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Research Article

Impact of Intercropping System on Yield and Quality of Lolium *Multiflorum* and *Trigonella foenum-graecuml*

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ABSTRACT

Due to the ever increasing pressure on cultivated land the importance of intercropping in farming practices has been recognized. This study was performed to evaluate the effect of intercropping ryegrass (*Lolium multiflorum* lam*)* with fenugreek (*Trigonella foenum-graecum* L.). For this purpose, a field experiment was arranged based on randomized complete block design with three replications at the experimental farm of faculty of agriculture Cairo University at Giza, Egypt during two seasons of 2015 and 2016. The experimental treatments were planting patterns (sole crop of rye or fenugreek and intercropping ratios of 1 rye: 1 fenugreek, 2 rye: 1 fenugreek and 1 rye: 2 fenugreek). Results showed that intercropping system had positive effects on ryegrass yield. Moreover, the planting ratio of 2 rye: 1 fenugreek gave the maximum values of ryegrass fresh and dry yield in both cuts compared with the other treatments of the sole crop and the other intercropping ratios in the first and second season, respectively. The application of sole crop had the highest fenugreek fresh and dry yield and seed yield too in both seasons compared with other treatments, respectively. While, the maximum significant levels of chemical contents (oil and protein percentage) of fenugreek seeds were found with the sole fenugreek crop and the intercropping ratio of 1 rye: 2fenugreek, respectively as compared with the other treatments but the differences between the fenugreek sole crop and the other studied intercropping system in the percentage of trigoniline were insignificant in both seasons, respectively. The maximum significant values of competitive ratio (CR) and aggresivity (A) for rye grass crop was found in the pattern ratio of 1rye: 2 fenugreek in both seasons, respectively. While the same situation was recorded with fenugreek crop in the pattern ratio of 2 rye: 1 fenugreek in both seasons, respectively. The highest total land equivalent ratio (LER) (3.08 and 2.98 for the first and second seasons, respectively) was obtained by sowing the crops in the intercrop ratio of 2 rye: 1 fenugreek and the lowest total LER (2.57and 2.48 in both seasons, respectively) was obtained by using the intercrop ratio of 1 rye: 1 fenugreek. In addition, all intercropping treatments in both seasons, respectively gave values of LER for rye grass or fenugreek or both of them more than one. These findings suggest that intercropping of fenugreek and ryegrass increased the total productivity per unit area.

Keywords:

INTRODUCTION

Medicinal plants play important roles in human health services worldwide. Many people in both developing and developed countries are turning to herbal medicine[1]. Fenugreek (*Trigonella foenum-graecum* L.) is an annual crop belonging to the legume family. Fenugreek (commonly known as *Methi*, is an important seed spice crop grown for its leaves as well as seeds, which are the rich source of protein, minerals and carbohydrates[2,3]. This crop is native to an area extending from Iran to northern India, but is now widely cultivated in China, north and east Africa, Ukraine and Greece[4]. In parts of Asia, the young plants are used as potherbs and the seeds as a spice or as herbal medicine[4,5]. India is the major producer of fenugreek followed by Morocco, Pakistan, Egypt, Ethopia and Mediterranean countries[6]. The species name "*foenum-graecum*" means "Greek hay" indicating its use as a forage crop in the past[4]. According to Lust [5] fenugreek is one of the oldest known medicinal plants in the recorded history. Fenugreek leaves and seeds have been used extensively to prepare extracts and powders for medicinal uses[7]. Fenugreek is reported to have, anti-fertility, anti-microbial and anti-parasitic effects[8]. Fenugreek seed in powder or germinated form exhibits anti-diabetic properties[9, 10] hypocholesterolaemic effect[11,12], anti-cancer effect[13], effect on thyroxine-induced hyperglycaemia[14] and protective effect on ethanol toxicity[15].

