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Effect of Intercropping Patterns of Dragon's Head and Dill (*Anethum graveolens* L.) on Yield, Yield Components and Essential Oil Yield of Dill

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ABSTRACT: Intercropping is considered for increasing and stability of yield per average unit. An experiment was conducted at the Research Farm of the Faculty of Agriculture, University of Tabriz, Iran in 2015 to study the effect of intercropping of Dill and Dragon's head on yield, yield components and essential oil yield of Dill. The experiment was arranged in RCB design with three replications. Intercropping patterns included; pure stand of Dragon's head, pure stand of dill variety Dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Dukat, pure stand of dill variety Super dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Super dukat. Results showed that sole cropping of dill variety Dukat and sole dill variety Super dukat produced the highest grain yield and Number of inflorescences and harvest index and1000 grains weight. Among the intercropping systems, 50% of optimum density of dill variety and Super dukat recorded the highest essential oil yield.

Key words: Dill, Dragon's head, Intercropping, Essential oil yield, Yield.

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 (Launay *et al.* 2009). For example, intercropping of maize with cowpea increased light interception, and improved soil moisture conditions compared with maize mono cropping (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 essential oil has an inhibitory effect on stored potatoes sprouting (Zehtab-Salmasi *et al.* 2006). Catizone *et al.* (1986) reported that intercropping between annual dill (*Anethum graveolens* L.), and perennial clary sage (*Salvia sclarea* L.) improved the efficiency of cropping systems. Carrubba *et al.* (2008) also reported that the presence of dill exerted residue in the soil had a significant effect on fennel seed yields at following years.

Dragon's head (*Lallemantia iberica* Fish. et Mey.) is an annual herb belongs to Lamiaceae family and spreads in southwestern Asia and Europe (Ursu and Borcean, 2012). It grows well in arid zones and requires a light well-drained soil (Ion *et al.*, 2011). Dragon's head is a valuable species, i.e. all plant parts (leaves or seeds) can be economically used (Hedrick, 1972). However, it is mainly cultivated for its seeds that contain about 30% oil with iodic index between 163 and 203. These seeds are used traditionally as stimulant, diuretic and expectorant as well as food (Naghibi, 1999).

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 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 these two medicinal plants.

MATERIALS AND METHODS

The field experiment was conducted in 2015 at the Research Farm of the University of Tabriz, Iran (latitude 38°05_N, longitude 46°17_E, altitude 1360 m above sea level). The climate of research area is characterized by mean annual precipitation of 285 mm, mean annual temperature of 10°C and mean annual minimum temperature of 4.2°C maximum temperature of 16.6°C. The experiment was arranged in a randomized complete block design, with three replications and nine treatments. The treatments were represented by the following; different planting patterns: pure stand of Dragon's head, pure stand of dill variety Dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Dukat, pure stand of dill variety Super dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Super dukat. All plots were irrigated immediately after sowing.

The main and secondary crops were Dragon's head 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 16 rows, seeds planted 15 cm apart and 1-2 cm deep. Optimum density for dill and Dragon's head were 40 and 160 plant/m^2, respectively. Weed controls were regularly performed by hands. Both plants were harvested after technical maturity and then laboratory measurements performed.

The evaluated traits for dill were number of inflorescences, 1000 grains weight, grain yield and biological, harvest index, essential oil yield.

Statistical analysis of the data was performed with MSTAT-C software. Duncan multiple rangetest was applied to compare means of each trait at 5% probability.

RESULTS AND DISCUSSION

Analysis of variance for dill yield and yield components and essential oil yield (Table 1), showed that different intercropping patterns have a significant effect on all studied traits except biological yield. 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 seeds weight. Darzi (2012) showed that nitrogen fixing bacteria had significant effects on umbel number per plant and seed yield of coriander (*Coriandrum sativum*).

Table 1. Analysis of variance of selected parameters of Dill affected by intercropping patterns.

