Trifolium alexandrinum*, L) seeds were kindly supplied by the forage crop section, FCRI, ARS, Giza. Liflona Italian ryegrass (*Lolium multiflorium westworidicum,* Lam.) was introduced from Italy. Monocultures and Binary mixture of these two forages were included. Seeding rates for different mixtures are summarized in (Table 1). Forages were seeded October, 3, 2014 and October, 9, 2015 in clay loam soil of the Experimental station at the Faculty of Agriculture, Alexandria University, 10 km south of Alexandria. Four replicates of five treatments were included in a randomized complete block design.Each plot was 6×7=42 m^2 in both seasons. Seeds of binary mixtures were mixed entirely prior to manual band seeding in 30 rows at 20 cm apart.

Four cutting were taken each season at 60, 105, 140, 170 days from planting, respectively. Green forage yield was estimated from five random square meters from each plot. A random area of 0.25 m^2 (50× 50 cm) from each plot was cut for botanical composition determination. A sub-sample of about 200 g fresh forage was taken from each plot for dry matter determination. Samples were chopped to 1-2 cm pieces, before drying to a constant weight in an oven at 70 ^{0}c . These samples were used to calculate dry matter yield. Plant height for barseem and ryegrass in each plot was taken as an average of five readings in each plot in each cut. Data of plant height were measured at each cut.

Competition indices:

Mixing advantage and competition effects between barseem clover and ryegrass were calculated. These included:

(i) Land equivalent ratio (LER):

LER indicates the efficiency of intercropping for using the resources of the environment compared with monocropping (Mead and Willey, 1980). The value of unity is the critical value. When the LER is greater than one the intercropping favors the growth and yield of the species. In contrast, when LER is lower than one the intercropping negatively affects the growth and yield of the plants grown in mixtures (Ofori and Stern, 1987: Caballero *et al.*, 1995). The LER was calculated as:

$$LER = (LER_{Barseem} + LER_{Rye}),$$

$$LER_{Barseem} = \left(\frac{Y_{BR}}{Y_B}\right), \quad LER_{Rye} = \left(\frac{Y_{RB}}{Y_R}\right)$$

Where Y_B and Y_R are the yields of common barseem and ryegrass, respectively, as sole crops and Y_{BR} and Y_{RB} are the yields of common barseem and ryegrass, respectively, as intercrops.

(i) Relative crowding coefficient (K):

Which is a measure of the relative dominance of one species over the other in a mixture (De Wit, 1960).

The K was calculated as:

$$K = (K_{Barseem} K_{Rye})$$

$$K_{Barseem} = \frac{Y_{BR} Z_{RB}}{(Y_B - Y_{BR}) Z_{BR}}, \quad K_{Rye} = \frac{Y_{RB} Z_{BR}}{(Y_R - Y_{RB}) Z_{RB}}$$

where Z_{BR} is the sown proportion of common Barseem in mixture with Rye and Z_{RB} the sown proportion of Rye in mixture.When the product of the two coefficients ($K_{Barseem}K_{Rye}$) is greater than one, there is a yield advantage, when K is equal to one there is no yield advantage, and when it is less than one there is a disadvantage.

(ii) Aggressivity (A):

Is another index that is often used to indicate how much the relative yield increase in 'a' crop is greater than that of 'b' crop in an intercropping system (McGilchrist, 1965). The aggressivity is derived from the equation:

$$A_{Rye} = \left(\frac{Y_{RB}}{Y_R Z_{RB}}\right) - \left(\frac{Y_{BR}}{Y_B Z_{BR}}\right)$$

if $A_{Rye} = 0$, both crops are equally competitive, if A_{Rye} is positive then the Rye species is dominant, if A_{Rye} is negative then the Rye species is the dominated species. Accordingly، aggressivity for common barseem can be derived from the equation

$$A_{Barseem} = \left(\frac{Y_{BR}}{Y_B Z_{BR}}\right) - \left(\frac{Y_{RB}}{Y_R Z_{RB}}\right).$$

