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Effect of different intercropping patterns on yield and yield components of dill and fenugreek

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ABSTRACT

A field experiment was conducted based on randomized complete blocks design (RCBD) in three replications during 2011 at the research farm of university of Tabriz, Iran. In this study two medicinal plants, dill (*Anethum graveolens* L.) and fenugreek (*Trigonella foenum-graecum*) intercropped at different additive (1:20, 1:40 and 1:60) and different replacement (1:1, 1:2 and 1:3) series. Results showed that dill plant at additive treatment especially in 1:20 and 1:60 series had maximum plant fresh and dry weights, umbels per plant, 1000 seed weight, seeds per plant, biological yield and harvest index. However, fenugreek plant at replacement treatment especially in 1:3 and 1:2 series had maximum biological yield, pod in main stem, pod in branches, seeds per pod, seed weights and grain yield. Fenugreek as a medicinal, forage and legume crop promote dill grows characters and could be an effective plant in intercropping systems.

INTRODUCTION

Intercropping is a sustainable practice used in many developed and developing countries and an essential element of agricultural sustainability . Intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture (Lithourgidis et al. 2011). It is known that legumes give benefits to the soil such as improved nutrient availability, improved structure, reduced pest and disease incidence, and hormonal effects through rhyzodeposition (Wani et al. 1995). The major benefit of legume crops comes from biologically nitrogen fixation, deriving from the symbiosis involving leguminous plants and rhizobium bacteria (Vance 1998).

The main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each monocrop of the mixture (Launayet al. 2009). For example, intercropping of maize with cowpea increased light interception,, and improved soil moisture conditions compared with maize monocropping (Ghanbari et al. 2010).

Dill (*Anethum graveolens* L.) is an annual herb used as carminative, and antispasmodic in medicine (Bailer et al. 2001, Sharma 2004) also its essentials have an inhibitory effect on stored potatoes sprouting (Zehtab-Salmasi et al. 2006). Catizone et al. (1986) reported that intercropping between anuual dill (*Anethum graveolens* L.), and Perennial clary sage (*Salvia sclarea* L.) improved the efficiency of cropping systems, Carrubba et al. (2008) results also indicate that the presence of dill exerted residue in the soil had a significant effect on fennel seed yields at following years.

Fenugreek (*Trigonella foenum-graecum*) is an annual crop from leguminoseae that their seeds have been used extensively to prepare extracts and powders for medicinal uses such as: anti-diabetic, anti-fertility, anticancer, anti-microbial, anti-parasitic and hypocholesterolaemic (Basch et al. 2003).

Mixtures can be formed by adding together the plant populations used in the pure stands (Agboola and Fayemi 1971). This means that in such additive intercropping the total plant population of the mixtures is doubled when two crops are intercropped

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in this manner (Ebwongu et al. 2001). In other words, an inherent feature of additive intercropping is that the total plant population of the mixture is greater than that of the pure stands, which may contribute to its yield advantage. The alternative method of forming crop mixtures is the 'replacement series' technique, in this method mixtures are formed by replacing a certain proportion of one species by another while keeping the total plant population pressure constant. The technique allows formation of a range of mixtures with different proportions of the two species. (Willey and Osiru 1972).

Some further interest in the potential role of medicinal and aromatic plants in intercropping systems has arisen from the widespread trend toward the cultivation. So the main idea of this study was introducing of suitable sowing patterns on two medicinal plants with respect to legume and medicinal plant intercropping such as dill and fenugreek intercropping.

MATERIAL AND METHODS

The field experiment was conducted during 2011 at the research farm of the faculty of agriculture, university of Tabriz, Iran (38°5N, 46°E). The experiment was based on randomized complete blocks design (RCBD) in 3 replications. In this study two medicinal plants, dill (*Anethum graveolens* L.) and fenugreek (*Trigonella foenum-graecum*) intercropped in different additive (1:20, 1:40 and 1:60) and replacement series (1:1, 1:2 and 1:3). The main and secondary crops were fenugreek and dill, respectively. As dill seeds are sensitive to seed bed, though soft and smooth seed bed prepared and covered by thin layer of sand silt. Each plot consists of 10 rows, seeds planted 20 cm apart and 1-2 cm deep. Optimum density for dill and fenugreek were 100 and 50 plant/m^2, respectively. Nitrogen fertilizer added in early growth period as starter by15 kg/ha. weed controls were regularly performed by hands. Both plants were harvested after technical maturity and then laboratory measurements performed.