Many intercropping systems were used for different purposes[16] and these systems have some advantages and disadvantages. For example, the main crop yields can be reduced by intercropping techniques, both as a result of loss of land to the legume, and also to competition for growth resources[17,18]. In the long term, unlegume/legume intercrops are likely to require fertilizers for the provision of Phosphorus (P), Potassium (K) and micronutrients in order to maintain satisfactory yields[19]. On the other hand,

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the main advantages of intercropping are the reduction in risk for total crop failure, and in product diversification-food crops are often mixed with cash crops to help ensure both subsistence and disposable income[17,20]. Biological Fixation (BNF) enables legumes to utilize atmospheric N, which is important in legume based cropping systems when fertilizer N is limited. BNF contributes in legume growth and grain production under different environmental and soil conditions. In addition, soil may have some surplus nitrogen through decomposition of legume residues when BNF contributes more N than the seed requires. Hence, grasses can use it during their growth[21,22] because the nitrogen is the most important nutrient required by the grasses[23]. Yield advantages from intercropping as compared to sole cropping are often attributed to mutual complementary effects of component crops, such as lower inputs through reduced fertilizer and pesticide requirements, and it contributes to a greater uptake of water and nutrients, increased soil conservation, and high productivity and profitability[24,25] compared to sole crop systems. Generally, monoculture legumes have higher yields compared to an intercropping system. However, in most cases, land productivity, measured by Land Equivalent Ratio (LER), clearly shows the advantage of mixed cropping[26,27]. Depending on component crops, yield advantage may vary considerably due to several factors, including differences in plant architecture, rooting patterns, competitive advantages and potential nitrogen fixing capacity of the legume. These, in turn, determine the optimum density, time of sowing and amount of fertilizer N. The need for simultaneous production of different food crops and/or cash crops can also encourage intercropping.
Lolium contains some species which are important grasses for both lawns, and feed livestock. Ryegrasses are also used in soil erosion control programs[28]. One of the most important forage crops is annual ryegrass (*Lolium multiflorum* Lam.), which is a cool-season grass that is suitable for quality herbage production on account of its rich protein, minerals, and water-soluble carbohydrate content[29]. It is generally a highly nutritious grass that may be presented as forage for beef cattle through grazing, dried out and fed as hay, or ensiled and fed as silage[30, 31], and desirably eaten by livestock, especially in milk production[30]. Moreover, ryegrasses are generally used in modern turf landscapes as a result of their higher quality[32]. Ryegrass should not be confused with rye (*Secale cereal* L.), which is a grain crop.

MATERIAL AND METHODS

The field experiment was carried out during the two successive seasons of 2015 and 2016 at the experimental farm of faculty of agriculture Cairo University at Giza Egypt to study the effect of intercropping system between (*Lolium multiflorum* Lam (Ryegrass) and *Trigonellafoenum-graecum* L. (fenugreek) plants, to estimate the effect of each crop on the other. Seeds of the two crops were obtained from the plant department of National research centre Cairo Egypt.
The soil was prepared and divided into plots of 2x2m with 3 rows 50cm a part. The seeds were sown on 15th November for the two seasons on both sides of the row. The experiment was based on randomized complete flock design with three replicates. All cultural practices and fertilizers were carried out as commonly recommended by the ministry of agriculture. Two cuts were taken from Rye, the first was in Feb. and the second was in May where as fenugreek yield was harvested in May.
The experiment consisted of five treatments as follow

- Fenugreek only.
- Rye only.
- One row Rye + one row fenugreek (1 Rye: 1 Fenugreek).
- Two row Rye + one rows fenugreek (2 Rye: 1 Fenugreek).
- One row Rye + two rows fenugreek (1 Rye: 2 Fenugreek).

The data recorded were

- Total fresh yield of rye (first and second cuts) (ton /fed).
- Total dry yield of rye (for the two cuts) (ton /fed).
- Total yield of fresh fenugreek herb (ton /fed.
- Total yield of dry fenugreek herb (ton /fed)
- Total yield of fenugreek seeds (kg /fed).