(iii) Competitive ratio (CR):

is another way to assess competition between different species. The CR gives a better measure of competitive ability of the crops and is also advantageous as an index over K and Aggressivity (Willey and Rao, 1980). The CR represents simply the ratio of individual LERs of the two component crops and takes into account the proportion of the crops in which they are initially sown. The CR is calculated according to the following formula:

$$CR_{Barseem} = \left(\frac{LER_{Barseem}}{LER_{Rye}}\right)\left(\frac{Z_{RB}}{Z_{BR}}\right)$$

$$CR_{Rye} = \left(\frac{LER_{Rye}}{LER_{Barseem}}\right)\left(\frac{Z_{BR}}{Z_{RB}}\right)$$

Table 1: List of plant materials included in the study, their with seeding rates (kg/ha), 100seeds weight (mg) and designation.

Species	origin	100 seeds weight (mg)	Seeding rate(kg/ha)	Seeding rates(kg/ha)	
				Monoculture	In Mixture
Lolium multiflorium, Lam.	Italy	827	57.6	57.6	A 38.59
"Italian ryegrass"					B43.20
					C 47.81
Trifolium alexandrinum,(L.)	Egypt	329	60.0	60.0	A 19.80
"Barseem clover"					B 15.00
					C 10.20

A;67:33%, B;75:25%, C;83:17% Barseem / Ryegrass% respectively.

(iv) Actual yield loss (AYL) index:

Banik *et al.* (2000) reported that the actual yield loss (AYL) index gave more precise information about the competition than the other indices between and within the component crops and the behaviour of each species in the intercropping system, as it is based on yield per plant. The AYL is the proportionate yield loss or gain of intercrops in comparison to the respective sole crop, i.e., it takes intoaccount the actual sown proportion of the component crops with its pure stand. In addition, partial actual yield loss $AYL_{Barseem}$or AYL_{Rye}) represent the proportionate yield loss or gain of each species when grown as intercrops, relative to their yield in pure stand. The AYL is calculated according to the following formula (Banik, 1996):

$$AYL = AYL_{Barseem} + AYL_{Rye},$$

$$AYL_{Barseem} = \left\{ \left[\left(\frac{Y_{BR} / X_{BR}}{Y_B / X_B} \right) \right] - 1 \right\},$$

$$AYL_{Rye} = \left\{ \left[\left(\frac{Y_{RB} / Z_{RB}}{Y_R / Z_R} \right) \right] - 1 \right\},$$

The AYL can have positive or negative values indicating an advantage or disadvantage accrued in intercrops when the main objective is to compare yield on a per plant basis.

(v) Money advantage of the intercropping system (MAI):

Moreover, none of the above competition indices provides any information on the economic advantage of the intercropping system. For this reason, the monetary advantage index (MAI) was calculated as:

$$MAI = \frac{(value\ of\ combined\ intercrops) \times (LER - 1)}{LER}$$

The higher the MAI value the more profitable is the cropping system (Ghosh, 2004). Also, intercropping advantage (IA) was calculated using the following formula (Banik *et al.*, 2000):

$$IA_{Rye} = AYL_{Rye} \times P_{Rye}$$

$$IA_{Barseem} = AYL_{Barseem} \times P_{Barseem}$$

Where P_{Rye} is the commercial value of cereal silage (thecurrent price is $43 per Mg), and $P_{Barseem}$ is the commercial value of vetch silage (the current price is $55 per Mg.(Data were subjected to analysis of variance(ANOVA) MSTAT-C package (Michigan State university, 1996). A combined analysis of variance over growing seasons was performed for the dry forage yield, partial LER and total LER, as well as for all other indices data. This was made because the Bartlett's test to check for homogeneity of variances of each parameter among years indicated that they were homogeneous. The ANOVA was performed by using a randomized block design replicated four times. Treatment mean differences were separated and tested by Fisher's protected least significant difference (LSD) at P = 0.05 significance level. Because the analysis of variance indicated no treatment × season interaction, the values are reported as means of the two growing seasons.

