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Forage Yield and Competition Indices of Triticale and Barley Mixed Intercropping with Common Vetch and Grasspea in the Mediterranean Region

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ABSTRACT

A 2-year study was conducted at Tel Hadya station (International Center for Agricultural Research in the Dry Area ICARDA) in north-west Syria, to investigate forage yield of triticale (x.*Triticosecale* Wittmack) and barley (*Hordum vulgare* L.) monoculture as well as in mixture with common vetch (*Vicia sativa* L.) and grasspea (*Lathyrus sativus* L.) in one seeding ratio (50:50) during stem elongation and booting stages of the cereal crops, in addition to assess some competition indices such as land equivalent ratio (LER), relative crowding coefficient (RCC or K) and aggressivity (A). Dry matter yield of triticale and barley monocultures fluctuated between small increase and small decrease in comparison with their mixtures. LER and K values exceeded unity in both stages, indicating that there was an advantage of intercropping for exploiting the environmental resources. Legume proportions were better in triticale mixtures in both stages. Aggressivity values indicated that triticale and barley were the dominant species in their mixtures.

Keywords: Mixture, Triticale, Barley, Land equivalent ratio, Relative crowding coefficient, Aggressivity.

INTRODUCTION

Cereals and legumes are considered as important forage crops, because of their nutritional value, especially protein content in legumes and crude fiber in cereals. Monocultures of legumes or cereals do not provide satisfactory results for forage production (Osman and Nersoyan, 1986). Legume crops are low-yielding, particularly in areas with low rainfall (Hadjichristodoulou, 1978) and hinder harvest because they normally lay on the soil surface (Robinson, 1969). On the other hand, small grain cereals provide high yields in terms of dry weight but produce forage with low protein (Lawes and Jones, 1971), and the quality of cereal hay is usually lower than that required to meet satisfactory production levels for many categories of livestock. In recent years, there has been increased interest in agricultural production systems in order to achieve high productivity and promote sustainability over time, such as crop rotation, relay cropping and intercropping of annual cereals with legumes. Intercropping of cereals with legumes has been a common cropping system in rain-fed areas, especially in the Mediterranean countries (Papastylianou, 1990; Anil et al., 1998; Lithourgidis et al., 2004; Lithourgidis et al., 2006).

Potential benefits of intercropping include increased total DM (Reynolds et al., 1994; Ghaffarzadeh, 1997; Holland and Brummer, 1999; Izaurralde et al., 1993). On the other hand, companion cereals provide structural support for legumes growth, improve light interception

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and facilitate mechanical harvest, whereas legumes improve the quality of forage (Robinson, 1969; Thompson et al., 1992). The best relationship between yield and quality was generally obtained when the cereal reached the boot stage and the legume reached the flowering stage (Carnide et al., 1998).

Caballero and Goicoechea (1986) and Thomson et al. (1990) reported that the most suitable cereal for mixtures with common vetch (*Vicia sativa L.*) is oat (*Avena sativa* L.), whereas Thompson et al. (1992) and Roberts et al. (1989) reported that barley (*Hordeum vulgare* L.) and wheat (*Triticum aestivum* L.), respectively, are the most suitable cereals for mixtures. However, Anil et al. (1998) reported that triticale (x.*Triticosecale* Wittmack) can be used as an alternative cereal for mixtures with common vetch.

The results of Lauriault and Kirksey (2004) indicated that intercropping wheat and triticale with pea (*Pisum sativum* L.) or hairy vetch (*Vicia villosa* L.) reduced yield of wheat and triticale compared with thier monocultures, but these yields were still greater than those of the other cereal forages, in addition to the fact that winter pea improved quality indicators when intercropped with wheat or triticale. Blade et al. (2002) at four locations found variable yield performance for barley and triticale in mixtures with peas.

In a study where berseem clover (*Trifoluim alexandrium* L.) was intercropped with one cultivar of each oat, barley and triticale. It was noticed that biomass yields, species' composition and forage quality were affected by cereal species. In addition, berseem clover mixtures with triticale and oat had greater cut1 silage-stage yields and a greater percentage of berseem clover than intercrops with barley. Moreover, triticale had advantages over barley and oat of greater silage yield when intercropped with berseem clover (Ross et al., 2004). Another study was carried out in north-west Syria (Jazraia region), to evaluate quality and quantity of triticale and barley when intercropped with vetch. The results of this study showed that the dry matter yield of triticale-vetch mixture was higher than that of barley-vetch mixture (Al-Yousif, 2000).