Chemical contents of fenugreek seeds (%)
The oil percentage of the fenugreek seeds: Fixed oil percentage was determined according to A.O.A.C. method[33]
The protein percentage of the fenugreek seeds: Nitrogen percentage was determined by Keldahl method as indicated by AOAC[34]. Protein percentage was calculated as follow.
(Protein percentage = Nitrogen percentage x 6.25)
The alkaloid (trigoniline) percentage of the fenugreek seeds: trigoneline was determined according to method as indicated by Rongjie Z, et al[35].
Land equivalent ratio (LER)
Measured for compared pure crop with intercropping system. LER is defined as the total land area required under mono-culture cropping giving the yields obtained in the intercropping system[36]. Total LER (LERT), including fenugreek partial LER (LERf) and ryegrass partial LER (LERr), was calculated as follows: LERT = LERf + LERr = YIf/YSf + YIr/YSr Where: YIf and YIr are biomass yields per unit area of intercropped ryegrass and fenugreek, respectively, and YSf and YSr are biomass yields per unit area of pure cropped fenugreek and ryegrass, respectively.
Aggresivity (A)
Aggresivity was calculated as: A cropA = (YAi/YAs x ZAp) – (YBi/YBs x ZBp), and A cropB = (YBi/YBs x ZBp) – (YAi/YAs x ZAP). Where: YAi = yield of crop A under intercropping; YAs = yield of crop A under sole cropping; YBi = yield of crop B under intercropping; YBs = yield of crop B under sole cropping; ZAp and ZBp are proportions of crop B and C in the mixture respectively. If A of crop A= 0, both crops are equally competitive, if A crop A= positive then crop A is dominant and if A of crop A = negative then crop A is weak.
Competitive Ratio (CR)
Competitive ratio was arrived at as follows: CR crop A = (LER cropA/LERcropB) (ZBp/ZAp) while CR cropB = (LER cropB/LER cropA) (ZAp/ZBp). Where: LER crop A

= YAi ÷ YAs; YAi is intercrop yield of Crop A; YAs is sole crop yield of crop A; LER crop B = YBi ÷ YBs; YBi is intercrop yield of Crop B; YBs is sole crop yield of crop B. ZAp and ZBp are proportions of crop B and C in the mixture respectively: A higher CR value of crop A indicates that crop A is highly competitive in resource acquisition and utilization over other crops growing in association.

Statistical Analysis

Data were analyzed using the analysis of variance (ANOVA) with SAS software[37]. It was carried out on the test treatments data. Treatments' means were compared using the LSD test at 5% level of probability.

RESULTS AND DISCUSSION

The fresh yield of Rye (ton/fad)

The fresh yield of Rye was significantly influenced by all intercropping systems (Table 1). The maximum fresh yield of rye plants (11.18 and 19.32 ton/fad in the first season and 11.68 and 19.11 ton /fad for both cuts, respectively) was recorded at the third intercropping systems of 2 rye: 1 fenugreek. On the contrary, culturing one row of rye and two rows of fenugreek significantly gave the minimum amount of fresh yield of Rye plants (3.65 and 7.30 ton/fad in the first season and 4.4 and 7.44 ton/fad in the second one for both cuts, respectively)

The dry yield of Rye (ton/fad)

From the data shown in the table (1) it is clear that the differences between all intercropping treatments and the sole crop of rye and fenugreek on the dry yield of rye plants are significant. Moreover, the third treatment recorded the highest yield of rye dry plant (1.41 and 2.63 ton/fad in the first season and 1.48 and 2.60 ton /fad in the second season in the first and second cuts, respectively). From the other hand, the fourth treatment had the lowest yield of rye dry plants (0.59 and 1.00 ton/fad in the first season and 0.52 and 1.01 ton/fad in the second season, for both cuts, respectively) compared with all other intercropping treatments and rye sole crop. Alizadeh et al.,[38] also in the study of bean and basil intercropping revealed that the highest bean height was in intercropping of 2 rows for basil and 4 rows for bean, although in 4 row for basil and 2 rows for bean the least height obtained. For that matter, it is probably that rye height was affected by using of N, which was fixed by fenugreek root's *Rhizobium* bacteria. So, consequence by using of N, plant had enough time for growing and for this reason stem weight was increased.

The fresh yield of Fenugreek (ton/fad)

The sole crop of fenugreek produced significantly the highest fresh weight (4.10 and 4.39 ton per fed in the first and second seasons, respectively) compared with all fenugreek intercropped treatments with rye. The fenugreek fresh weight was affected by planting patterns used in the all intercropping systems and the lowest plant fresh weight (1.72 ton fresh plants / fad in both seasons, respectively) was found in the treatment of 2 rye: 1 fenugreek (table 2).