RESULTS AND DISCUSSION

(i) Means of studied forages:

Combined analysis over years for each studied character in each separate cutting were performed, since, the assumption of homogeneity of variances (Bartlett's test) had not rejected.

Dry forage yield of the five studied forages (two monocultures and three binary mixtures) were presented in Table (2). Barseem monoculture significantly enjoyed the largest dry forage per square meter in all the studied cutting and as a seasonal total. Whereas, ryegrass monoculture, significantly showed small dry forage yield during the third, fourth cuttings and total seasonal yield. Percentage of ryegrass in barseem-ryegrass mixture showed undistinguished contribution to dry forage yield of the first and second cuttings. While, the highest significant total seasonal dry yield obtained with increasing the percentage of barseem contribution to binary mixture.

Botanical composition of the studied forages as an average of the two study seasons in each cutting were presented in Table (3). Barseem contribution to composition of binary mixtures increased proportional to barseem seeding ratio during the first three cuttings, mean while,

Table 2: Dry forage yield (kg.5m²) of the five studied forages(two monocultures and three binary mixtures)for each cutting as an average of the two study seasons

Forages	Seed ratios	Dry forage yield (kg.5m²)				
		1st cutting	2nd cutting	3rd cutting	4th cutting	Over all cutting
Barseem	100	3.050	2.575	2.275	2.225	10.124
Barseem:Rye	67:33	2.600	2.500	2.025	2.300	9.200
Barseem: Rye	75:25	2.300	2.475	2.275	2.050	9.100
Barseem: Rye	83:17	2.500	2.625	2.275	2.350	9.752
Rye	100	2.375	2.125	1.775	1.775	8.052
$L.S.D_{0.05}$		0.360	n.s	0.184	0.197	0.520

Table 3: Botanical composition of five studied forages as an average over seasons for each cutting

Forages	Seed ratios	1 st cutting			2 nd cutting		
		Barseem%	Rye %	Weed %	Barseem%	Rye %	Weed %
Barseem	100	64.77		35.22	69.22		30.77
Barseem: Rye	67:33	48.45	37.37	14.17	52.20	41.17	6.850
Barseem :Rye	75:25	53.90	42.50	3.600	54.60	42.85	3.200
Barseem :Rye	83:17	59.40	39.95	1.550	58.02	39.22	2.750
Rye	100		87.60	12.40		86.55	13.45
$L.S.D_{0.05}$		5.037	3.157	6.500	5.035	3.048	4.650
		3 rd cutting			4 th cutting		
		Barseem%	Rye %	Weed %	Barseem%	Rye %	Weed %
Barseem	100	91.85		8.150	88.45		11.55
Barseem: Rye	67:33	54.42	26.22	19.35	64.70	34.12	1.675
Barseem :Rye	75:25	52.97	25.35	21.67	55.05	34.80	10.15
Barseem :Rye	83:17	60.57	28.75	10.67	56.10	39.92	10.97
Rye	100		85.10	14.90		86.75	13.25
$L.S.D_{0.05}$		5.612	3.844	5.819	3.198	5.836	5.283

vice verse was true by the fourth cutting. In the meantime, ryegrass contribution to the composition of the binary mixture was maximum when mixing ratio was 75:25 barseem: rye approximately in all four cutting.

Weeds percentage in barseem monoculture were descending from 35.23 till 11.55% with the progress of cuttings, expressing the least contribution at the third cutting.

Ryegrass monocultures, exhibited lower weeds percentage relative to barseem monoculture, in all studied cuttings. In the meantime, binary mixtures of barseem ryegrass showed the least significant weeds contributions in all cuttings.

Plant height of barseem and ryegrass monocultures and binary mixtures at the start of the season (first cutting) and the end of the season (fourth cutting) to indicate the degree of competition for irradiance, were presented in Table (4).