However, several factors can affect the growth of the species used in intercropping, including cultivar selection, seeding ratios and competition between mixture components (Droushiotis, 1989; Roberts et al., 1989; Papastylianou, 1990; Caballero et al., 1995; Carr et al., 2004). Studies of cereal intercrops in Alberta (Canada) have found that triticale and wheat were less competitive in mixtures than barley and oat were (Berkenkamp and Meeres, 1987). Several indices such as land equivalent ratio, relative crowding coefficient, competition ratio, aggressivity, actual yield loss and intercropping advantage have been developed to describe competition and advantage in intercropping (McGilchrist, 1965; Willey, 1979; Banik, 1996; Ghosh, 2004; Midya et al., 2005).

The objectives of this study are first to investigate the potential of cereal crops monoculture as well as mixtures with legume ones for forage yield at different growth stages in Mediterranean conditions, and second to estimate the effect of competition among the different crops used in the intercropping systems, and examine the different competition indices in these intercropping systems.

MATERIALS AND METHODS

Plant Material

One triticale line obtained from CIMMYT and characterized by its vigor growth and high biological yield, one local barley cultivar (Arabic aswad), common vetch (line 2604) and grasspea (line 554) were used in this experiment. The seeds of barley, common vech and grasspea were obtained from the International Center for Agricultural Research in the Dry Areas (ICARDA).

Site Description

The experiment was conducted during two growing seasons (2006-2007 and 2007-2008), at Tel Hadya station (ICARDA) in north-west Syria which is characterized by Mediterranean conditions. Climatic data during the study period are shown in Figure (1).

Crop Management and Experimental Design

Seedbed preparation included plowing, disk harrowing and cultivation. The mentioned plant material monocultures as well as mixtures (cereals and legumes), in one seeding ratio (50:50) based on seed weight, were sown in the middle of December at a seeding rate of 130 kg ha^{-1} for cereals and 160 kg ha^{-1} for legumes. Seeds in mixture treatments were mixed and sown together. The experimental design comprised a randomized complete block (RCBD) with eight treatments (four monocultures and four mixtures). The experimental plots were 1.6 X 2.5 m (eight rows, 20 cm apart), with three replications for each treatment.

Treatments

Eight treatments were applied: pure triticale (PT), pure barley (PB), pure common vetch (PV), pure grasspea (PGP), triticale + common vetch (TV), triticale + grasspea (TGP), barley + common vetch (BV) and barley + grasspea (BGP).

Measurements

Pure stands and mixtures were harvested at two growth stages of cereals (stem elongation and booting) according to Zadock`s et al. (1974). At each stage, four rows of each plot were cut to ground level with manual shears, and the forage in mixture treatments was separated by hand for the determination of the cereals' and legumes' percentage in each mixture. The samples were dried in the oven at 70˚C to a constant weight to determine the dry matter yield. Then, the growth rate of the species between the two cutting dates was calculated.

The land equivalent ratio (LER) was used as the criterion for mixed stand advantage as both cereal and legume were desired species (Willey and Osiru, 1972). In particular, LER indicates the efficiency of intercropping for using the resources of the environment compared with monocropping (Mead and Willey, 1980). When the LER is greater than one, the intercropping enhances 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:

$LER = LER_{cereal} + LER_{legume}$, where:

$$LER_{legume} = \left(\frac{Y_{lc}}{Y_l}\right),\ LER_{cereal} = \left(\frac{Y_{cl}}{Y_c}\right),$$

where Y_c and Y_l are the yields of cereal and legume, respectively, as monoculture crops, and Y_{lc} and Y_{cl} are the yields of legume and cereal, respectively, as intercrops.

Another coefficient that is used is the relative crowding coefficient (RCC or K) which is a measure of the relative dominance of one species over the other in a mixture (De Wit, 1960). K was calculated as:

$K = K_{legume}\ K_{cereal}$

$$K_{legume} = \frac{Y_{lc} Z_{cl}}{(Y_l - Y_{lc}) Z_{lc}}, \quad K_{cereal} = \frac{Y_{cl} Z_{lc}}{(Y_c - Y_{cl}) Z_{cl}},$$

where Z_{lc} is the sown proportion of legume in the mixture with cereal and Z_{cl} is the sown proportion of cereal in the mixture. When the product of the two coefficients (K_{legume} K_{cereal}) is greater than one there is a yield advantage, but when K is equal to one there is no yield advantage, and when it is less than one there is a disadvantage.