The dry yield of Fenugreek (ton/fad)

The results of different parameters of fenugreek in intercrops with rye are shown in table 2. Illustrate that the sole fenugreek produced significantly the maximum yield of dried plants (1.64 and 1.75 ton/fad in both studied seasons, respectively). From the other hand, the third treatment of 2 rye: 1 fenugreek recorded the minimum yield of dried plants (1.24 and 1.31 ton/fad in the first and second seasons, respectively) as compared with the other studied systems of intercropping. Competition among mixtures is thought to be a major factor affecting yield as compared with sole cropping[39]. The high fenugreek fresh weight observed in the sole fenugreek crop could be attributed to high plant density and lack of competition for resources such as light, nutrients and water[40]. Previous studies reported yield reduction in cowpea and maize in maize-cowpea intercrops[41] due to lower plant densities.

The seed yield of Fenugreek (Kg/fad)

The sole crop of fenugreek produced the maximum yield of seed (477.89 and 466.21 Kg/fad in the first and second seasons, respectively). While, the intercropping ratio of 2 rye: 1 fenugreek recorded the minimum fenugreek seed yield (175.73 and 160.92 Kg/fad in both seasons, respectively) compared with the other studied intercropping ratios and sole crop of fenugreek. Because of lower density of fenugreek in rye-fenugreek intercropping than sole cropping of fenugreek, lower seed yield of fenugreek were observed for intercropping system than sole cropping (Table 3). Higher grain yield under sole cowpea compared to intercropping were reported by Chemeda[42]. While, Obiero et al.[43] found that intercropping of castor with maize and beans did not show any significant difference on the castor seed oil content.

Chemical contents of fenugreek seeds (%)

It is clear from table (4) that, the differences between all treatments in seeds oil and protein percentage of fenugreek were significant. While, the differences between the trigoniline percentage were insignificant. The sole crop gave the maximum values of seed chemical content compared with intercropping treatments. Moreover, the differences between the seeds oil and protein percentage in the fenugreek sole crop and intercropping ratio of 1 rye: 2 fenugreek were insignificant in the first and second seasons, respectively. These results are in contrast with Abdelkader and Hamad[44] who studied the effect of intercropping pattern and foliar fertilization rate on Safflower (*Carthamus tinctorius* L.) and fenugreek and found that protein content of seed as well as trigonilline content per fenugreek plant was increased with intercropping pattern treatments compared to sole crop in most cases. This difference is probably due to the nature of the Safflower plants compared with the ryegrass used in this study.

Land Equivalent Ratio (LER)

It was obvious from table (5) that the higher LER in intercropping treatment was showed that yield advantage over pure cropping due to better land utilization. The mean LER values were always greater than 1.0. Advantage from non legume–legume intercropping systems has been reported previously in crops such as wheat and legume[45], pea and barley[46], field bean and wheat[47] maize and faba bean[48] and maize and cowpea[49]. The maximum rye (Land Equivalent Ratio) LER (1.83 and 1.81 for the first and second seasons, respectively) was obtained by sowing the

Table 1: The fresh and dry grass yield of *Lolium multiflorum* as affected with different intercropping treatments.

Character	Season-1				Season-2			
	Yield (ton fed^{-1})				Yield (ton fed^{-1})			
	Fresh		Dry		Fresh		Dry	
Treatment	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Rye	9.44	15.67	1.19	2.13	9.87	15.75	1.25	2.14
1 Rye : 1 Fenugreek	6.58	10.38	0.83	1.41	6.34	12.09	0.80	1.65
2 Rye : 1 Fenugreek	11.18	19.32	1.41	2.63	11.68	19.11	1.48	2.60
1 Rye : 2 Fenugreek	3.65	7.30	0.59	1.00	4.14	7.44	0.52	1.01
F test	**	**	**	**	**	**	**	**
LSD 5%	1.51	1.20	0.12	0.17	0.24	1.59	0.15	0.21
CV %	9.77	4.63	6.11	4.67	7.75	5.86	7.59	5.81

Table 2: The fresh and dry weight yield of Fenugreek as affected with different intercropping treatments.

Character	Season-1		Season-2	
	Yield (ton fed-1)		Yield (ton fed-1)	
Treatment	Fresh	Dry	Fresh	Dry
Fenugreek	4.10	1.64	4.39	1.75
1 Rye : 1 Fenugreek	2.69	1.07	2.57	1.03
2 Rye : 1 Fenugreek	1.72	0.69	1.72	0.69
1 Rye : 2 Fenugreek	3.11	1.24	3.28	1.31
F test	**	**	**	**
LSD 5%	0.58	0.23	0.29	0.12
CV %	9.97	10.04	4.80	4.84

Table 3: The seed yield (ton /fed) of Fenugreek as affected with different intercropping treatments.