Barseem plant height, significantly suppressed by the inclusion of ryegrass in early season (first cutting). While, that effect had not reached the level of significant late in the season (fourth cutting). In the meantime, neither berseem plant height nor ryegrass plant height showed any significant reflection to seed ratios of binary mixtures.

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Table 4: Plant height of barseem and ryegrass in monocultures and binary mixtures at variable seeding ratios at early (first cutting) and late (fourth cutting) season

Forages	Seed ratios	1 st cutting		4 th cutting	
		Barseem plant height	Ryegrass plant height	Barseem plant height	Ryegrass plant height
Barseem	100	64.30		55.22	
Barseem: Rye	67:33	58.72	49.40	55.22	42.92
Barseem :Rye	75:25	56.500	50.10	52.35	46.75
Barseem :Rye	83:17	53.47	50.75	50.52	46.07
Rye	100		53.52		34.15
$L.S.D_{0.05}$		3.484	7.539	2.364	14.13

(ii) Competition indices :

1-land equivalent ratio(LER)

The land equivalent ratio (LER) indicates the efficiency of mixture for using environment resources in comparison to monocultures (Mead and Willey, 1980). The value of unity is the critical value. When the LER is greater than one, the mixture favors growth and yield of the mixed species. In contrary, LER values less than one, indicates negative effect of mixing on growth and yield of mixed species (Caballero *et al.*, 1995). Land equivalent ratios (LER) for mixtures of barseem clover with ryegrass at three seeding ratios were presented in Table (5).All estimates indicated a synergestic effect of barseem inclusion to ryegrass growth and yield and vice verse(Partial LER of barseem and ryegrass). This effect was noticed in all studied four cuttings.

Partial LER $_{Rye}$ was of lower magnitude than the corresponding value for barseem clover. Seeding ratio had unsignificant effects on the estimated partial LER values for barseem in rye-grass during the first three cuttings. Meanwhile, partical LER $_{Rye}$ values at the fourth cutting were significantly highest at 83:17 barseem to rye seeding ratio (1.530). Also, the partial LER $_{Rye}$ was unsignificantly different for 75:25 and 67:33 seeding ratios (1.319 and 1.331, respectively). These values indicate an advantage for both mixtures components (Chen *et al.*, 2004). Yield advantage in term of total LER was significantly greatest by the fourth cutting for 83:17seeding ratio (2.729). This mean that monocrops requires 2.729 time land area to produce the obtained yield from the mixture.

In the meantime, any of the other seeding ratios (67:33 or 75:25) requires 2.4 times land area by monocrops to produce the corresponding yield of mixture (Midya *et al.*, 2005). In all studied seeding ratios, total LER indicated an advantage for mixture over monocultures in term of the use of environmental resoures (Mead and Willey, 1980).

Disadvantages of mixtures over pure stands were reported by (Ghosh, 2004 and Midya *et al.*, 2005).

Table 5: Land equivalent ration (LER) for mixtures of barseem clover and ryegrass in three seeding ratios

Forages	Seed ratios	Relative equivalent ration (LER)		
		LER $_{Barseem}$	LER $_{Rye}$	LER $_{Mixture}$
Barseem : Rye			1st cutting	
	67 : 33	1.316	1.255	2.570
	75 : 25	1.162	1.105	2.267
	83 : 17	1.269	1.211	2.480
	L.S.D $_{0.05}$	n.s	n.s	n.s
Barseem : Rye			2nd cutting	
	67 : 33	1.432	1.412	2.843
	75 : 25	1.393	1.377	2.770
	83 : 17	1.477	1.458	2.934
	L.S.D $_{0.05}$	n.s	n.s	n.s
Barseem : Rye			3rd cutting	
	67 : 33	0.974	1.331	2.305
	75 : 25	1.092	1.465	2.557
	83 : 17	1.098	1.507	2.605
	L.S.D $_{0.05}$	n.s	n.s	n.s
Barseem : Rye			4 th cutting	
	67 : 33	1.032	1.319	2.351
	75 : 25	1.045	1.331	2.377
	83 : 17	1.198	1.530	2.729
	L.S.D $_{0.05}$	n.s	0.115	0.250