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

$$A_{cereal} = \left(\frac{Y_{cl}}{Y_c Z_{cl}}\right) - \left(\frac{Y_{lc}}{Y_l Z_{lc}}\right), \quad A_{legume} = \left(\frac{Y_{lc}}{Y_l Z_{lc}}\right) - \left(\frac{Y_{cl}}{Y_c Zcl}\right),$$

if $A_{cereal} = 0$, both crops are equally competitive, if A_{cereal} is positive then the cereal species is dominant and if A_{cereal} is negative then the cereal species is the dominated species.

STATISTICAL ANALYSIS

Standard analysis of variance (ANOVA) was used to analyze the obtained data across both years. The *F* estimates were directly obtained by the general linear model (GLM) procedure of the GenStat11 package, and then differences between means were compared based on the *F*-test. Means were compared by least significant differences (LSD) when *F*-test indicated significant differences (Steel and Torrie, 1984).

RESULTS

Dry Matter Production

Cutting at Stem Elongation Stage (Cut 1)

The analysis of variance (ANOVA) for dry weight data indicated that there were significant differences among treatments (P<0.001) and growing seasons (P<0.01), in addition to a significant interaction between these two factors (P<0.01). The greatest value of dry matter yield in the first growing season was obtained from barley pure stand (4795 kg ha^{-1}), followed by barley-grasspea mixture (4365 kg ha^{-1}). The same trend was observed in the second growing season in terms of the superiority of barley pure stand and barley-grasspea mixture which provided the greatest value (4353 and 3958 kg ha^{-1}, respectively). In general, pure triticale and barley and their mixtures were better than pure legumes in both years (Table 1).

Cutting at Booting Stage (Cut 2)

Highly significant differences (P<0.001) were found between treatments, years and treatment – year interaction (Table 2). In the first growing season, pure triticale had the greatest dry matter yield which was (11692 kg ha^{-1}), followed by barley-grasspea and barley-common vetch which provided 11645 and 11418 kg ha^{-1}, respectively. Similarly, in the second growing season, the greatest value of dry matter was obtained from triticale monocrop (6400 kg ha^{-1}). However, forage yields of all mixtures were lower than yields of cereal in monocultures. In the first year, mixtures of triticale with common vetch and grasspeaa had forage yields lower than those in barley ones, where the contrary was observed in the second year. In addition, both triticale and barley monocultures and mixtures produced more forage yield than the monocultures of common vetch and grasspea (Table 2).

Growth Rate

The mean values of dry matter yield changing dynamics between cut1 and cut2 are shown in Figure 2. There were significant differences between treatments (P<0.01) and growing seasons (P<0.001), but there were no significant differences due to treatment by growing season interaction. Thus, treatment means averaged between (61.4%) and (71.4%) in the first year, and between (21.5%) and (46.8%) in the second one. However, the growth rate of individual triticale and barley among their mixtures was greater than in monoculture, whereas the contrary was noted for common vetch and grasspea (Fig. 2).

Land Equivalent Ratio (LER)

Cut 1

Analysis of variance showed significant differences between treatments for both LER_{cereal} (P<0.05) and LER_{legume} (P<0.001), whereas no significant difference was noted for LER_{total}. In addition, there was no treatment by growing season interaction.

Partial LER of legume decreased in the case of common vetch-cereal mixtures, and the contrary was observed in the case of grasspea. However, in all cases the partial LER values for common vetch and grasspea were lower than 0.5, which indicates that there was a disadvantage for legumes in these intercropping systems and an advantage for cereals which had LER values higher than 0.5 (Table 3). In the cases of barley-common vetch, barley-grasspea and triticale-common vetch mixtures, the LER_{total} exceeded unity, whereas it was lower than one in the triticale-grasspea mixture (Table 3).

Cut 2

Although there were no significant differences between treatments in term of LER_{total}, the partial LER_{cereal} (P<0.01) and LER_{legume} (P<0.001) values differed significantly. The land equivalent ratio of triticale exhibited an increasing trend in the second cutting date, and similar to the first cutting date the mean values of LER_{legume} were lower than 0.5, and LER_{cereal} had values greater than 0.5 in all cases. In addition, LER_{total} exceeded unity in all treatments (Table 3).