Character	Seed yield (Kg fed-1)	
Treatment	Season-1	Season-2
Fenugreek	477.89	466.21
1 Rye : 1 Fenugreek	239.64	233.42
2 Rye : 1 Fenugreek	175.73	160.92
1 Rye : 2 Fenugreek	351.38	320.75
F test	**	**
LSD 5%	25.53	40.81
CV %	4.11	6.92

crops in a ratio of Intercrop of 2 rows of rye and one row of fenugreek and the minimum rye LER (1.35 and 1.44 in both seasons, respectively) was obtained by sowing the crops as 1 row of rye and 1 row of fenugreek. The differences in fenugreek LER values insignificant but they were greater than one in all intercropping systems which indicated yield advantage of intercropping. The different planting patterns showed similar trends for the two seasons with the planting patterns involving 2 rye: 1 fenugreek recording high significant total LER values (3.08 and 2.98 in both seasons, respectively) followed by 1 rye: 1 fenugreek (2.66 and 2.61 in the first and second seasons, respectively) and lastly 1 Rye: 2 Fenugreek (2.57 in the first season and 2.48 in the second one, respectively). Furthermore, the differences between the total LER values of the first and third intercropping treatment in the second season were insignificant (Table 5). These findings indicated that these intercropping systems had yield advantage over the corresponding monocrops in terms of the better use of land and environmental resources for plant growth[46]. Dhima *et al*[50] were shown that when LER is greater than 1, the intercropping improves the growth and biomass of the species. In contrast, when LER is lower than 1, the intercropping negatively effect on the growth and yield of plants grown in mixtures[50]. The LER values were greater than one, indicating more efficient benefits of plant growth factors by intercrops compared to pure crops[51]. Gupta and Rathore[52] indicated high castor equivalent yield, land equivalent ratio and net returns under castor with green grams.

Competitive Ratio (CR)

In terms of competitive ratio, rye was highly competitive than fenugreek in the both intercropping ratios of 1 rye: 1 fenugreek and 1 rye: 2 fenugreek during the first season and second one, respectively. In contrast, fenugreek was the more competitive of two studied crops in the intercropping ratio of 2 rye: 1 fenugreek during the both seasons, respectively. Competitive ratio of some intercropped crops were studied by Yilmaz et al.[53] and Takim[54].

Aggresivity (A)

At the first and third planting patterns rye had high aggresivity values than fenugreek indicating that the rye was the dominant crop species in the first and second seasons, respectively in these treatments (Table 6). However, fenugreek showed significant dominance over rye in the second intercropping treatment in both seasons, respectively. Positive values for some crops have been reported in earlier experiments, for instance, Yilmaz *et al.*[53] reported maize as the dominant crop specie within a maize-cowpea-bean intercrop. Mohammadi *et al.*[55] reported dominance of cotton under cotton-sorghum-cowpea intercrop.

Finally, Intercropping with legumes is an excellent practice for controlling soil erosion and sustaining crop production[56]. Legumes enrich soil by fixing the atmospheric nitrogen changing it from an inorganic form to forms that are available for uptake by plants. Biological

Table 4: The Chemical contents (oil, protein and alkaloid %) of fenugreek seed as affected with different intercropping treatments.

Character	Chemical contents' in seeds (%)					
	Oil		Protein		Alkaloid (trigoniline)	
Treatment	Season-1	Season-2	Season-1	Season-2	Season-1	Season-2
Fenugreek	9.50	9.70	20.80	21.00	0.115	0.110
1 Rye : 1 Fenugreek	8.75	9.35	19.70	19.60	0.105	0.105
2 Rye : 1 Fenugreek	8.50	9.15	19.40	19.50	0.100	0.102
1 Rye : 2 Fenugreek	9.25	9.50	20.20	19.90	0.108	0.106
F test	*	*	*	*	-	-
$LSD_{5\%}$	0.31	0.31	0.67	1.12	-	-

Table 5: Means of Land Equivalent Ratio (LER) as influenced by different intercropping ratios.