2-Relative crowding coefficient (K)

Although unsignificant differences among the Relative crowding coefficient (K) values for all studied seeding ratios were detected Table (6), it seems that partial KBarseem were higher than the obtained figures for KRye in most cases. Indicating that barseem is more competitive than the associated crop ryegrass (Banik et al., 2000). In most cases K values were below one, which indicates that there was a yield disadvantage (Wiley and Rao, 1980 and Ghosh, 2004).

3-Aggressivity (A), Competitive ratio (CR) and Actual yield loss (AYL):

The results of Aggressivity (A) (Table 7), conformed with those of LER andrelative crowding coefficient. In all cuttings the calculated A valuesindicated ryegrass as the dominant species (A_{Rye} positive) in barseem ryegrass mixtures. The A_{Rye} values increased with each decrease in ryegrass seeding ratio. Whereas, $A_{Barseem}$ values decreased with gradual increase in barseem seeding ratio.

These results indicated that barseem clover was not a competitive crop as ryegrass (Midya *et al.*, 2005), (Dhima *et al.*, 2007) found that barley or oat were dominant species in common vetch-cereal mixtures.

Table (8) illustrated the Competitive ratio (CR) for mixtures of barseem clover with ryegrass in three seeding ratios. Mixed barseem clover had higher competitive ratio in all mixing ratio during all cuttings.

Mixing ratio 67:33 significantly enjoyed the highest $CR_{Barseem}$ value in all cuttings. Meanwhile, 83:17 barseem: rye mixture showed CR_{Rye} value higher than $CR_{Barseem}$ especially in the third and fourth cuttings. In most cases the $CR_{Barseem}$ and CR_{Rye} decreased as the proportion of barseem increased in the mixture, i.e; the proportion of ryegrass decreased. This indicates that barseem clover was more competitive as ryegrass was affected more in mixtures.

Actual yield Loss (AYL) had positive values in barseem-rye mixtures during the first and second cutting (Table 9).

$AYL_{Barseem}$ values were negative for all seeding ratios during the third cutting and for 75:25 or 83:17 barseem to rye mixture in the fourth cutting. Positive $AYL_{Barseem}$ values indicate a yield advantage to barseem possibly because of the positive effect of rye on barseem when grown in mixture. (Banik *et al.*, 2000).

Table 6: Relative crowding coefficient (K) for mixtures of barseem clover and rye-grass in three seeding ratios

Forages	Seed ratios	1st cutting		2nd cutting		3rd cutting		4th cutting	
		Relative crowding coefficient (K)							
Barseem :Rye		$K_{Barseem}$	K_{Rye}	$K_{Barseem}$	K_{Rye}	$K_{Barseem}$	K_{Rye}	$K_{Barseem}$	K_{Rye}
	67 : 33	0.786	0.544	1.305	3.142	0.473	0.453	0.736	0.535
	75 : 25	0.606	0.402	1.505	0.813	0.487	0.458	0.505	0.466
	83 : 17	0.881	0.351	2.192	0.530	0.478	0.386	0.540	2.187
	L.S.D 0.05	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

Table 7: Aggressivity (A) for mixtures of barseem clover and ryegrass in three seeding ratios

Forages	Seed ratios	1st cutting		2nd cutting		3rd cutting		4th cutting	
		Aggressivity (A)							
Barseem :Rye		$A_{Barseem}$	A_{Rye}	$A_{Barseem}$	A_{Rye}	$A_{Barseem}$	A_{Rye}	$A_{Barseem}$	A_{Rye}
	67 : 33	-0.473	0.476	-0.650	0.656	-0.260	0.263	-0.363	0.368
	75 : 25	-1.050	0.923	-1.343	1.347	-0.752	0.531	-1.140	1.079
	83 : 17	-1.943	1.644	-2.155	2.331	-1.757	1.762	-2.140	2.147
	L.S.D 0.05	0.622	0.679	1.009	0.897	0.490	0.638	0.484	0.438