Relative Crowding Coefficient (K)

Cut 1

The data presented in Table (4) revealed that barley was more competitive than triticale when they were mixed with common vetch, whereas the contrary was noted when grasspea was the intercropped legume. These results can be explained by the mean values of the competitive ratio for barley in its mixture with grasspea (4.0) and with common vetch (4.2), in comparison to triticale mixtures which recorded (9.3) with grasspea and (2.4) with common vetch.

Cut 2

Mean values of this parameter showed that cereals became more competitive than legumes in the second cutting date in comparison to the first one. In cut2, the superiority of barley in K values was observed when mixed with common vetch (145.0) and with grasspea (75.0), whereas triticale became less competitive than barley during this cutting date. Although cereals were more competitive than legumes in mixtures, it was observed that common vetch was more competitive than grasspea (Table 4).

Aggressivity (A)

Cut 1

The results of aggressivity conformed to those of LER and the relative crowding coefficient. In all treatments, cereals were the dominant species as measured by the positive values of aggressivity, whereas the A values for legumes were negative (Table 5).

Intercropped grasspea had higher values in both mixture treatments. However, when triticale was the cereal proportion in the mixture, the aggressivity values which ranged from (0.54) to (0.73) were higher than those in the case of barley with reported values ranging from (0.37) to (0.62). In addition, the differences between treatments were significant ($P<0.001$) for both A_{cereal} and A_{legume} (Table 5).

Cut 2

A similar trend was observed in the second date, where triticale recorded the greatest values in its mixture with common vetch (0.87) and with grasspea (0.63), followed by barley mixed with common vetch (0.62). Although, grasspea had lower values of aggressivity when mixed with triticale or barley in comparison with common vetch, the two legume crops had negative values in this intercropping system (Table 5).

DISCUSSION

The obtained results revealed that triticale and barley are crops which can be used as sole crops or in mixture systems with forage legumes, but it is felt important to determine the optimum date for cutting, which has an important role in terms of the effect on fresh and dry matter yield. The differences between the two growing seasons in term of dry matter of forage yield, which had a decreasing trend in the second year, can be attributed to the lack of soil moisture, due to the lower rainfall in comparison to the first year. This result is in agreement with Rao et al. (2000) who found that forage yields of small grains were depressed by moisture stress.

It was observed that the booting stage is the optimum date for forage production from triticale, as a result of producing the greatest forage yield from monoculture and intercropping systems. This result is in agreement with (Juskiw et al., 2000; Hall and Kephart, 1991; Ross et al., 2004; Baron et al., 1992; Jedel and Salmon, 1995) who reported that triticale intercrops had an advantage of greater booting yield and greater companion legume crop percentage. Moreover, this result was supported by the values of land equivalent ratio which exceeded unity in the booting stage, and this case indicates an advantage of intercropping over monocultures in terms of using the environmental resources for plant growth (Mead and Willey, 1980; Karadag and Buyukburc, 2004). Although the values of LER in Cut1 were higher than one, they are still less than in Cut2. However, the superiority of barley over triticale in dry matter yield during the first cutting date in both of monoculture and mixtures can be interpreted by the vigor growth of barley in the early stages of its life-cycle in comparison to triticale.

The partial LER_{legume} was lower than 0.5 which indicates that there was a disadvantage for legume in these intercropping systems and an advantage for cereals which recorded LER values higher than 0.5 (Chen et al., 2004). Yield advantage in term of LER_{total} was greatest in the cases of common vetch-triticale mixture (1.00) and common vetch-barley mixture (1.03) when the forage removed at stem elongation, whereas grasspea mixtures with barley and triticale recorded the greatest values at the booting stage (1.07 and 1.09, respectively), and this indicates that 7% and 9% more area would be required by a sole cropping system to equal the yield of intercropping system (Midya et al., 2005).