Character	Land Equivalent Ratio (LER)					
Treatment	Season-1			Season-2		
	Rye	Fenugreek	Total	Rye	Fenugreek	Total
1 Rye : 1 Fenugreek	1.35	1.31	2.66	1.44	1.17	2.61
2 Rye : 1 Fenugreek	1.83	1.25	3.08	1.81	1.17	2.98
1 Rye : 2 Fenugreek	1.43	1.14	2.57	1.36	1.12	2.48
F test	**	-	*	*	-	**
$LSD_{5\%}$	0.21	0.36	0.47	0.25	0.17	0.24

Table 6: Means of Competitive Ratio (CR) and Aggresivity (A) as influenced by different intercropping ratios

Character	Competitive Ratio (CR)				Aggresivity (A)			
Treatment	Season-1		Season-2		Season-1		Season-2	
	Rye	Fenugreek	Rye	Fenugreek	Rye	Fenugreek	Rye	Fenugreek
1 Rye : 1 Fenugreek	1.07	0.97	1.54	0.67	0.04	-0.04	0.27	-0.27
2 Rye : 1 Fenugreek	0.74	1.38	0.77	1.31	-1.59	1.59	-1.45	1.45
1 Rye : 2 Fenugreek	2.52	0.40	2.42	0.41	2.29	-2.29	2.16	-2.16
F test	**	**	**	**	**	**	**	**
$LSD_{5\%}$	0.34	0.32	0.54	0.27	0.35	0.35	0.34	0.34

fixation of atmospheric nitrogen can replace nitrogen fertilization wholly or in part. When nitrogen fertilizer is limited, biological nitrogen fixation is the major source of nitrogen in legume-cereal mixed cropping systems[57]. Moreover, because inorganic fertilizers have contributed to environmental damage such as nitrate pollution, legumes grown in intercropping are regarded as an alternative and sustainable way of introducing N into lower input agroecosystems[57].

Although the fresh, dry and seed yield of fenugreek have decreased as a result of the intercropping. The insignificant differences in the fenugreek seed oil and protein percentage were found between the sole crop and intercropping ratio of 1rye:2 fenugreek, also, the differences in trigoniline percentage between all treatments were insignificant too in both seasons, respectively. More over the intercropping had positive effects on increasing the fresh and dry yield of ryegrass plants in the treatment of 2 rye: 1 fenugreek compared with rye sole crop. And the same treatment recorded significantly the maximum values of total Land Equivalent Ratio (LER) compared with the other treatments in both seasons, respectively. So that, Fenugreek is a good legume crop for intcropping system as it also has got wide adaptability with respect to soil and climatic conditions. Moreover, it performs well under moderately saline soil conditions where no other grain legume crop is profitable. It is also the most drought tolerant temperate leguminous crop which improves the soil fertility and adds about 283 kg atmospheric nitrogen per hectare into the soil[58,59]. Besides it is also grown as a green manure crop in some parts of the world. Therefore, in true sense, it is a multipurpose crop having paramount importance. The planting pattern of 2 rye: 1 fenugreek made the fenugreek crop the dominance and highly competitive over rye but the rye crop became dominance and highly competitive over the fenugreek in the other intercropping ratio in the first and second seasons, respectively. The treatment of 1rye: 2 had the maximum significant values of competitive ratio (CR) and aggresivity (A) for rye grass crop, but the same situation was recorded with fenugreek crop in treatment of 2 rye: 1 fenugreek in both seasons, respectively.

In sharp contrast to agriculture, where plant quality and yield are of major importance, ornamental horticulture is concerned exclusively with the creation of an environment aesthetically suitable for recreation or relaxation; the value of turfgrass depends on its color, density and general appearance rather than its yield[60] (Beard, 1982). It can recommend the intercropping of the *Trigonella foenum-graecum* L. in a few rows with the *Lolium multiflorum* Lam in the green surface to provide a good organic source of needed nitrogen for the ryegrasses in the cold season.

CONCLUSION

Fenugreek could be an effective plant in intercropping system and could promote ryegrass growth characters and increase its yield in despite of decreasing fenugreek fresh, dry and seed yield compared with the sole crop of each of them. From the other hand, Chemical contents of fenugreek with the intercropping ratio of 1 rye: 2 fenugreek did not significantly affect with intercropping compared with sole crop of fenugreek and the percentage of trigoniline did not differ signiffecantly by intercropping compared with the sol crop in both season, respectively. Moreover, the best LER was obtained from cropping ratio of 2 rye: 1 fenugreek. From the above mentioned results it was found that the intercropping was advantageous compared to both sole crops of ryegrass and fenugreek.

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