Table 8: Competitive ratio (CR) for mixtures of barseem clover and rye-grass in three seeding ratios

Forages	Seed ratio	1st cutting		2nd cutting		3rd cutting		4th cutting	
		Competitive ratio (CR)							
Barseem:Rye		$CR_{Barseem}$	CR_{Rye}	$CR_{Barseem}$	CR_{Rye}	$CR_{Barseem}$	CR_{Rye}	$CR_{Barseem}$	CR_{Rye}
	67 : 33	0.517	0.210	0.509	0.217	0.359	0.304	0.386	0.284
	75 : 25	0.350	0.179	0.344	0.191	0.250	0.259	0.261	0.241
	83 : 17	0.214	0.134	0.211	0.138	0.149	0.194	0.160	0.182
	L.S.D 0.05	0.025	0.012	0.108	n.s	0.052	0.046	0.068	0.060

Table 9: Actualyield loss (AYL) index for mixtures of barseem clover and ryegrass in three seeding ratios

Forages	Seed ratio	1 st cutting		2nd cutting		3rd cutting		4th cutting	
		Actual yield loss (AYL) index							
		$AYL_{Barseem}$	AYL_{Rye}	$AYL_{Barseem}$	AYL_{Rye}	$AYL_{Barseem}$	AYL_{Rye}	$AYL_{Barseem}$	AYL_{Rye}
Barseem :Rye									
	67 : 33	0.123	0.292	0.123	0.442	-0.063	-0.112	0.090	0.191
	75 : 25	0.112	0.942	0.069	0.980	0.192	-0.130	-0.168	0.602
	83 : 17	0.106	1.681	0.011	1.668	0.989	-0.590	-0.128	1.236
	L.S.D $_{0.05}$	n.s	0.213	n.s	0.270	n.s	0.201	n.s	0.354

It was also revealed that in barseem ryegrass mixture, barseem was the dominant species, because the partial AYL of barseem was greater than the partial AYL of ryegrass. According to (Banik *et al.*, 2000), the AYL index can give more precise information than the other indices on theinter and intra-specific competition of the component crops and the behavior of each species included in the mixture. Quantification of yield loss or gain due to association with other species or the variation of the plant population could not be obtained through partial LER_S, whereas, partial AYL show the yield loss or gain by its sign as well as its value .Thus, there was a 12.3, 11.2 and 10.6 % increase in first cutting yield of barseem in barseem ryegrass mixtures 67:33, 75:25 and 83:17 seeding ratios, respectively ($AYL_{Barseem}$ =0.123, 0.112 and 0.106, respectively).

On contrast, there was a 11.2,13.0 and 59.0% reduction in third cutting yield of ryegrass in mixtures of 67:33, 75:25 and 83:17% seeding ratios of barseem and ryegrass (AYL_{Rye}= -0.112 ,-0.130 and -0.590, respectively). The sum of the two partial AYL components can judge, wether one component reduction could be compensated by the other's increase or not.

4- Monetary advantage index and Intercropping advantage:

Monetary advantage index (MAI) values (Table 10) resembled the values of actual yield loss in sign and trend.

Positive values for partial IA index of barseem and rye were noticed, indicating a definite yield advantage during the first and second cutting. The highest significant IA values were provided by IA_{Rye} for 83:17 seeding ratio in the first cutting (285.7), the secondcutting (316.9), the third cutting (207.7) and the fourth cutting (284.3).The fact that IA values were positive for most mixtures, indicate, that these mixing ratios had the highest economic advantage. These results were in agreement with those reported for AYL in (Table 9). Similarly, (Ghosh, 2004) indicated that economic benefit might expressed when mixtures show high values of LER, K and IA.