On the other hand, legumes' contributions (dry matter basis) in triticale mixtures were better than in barley ones in both cutting dates, averaging from 21.1% in cut1 to 22.5% in cut2, and ranging from 12.1% to 14.1% in cut1 and cut2, respectively. In addition, this result was promoted by the lower values of K for triticale in the mixture treatments in comparison with the values recorded for barley. The smaller effect of triticale on the growth rate of common vetch and grasspea compared to that of barley, could be explained by the lower competitive ability of triticale compared to that of barley (Dhima and Eleftherohorinos, 2001; Dhima et al., 2007) resulting in greater contribution of legumes in triticale mixtures. Moreover, K values of cereals exhibited an increasing trend from the first cutting date through the second one, while the contrary was observed in K values of legumes which decreased indicating the dominance of cereals under these crop mixtures. This increasing trend in K values for cereals caused a decrease in the legume percentage in the mixture, because of the greater growth rate of cereals and using the environmental resources better than legumes (Hadjichristidoulou, 1976). This was supported by the positive values of triticale and barley in all cases and in both cutting dates, which shows that cereals were the dominant crops in intercropping systems. Similarly, Dihma et al. (2007) found that triticale and barley were the dominant species in mixtures with common vetch at the seeding ratio of (55:45). The K_{total} was above one in both cutting dates (except for the barley-grasspea mixture at cut1), which indicates a definite yield advantage due to intercropping (Banik et al., 2000).

Pure stands and mixtures of cereals gave higher dry matter yields compared with common vetch and grasspea pure stands and mixtures in both cutting dates. On the other hand, the growth habit of legumes in mixture treatments was better than in monocultures, as a result of cereals' support which avoid legumes laying on the soil surface. The forage yields recorded by common vetch and grasspea in mixture treatments are in agreement with (Anil et al., 1998; Thomson et al., 1990) which consider these two crops among the important crops in mixture systems.

CONCLUSION

The results of the present study clearly indicate that intercropping triticale and barley with common vetch and grasspea affects the individual yield of the species, in addition to the competition between the components of the mixture. The greater forage yield in the first growing season for pure stands and mixtures of both cereals and legumes can be attributed to the better conditions in the first year than in the second one. The LER and K values exceeded unity in the two cutting dates indicating the advantage of intercropping over monoculture system, as a result of exploiting the environmental resources. The greater contribution of legumes was found when common vetch and grasspea were mixed with triticale than with barley. Aggressivity values indicated that triticale and barley were the dominant species in the intercropping system.

Further research is needed to determine the optimum seeding rates for the mixtures and the relative N needs of cereal-legume mixtures compared with monoculture cereal forages, in addition to study the nutritive value of the mixture during different cutting stages.

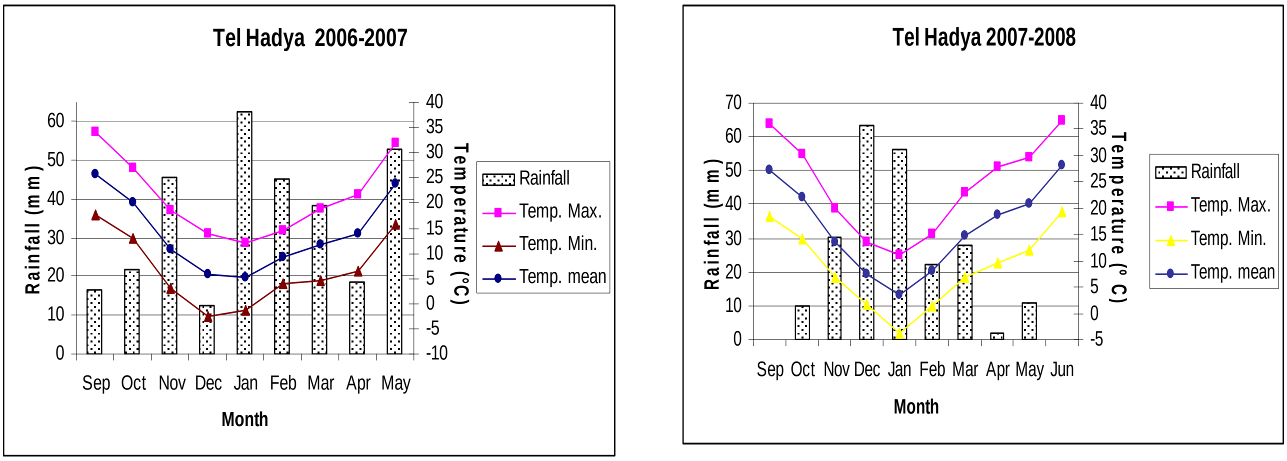

Figure 1: Monthly temperature and rainfall at Tal Hadya, for 2007/2008 and 2008/2009 growing seasons.