The evaluated traits for fenugreek were plant fresh weight (FW), plant dry weight (DW), pod number on main stem (PMS), pod number on branches (PNB), seeds per pod (SPPOD), seeds per plant (SPP), seeds weight per plant (SWPP), 1000 seed weight, seed yield and biological yield. Also, plant fresh weight (FW), plant dry weight (DW), umbels per plant, umbellules per plant, seeds per plant (SPP), 1000 seed weight, seed yield, biological yield and harvest index were evaluated for dill.

For data analysis MSTAT-C and SPSS16.0 softwares were used.

RESULTS AND DISCUSSION

Analysis of variance for fenugreek yield and yield components (table 1), showed that different intercropping patterns have a significant effect on all studied traits except 1000 seed weight. Marin et al. (1998) revealed that maize grain yield was not affected by intercropping. Mirhashemi et al. (2009) in the fenugreek and ajowan intercropping reported that different intercropping systems had no effect on 1000 seed weights.

Fenugreek mean comparisons (table 2), revealed that the highest plant fresh and dry weights amounts were obtained from 1:3 and 1:2 replacement series. This may cause by decreasing of interaspecific competition and enough using of growing space, 1:3 and 1:2 series had the least row spaces therefore the maximum using of resources has happened for these treatments . Sunil et al. (2005) indicated that intercropping of maize and cowpea in 2:2 row proportions recorded significantly higher green fodder, dry matter. In this sense, by having suitable growing condition, pods numbers affected by different intercropping patterns where 1:2 and 1:3 series had the highest pods number in main stem, respectively, also there were no statically differences among 1:2, 1:3, 1:60 series and monocropping for fenugreek. Among all replacement series the 1:2 and 1:3 treatments had the highest pods number in branches, whereas among additive series, the 1:20 and 1:60 treatments had the highest pods numbers. The least pod number was observed in monocropping fenugreek (table 2).

Replacement series had maximum seeds number per plant and seed yield. Decreasing of plant number, better developing of branches and leaves of fenugreek led to maximum using of environmental conditions therefore extra assimilate transmitted to the pod part so seeds number per pod, seeds number per plant, pod coat weight and seeds weight per plant were increased. Whereas the 1:20, 1:60 additive series treatment had the highest records (table 2).

Also there was no significant difference between biological yield of 1:2, 1:3, 1:20, 1:40, 1:60 and sole fenugreek treatments, but 1:2, sole fenugreek and 1:3 treatments had the highest biological yield. The yield advantages in intercropping system are associated with the full use of environmental resources over time (Madar 2001). Reddy and Reddi (1981) observed higher grain yield of maize when intercropped with groundnut and green gram. Singh et al. (2000) observed that intercropping of maize with vegetable pea and lentil increased the dry matter accumulation and yield attributes. their results also showed that the number and weight of grains per cob

Table 1. Analysis of variance of the data for fenugreek yield and yield components

Source	df	Fresh weight	Plant dry weight	pod number on main stem	pod number on branches	seeds per pod	seeds per plant	Seed yield	seeds weight per plant	1000 seed weight	Biological yield
R	2	19.493	0.267	8.123	0.19	0.253	479.05	3210319.04	0.032	0.515	0.067
T	6	22.914*	0.894*	4.748*	14.99**	5.632*	787.54**	8147038.09*	0.081*	0.201^{ns}	0.223*
E_a	12	5.962	0.276	1.084	0.742	1.217	123.618	1837602.38	0.018	0.275	0.069
Total	20										
C.V%		17.32	13.00	13.72	14.06	13	5.75	26/69	26.69	10.06	13

**,* : significant at $p \leq 0.01$ and $p \leq 0.05$, respectively.

Table 2. Comparison of means of fenugreek yield and yield components

Treatment	Plant fresh weight (g\p)	Dry Weight (g\p)	pod number on main stem	pod number on branches	seeds per pod	seeds per plant	Seed yield(g)	seeds weight per plant (g)	biological yield (t\ha)
1(1:1)	13.35a	3.045d	6.25b	3.35d	9.3a	34.99b	3013d	0.301d	1.552b
2(1:2)	16.10a	4.42abc	8.95a	9.0a	10.05a	68.59a	6351ab	0.635ab	2.21a
3(1:3)	16.27a	4.64a	8.7a	6.85b	8.77a	71.25a	7657a	0.766a	2.32a
4(1:20)	15.93a	3.953bc	6.733b	8.9a	10.0a	44.37b	5697abc	0.57bc	1.977ab
5(1:40)	8.5b	3.835c	5.9b	4.2cd	7.2b	34.4b	3377cd	0.338d	1.917ab
6(1:60)	15.22a	3.90bc	8.4a	5.9b	7.1b	32.38b	4387bcd	0.439cd	1.95ab
7(sole fenugreek)	13.33a	4.513ab	8.2a	4.7c	7.0b	47.4b	5073abcd	0.507bc	2.257a

Different letters in each column indicate significant difference at $p \leq 0.05$

and 1000 grain weight improved intercropped maize yields over sole maize yields.