Differences noticed between mixtures in this recent study might due to Aggressivityof ryegrass that might be influenced by factors related to climate and nutrients. For example differences in plant height between the two mixed species that is affected by density of each component species that can affect nitrogen fixation and reduce light interception due to shading. This can result in poor nodulation, growth and competitive potentiality of barseem. Also, the advantage of mix growing can be attributed to the better utilization of growth resources.

(iii) Correlation:

To illustrate the relationship between each of the estimated competition indices and mixtures forage characters, correlation matrix was calculated for each pair separately (Table 11). Partial $LER_{Barseem}$ was positively and significantly correlated with dry yield (r=0.819). Whereas, negative and significant correlation was obtained between the farmer index and weed percentage (r=-0.341). Partial LER_{Rye} scored positive and significant correlation with dry yield and negative significant correlation with ryegrass percentage (r=0.408 and -0.210, respectively). Total LER showed positive and significant correlations with each of dry yield and ryegrass percentage (r=0.758 and 0.208, respectively) and negative significant correlation with weeds percentage. Consequently, partial LER index is positively significant correlated with dry yield of mixture and negatively correlated with the assigned mixture's component. While, total LER index is positively significant correlated with mixture's dry yield and percentage of the companion grass species, but negatively correlated with both barseem and weed percentage in botanical composition. So that, Land area required to attaine the obtained forage yield of mixture when growing the component species in monoculture pass through proportional relation.

Relative Crowding Coefficient (RCC or K) which is a measure of the relative dominance of one species over the other in mixture showed a positive and significant correlation with dry yield when calculated as $K_{Barseem}$ (r=0.485) and with ryegrass percentage in botanical composition when calculated as partial K_{Rye} (r=0.134).

Table 10: Interceoppingadvantage (IA)for mixtures of barseem clover and ryegrass in three seeding ratios

Forages	Seed ratio	1 st cutting		2nd cutting		3rd cutting		4th cutting	
		Intercropping advantage (IA)							
Barseem :Rye		IA Barseem	IA Rye	IA Barseem	IA Rye	IA Barseem	IA Rye	IA Barseem	IA Rye
	67 : 33	22.06	4.688	29.06	84.50	-28.900	-14.12	23.00	44.16
	75 : 25	20.29	160.25	12.04	186.2	-53.05	40.34	-42.42	138.9
	83 : 17	19.14	285.7	2.814	316.9	-44.60	207.6	-58.95	284.3
	L.S.D $_{0.05}$	n.s	39.24	n.s	50.676	n.s	48.45	18.84	81.18

Table 11: Correlation Matrix between forages characters and compatibility indices for Barseem Ryegrass mixtures

Indices	Forages Characters: Dry yield kg.5m^2	Barseem %	Rye %	Weed%
$LER_{Barseem}$	0.819**	-0.172 n.s	0.558 n.s	-0.341**
LER_{Rye}	0.408**	0.161 n.s	-0.210**	0.085 n.s
$LER_{Mixtures}$	0.758**	-0.003 n.s	0.208**	-0.155**
$K_{Barseem}$	0.485**	0.145 n.s	0.328 n.s	0.354 n.s
K_{Rye}	0.146 n.s	-0.122 n.s	0.134**	-0.030 n.s
$A_{Barseem}$	-0.401**	-0.161 n.s	-0.294 n.s	0.353**
A_{Rye}	0.414**	0.190 n.s	0.290 n.s	-0.378**
$CR_{Barseem}$	0.048 n.s	-0.406**	0.271**	0.050 n.s
CR_{Rye}	-0.444**	0.007 n.s	0.612**	0.408**
$AYL_{Barseem}$	0.102 n.s	-0.029 n.s	0.305**	-0.231**
AYL_{Rye}	0.391**	0.199**	0.522**	-0.578**
$IA_{Barseem}$	0.339**	0.213*	0.612**	-0.648**
IA_{Rye}	0.349**	0.209*	0.458**	-0.532**

Correlations among the estimated competition indices were presented in (Table 12). LER showed significant positive correlations with all estimated indices except for $A_{Barseem}$ and CR_{Rye}, where negative correlations were obtained. The strongest correlations were those recorded for $LER_{Mixture}$, $K_{Barseem}$ and CR_{Rye} (0.797,0.721 and -0.573, respectively).