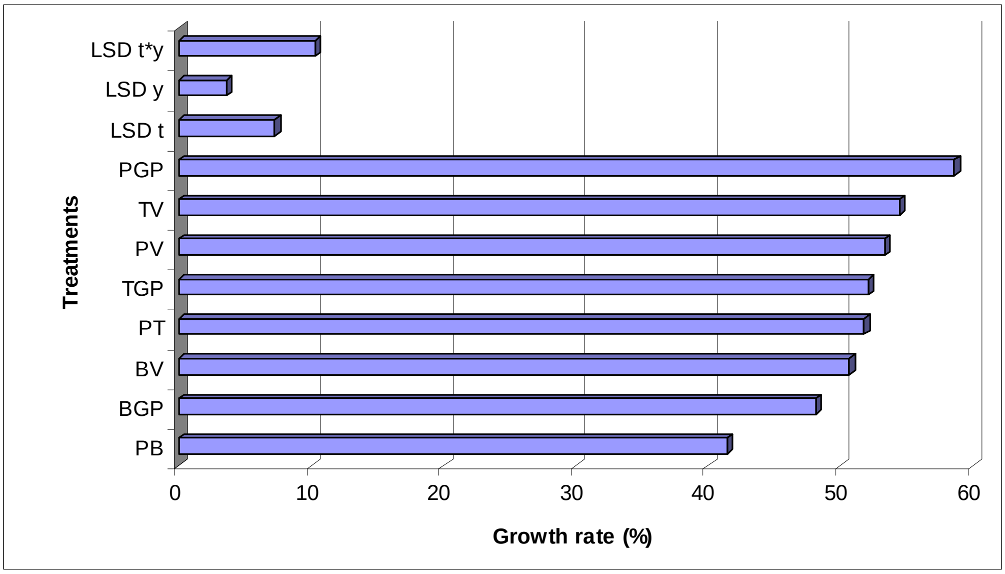

Figure 2: Changing dynamics in growth rate of triticale and barley grown as pure stands and in mixtures with common vetch and grasspea.

t: treatment; y: year; t*y: treatment-year interaction.

Table 1: Dry matter (kg ha $^{-1}$) produced by pure triticale, pure barley and their mixtures with common vetch and grasspea at stem elongation.

Treatment	*2006-2007*			*2007-2008*			*Mean*		
	Total	**Cereal**	**Legume**	**Total**	**Cereal**	**Legume**	**Total**	**Cereal**	**Legume**
PT	4208	4208	0	3517	3517	0	3863	3863	0
PB	4795	4795	0	4353	4353	0	4574	4574	0
PV	2298	0	2298	2150	0	2150	2224	0	2224
PGP	1940	0	1940	1690	0	1690	1815	0	1815
TV	3652	3061	591	3207	2351	855	3430	2706	723
TGP	3942	3666	276	3255	2777	478	3599	3222	377
BV	4087	3497	590	3688	3342	346	3888	3420	468
BGP	4365	4075	290	3958	3775	183	4162	3925	237
P value				T ***; Y**; TxY**					
LSD (0.05)	441	400	114	564	752	82			

T: treatment; Y: year; TxY: treatment-year interaction.

, * significant at the 0.01 and 0.001 probability levels, respectively.

Table 2: Dry matter (kg ha $^{-1}$) produced by pure triticale, pure barley and their mixtures with common vetch and grasspea at the booting stage .

Itm	*2006-2007*			*2007-2008*			*Mean*		
	Total	**Cereal**	**Legume**	**Total**	**Cereal**	**Legume**	**Total**	**Cereal**	**Legume**
PT	11692	11692	0	6400	6400	0	9046	9046	0
PB	11283	11283	0	6130	6130	0	8707	8707	0
PV	7073	0	7073	3670	0	3670	5372	0	5372
PGP	5790	0	5790	3693	0	3693	4742	0	4742
TV	10958	8177	2782	5925	4918	1007	8442	6548	1895
TGP	11395	10029	1366	5903	5196	707	8649	7613	1037
BV	11645	9986	1659	5883	5076	807	8764	7531	1233
BGP	11418	10773	645	6103	5852	251	8761	8313	448
P value				T ***; Y***; TxY***					
LSD (0.05)	1304	1737	343	944	1161	155			

T: treatment; Y: year; TxY: treatment-year interaction.