Legumes based cropping systems are considered to be better alternatives for securing nitrogen economy and increasing yield of maize besides bonus yield, greater productivity per unit time and space and higher net returns of intercropping system over monoculture (Mandal and Mahapatra 1990; Shah et al. 1991). Singh et al. (2002) observed that the maize and cowpea intercropping system having the maximum maize green cob yield.

Analysis of variance of the data for dill yield and yield components (table 3), showed that different intercropping patterns had significant effects on plant fresh and dry weights, umbels per plant, biologic yield, seed yield and harvest index ($p \leq 0.05$) and had strong meaningfulness difference on seeds number per plant and 1000 seed weight ($p \leq 0.01$). Darzi (2012) showed that nitrogen fixing bacteria had significant effects on umbel number per plant and seed yield of coriander *(Coriandrum sativum).*

Means of the dill yield and yield components showed in table 4. Among various treatments, 1:20 additive series had maximum plant fresh and dry weights, 1000 seed weight, biological yield and harvest index. Gangwar and Kalra (1982) found that the dry matter accumulation and grain yield of rainfed maize grown in mixture with legumes increased compared to sole

Table 3. Analysis of variance of the data for dill yield and yield components

Source	df	Plant fresh weight	Plant dry weight	umbels per plant	Umbellules per plant	seeds per plant	1000 seed weight	Seed yield	biological yield	harvest index
R	2	0.922	0.022	1.190	370.574	4106.486	0.049	30912100/00	0.022	46.342
T	6	2.713*	1.908*	2.597*	274.813ns	57885.954**	0.054**	30963638/065*	1.908*	75.157*
Ea	12	0.778	0.563	0.549	215.312	3895.017	0.008	9192133/33	0.563	17.361
Total	20									
C.V%		19.01	23.79	12.30	22.03	8.82	6.0	27/91	23.79	11.09

**,*: significant at $p \leq 0.01$ and $p \leq 0.05$, respectively

Table 4. Comparison of means of dill yield and yield components

Treatment	Plant fresh weight (g\p)	Dry Weight (g\p)	umbels per plant	seeds per plant	1000 seed weight (g)	Seed yield (g)	biological yield (t\ha)	harvest index
1(1:1)	4.603bc	2.883cd	5.633cd	666.1b	1.368d	10760a	2.883bc	41.57a
2(1:2)	4.930b	2.804cd	6.5abc	877.7a	1.637ab	9983ab	2.827bc	38.72abc
3(1:3)	3.520c	2.135d	4.667e	543.5c	1.397cd	6687b	2.135c	33.59bc
4(1:20)	6.513a	4.475a	6.733ab	729.4b	1.738a	15870a	4.475a	44.36a
5(1:40)	3.953bc	3.163bc	5.967bcd	654.4b	1.549bc	10110ab	3.163abc	32.53c
6(1:60)	4.360bc	3.394ab	7.4a	893.2a	1.50bcd	14290a	3.934ab	40.73a
7(sole dill)	4.823b	2.662cd	5.267de	577.6c	1.440cd	8343b	2.662bc	31.61c

maize. In the 1:20 series due to lower plant density and better using of available N which were fixed by fenugreek roots, plant could developed it's vegetative parts rapidly so maximum yield achieved from this treatment. Another treatment which had the highest records was 1:60 additive series which had maximum umbeles per plant, seed yield and seeds per plant.

Boroomand zadeh et al. (2009) and Gill et al (1999) mentioned that by increasing of density, the umbels per plant decreased. This results is agree with our results which at replacement series including one row dill and one row fenugreek and sole fenugreek

treatment where the plants density was more than additive series, plant dry weight, umbels per plant, 1000 seed weight, biological yield and harvest index were decreased (table 4).

Maximum Land equivalent ratio (LER) was obtained in 1:20, 1:60 treatments (2.63, 2.39 respectively). All the treatment's LER were more than one (X>1), however, there was no significant difference among the treatments.

CONCLUSION

In conclusion, both dill and fenugreek plants for suitable growing needs to enough space so fenugreek at replacement series and dill at additive series had the highest performance. It could be suggested that using of nitrogen which were fixed by fenugreek and using of enough space for plant growing, let dill to be suitable plant for intercropping and this research showed that fenugreek could be an effective plant in intercropping system and could promote dill growing characters. Further long-term experiments will be necessary in order to demonstrate the application of such a technique to other medicinal and aromatic plant mixtures.

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