LER_{Rye} had astrong significant positive correlation with $LER_{Mixture}$ (r=0.812). $LER_{Mixture}$ showed a strong significant positive correlation with $K_{Barseem}$(r=0.627) and A_{Rye}(r=0.512).$A_{Barseem}$showed the strongest significant correlation with A_{Rye} (r=0.953) $CR_{Barseem}$ (r=0.744) and CR_{Rye} (r=0.562). Also, negative significant strong correlation had detected between $A_{Barseem}$ and AYL_{Rye} (r=-0.858) and IA_{Rye} (r=-0.891). In the meantime, A_{Rye} expressed negative significant strong correlation with both of $CR_{Barseem}$ (r=-0.713) and CR_{Rye} (r=-0.558). While, positive strong correlation was detected with AYL_{rye} (r=0.850) and IA_{Rye} (r=0.894). $CR_{Barseem}$ showed strong significant positive correlation with IA_{Baseem} (r=0.595) and negative significant strong correlation with AYL_{Rye} and IA_{Rye} (r=-0.568 and -0.627, respectively). CR_{Rye} showed positive significant strong correlation with AYL_{Rye} (r=0.827) and negative significant strong correlation with IA_{Rye} (r=-0.782). AYL_{Rye} scored positive significant strong correlation with IA_{Rye}.

Commonly, the estimated indices showed different correlations. Monetary advantage index (MAI) or Intercropping advantage (IA)which is the economic measure to mixtures profitability, showed strong positive correlation with each of A_{rye} and AYL_{Rye} as a partial IA_{Rye}. Whereas, $IA_{Barseem}$ showed positive significant strong correlation with $CR_{Barseem}$ .Actual Yield loss AYL_{Rye} showed positive significant strong correlation with A_{Rye} and CR_{Rye} .Whereas, negativesignificant strong correlation were obtained for $CR_{Barseem}$ and $A_{Barseem}$.

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الملخص العربى

دلائل المنافسة لمخاليط البرسيم المصري مع حشيشة الراي الايطالية

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توضح الدراسة الحالية تأثيرات زراعة حشيشة الراي الايطالية مع البرسيم المصري في مخاليط. وقد وضع في الاعتبار تأثيرات معدلات التقاوي علي مكونات المخلوط ودرجة التنافس واقتصاديات الانتاج. وقد اظهرت النتائج تفوق الزراعات المفردة من البرسيم معنويا في محصول العلف الجاف للمتر المربع في جميع الحشات المدروسة والمحصول الاجمالي. بينما أظهرت الزراعات المفردة للراي محصول علف جاف محدود خلال الحشات الثالثة والرابعة والمحصول الاجمالي. حيث تزايد المحصول الموسمي مع زيادة نسبة تقاوي البرسيم في المخلوط. وفي ذات الوقت زادت تأثيرات الراي علي المحصول عند نسبة خلط ٧٥%: ٢٥% برسيم: راي خلال الحشات الاربعة. وبصفة عامة أظهرت الدلائل المحسوبة درجات ارتباط مختلفة. الميزة الاقتصادية (MAI) او ميزة الخلط(IA) والتي تقدر العائد الاقتصادي للمخلوط. أظهرت تلازم موجب قوي مع كل من تقديرات AYL_{Rye} و A_{Rye}. بينما أظهرت قيم $IA_{Barseem}$ تلازم موجب مع $CR_{Barseem}$. معامل الفقد الحقيقي في المحصولAYL_{Rye} أظهر تلازم موجب معنوي مع A_{Rye} CR_{Rye}. بينما سجلت قيم تلازم سلبي معنوي مع كل من $CR_{Barseem}$,$A_{Barseem}$.