*** significant at the 0.001 probability level.

Table 3: **Variation in land equivalent ratio (LER) at stem elongation and booting stages in mixtures of triticale and barley with common vetch and grasspea.**

	Stem elongation stage			***Booting stage***		
	LER *cereal*	**LER** *legume*	**LER** *total*	**LER** *cereal*	**LER** *legume*	**LER** *total*
TV	0.87	0.13	1.00	0.96	0.09	1.05
TGP	0.76	0.21	0.97	0.86	0.23	1.09
BV	0.83	0.21	1.05	0.84	0.22	1.06
BGP	0.70	0.33	1.03	0.74	0.33	1.07
Mean	0.79	0.22	1.01	0.85	0.22	1.06
P value	*	***	ns	**	***	ns
LSD (0.05)	0.12	0.04	0.14	0.11	0.04	0.14

*, **, *** significant at the 0.05, 0.01 and 0.001 probability levels, respectively; ns: non-significant.

Table 4: Variation in relative crowding coefficient (RCC or K) at stem elongation and booting stages in mixtures of triticale and barley with common vetch and grasspea.

Item	***Stem elongation stage***			***Booting stage***		
	K *cereal*	**K** *legume*	**K** *total*	**K** *cereal*	**K** *legume*	**K** *total*
TV	2.4	0.51	1.18	3.0	0.52	1.0
TGP	9.3	0.28	2.27	8.0	0.28	2.0
BV	4.2	0.28	1.32	145.0	0.30	53.0
BGP	4.0	0.16	0.82	75.0	0.10	7.0
Mean	5.0	0.31	1.4	58.0	0.30	16.0
P value	ns	***	ns	ns	***	ns
LSD (0.05)	9.58	0.09	2.01	234.4	0.07	78.00

*** significant at the 0.001 probability level; ns: non-significant.

Table 5: Variation in aggressivity (A) at stem elongation and booting stages in mixtures of triticale and barley with common vetch and grasspea.

Item	*Stem elongation stage*		*Booting stage*	
	A *cereal*	**A** *legume*	**A** *cereal*	**A** *legume*
TV	0.73	-0.73	0.87	-0.87
TGP	0.54	-0.54	0.63	-0.63
BV	0.62	-0.62	0.62	-0.62
BGP	0.37	-0.37	0.40	-0.40
Mean	0.57	-.075	0.63	-0.63
P value	***	***	***	***
LSD (0.05)	0.11	0.11	0.09	0.09

*** significant at the 0.001 probability level.

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الغلة العلفية ومؤشرات التنافس لدى محصولي التريتيكالي والشعير في نظام الزراعة المختلطة مع البيقية والجلبان في ظروف منطقة حوض المتوسط

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ملخص

نفذت هذه التجربة خلال موسمين زراعيين في شمال-غرب سوريا في محطة تل حديا (المركز الدولي للبحوث الزراعية في المناطق الجافة ICARDA) بهدف دراسة الغلة العلفية للتريتيكالي (*x.Triticosecale* Wittmack) والشعير (*Hordum vulgare* L.) في نظم الزراعة المنفردة والمختلطة مع البيقية (*Vicia sativa* L.) والجلبان (*Lathyrus sativus* L.) بمعدل بذر مقداره (50:50) خلال مرحلتي تطاول الساق والحبل. وقد تم تقييم نظام الزراعة المختلطة بالاعتماد على بعض معايير التنافس مثل نسبة التكافؤ LER ومعاملات التنافس النسبي K أو RCC و A. تفاوتت المادة الجافة للتريتيكالي والشعير في الزراعة المنفردة بين زيادات وانخفاضات بسيطة مقارنةً بالزراعة المختلطة. تجاوزت قيم LER و K الواحد الصحيح في معاملات الخلائط خلال موعدي الحش مما يدل على تفوق نظام الزراعة المختلطة على نظام الزراعة المنفردة من حيث استخدام المصادر المتوفرة بشكل أفضل. تفوقت النسبة المئوية للبقوليات في معاملات خلط التريتيكالي معنوياً على معاملات خلط الشعير في كل من موعدي الحش، وأشارت قيم A إلى أن التريتيكالي والشعير هما المحصولان المسيطران عند خلطهما مع المحاصيل البقولية.

الكلمات الدالة: الزراعة المختلطة، تريتيكالي، شعير، نسبة التكافؤ، معاملات التنافس النسبي.

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