		Mean square					
SOV	**df**	**Number of inflorescences**	**Grain yield**	**Biological yield**	**Harvest index**	**1000 grains weight**	**Essential oil yield**
Block	2	4.52	93.167	213.167	9.042	3.015	0.689
Intercropping	7	291.976**	3271.470*	4809.238ns	56.476**	0.239**	0.914*
Error	14	36.208	1181.024	7126.801	6.708	0.032	0.252
(CV)%		8.01	15.19	17.10	5.67	10.22	17.17

Ns=Non significant; * and ** = Significant at 5% and 1% probability level, respectively.

Dill mean comparisons (Table 2), revealed that the highest number of inflorescences and grain yield amounts were obtained from pure stand of dill variety Dukat, additive intercropping of optimal density of Dragon's head + 25% of optimum density of dill variety Dukat, pure stand of dill variety Super dukat and additive intercropping of optimal density of Dragon's head + 25% of optimum density of dill variety Super dukat. The least number of inflorescences was observed in additive intercropping of optimal density of Dragon's head + 50% and 75% of optimum density of dill variety Super dukat dill (Table 2). Gangwar and Kalra (1982) found that the dry matter accumulation and grain yield of rain fed maize grown in mixture with legumes increased compared to sole maize. Boroomand zadeh *et al.* (2009) and Gill *et al* (1999) mentioned that by increasing of density, the umbels per plant decreased.

Statistical analysis of the data indicated that different intercropping patterns significant effect on 1000 grains weight and harvest index of dill (Table 1). Maximum 1000 grains weight (2.283 g) was obtained in additive intercropping of optimal density of pure stand of dill variety Dukat. Minimum 1000 grain weight was recorded in the additive intercropping of optimal density of Dragon's head + 75% of optimum density of dill variety Super dukat, Maximum harvest index pure stand of dill variety Dukat, additive intercropping of optimal density of Dragon's head + 25% of optimum density of dill variety Dukat, pure stand of dill variety Super dukat (Table 2).

Table 2: Comparison of means of dill yield and yield components and Essential oil yield.

Treatment	Numberof inflorescences	Grain yield (g\m^2)	Harvest index	1000 grains weight (g)	Essential oil yield (g\m^2)
A1	86.04a	271.02a	50.01a	2.283a	2.61bc
A2	82.67a	236.01a	50.08a	1.793bc	3.02ab
A3	79.08ab	213.02ab	47.33ab	1.673cd	3.61a
A4	69.11bc	213.08ab	41.33cd	1.55cd	2.94ab
A5	80.33a	262.3a	49.33a	2.03ab	1.96c
A6	80.67a	233.la	45.67abc	1.7bc	3.11ab
A7	65.01c	217.01ab	43.32bc	1.6cd	3.58a
A8	58.01c	165.01b	38.3d	1.4d	2.52bc

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

The treatments were represented by the following; different planting patterns treatment: A1, A2, A3, A4, A5,A6,A7 and A8: respectively, pure stand of dill variety Dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Dukat, pure stand of dill variety Super dukat, additive intercropping of optimal density of Dragon's head + 25%, 50% and 75% of optimum density of dill variety Super dukat. Almost in all the treatments intercropped dill plants produced a significantly higher amount of essential oil when compared to mono cultured plants (Table 2) Maffei and Mucciarelli (2003) relived that in peppermint/soybean strip intercropping, essential oil content increased up to 50% and quality of essential oil improved.

Dill mean comparisons (Table 2), revealed that the highest Essential oil yield amounts were obtained from additive intercropping of optimal density of Dragon's head + 50% of optimum density of dill variety Dukat and Super dukat, Minimum essential oil yield was recorded in the pure stand of dill variety Super dukat.

CONCLUSION

This research showed that Dragon's head 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.

Intercropping of Dill with Dragon's head caused significant reductions in dill yield due to competition. Better Essential oil yield was obtained in plots pure stand of Dragon's head and better oil yield was obtained in plots 50% of optimum density of dill variety Dukat andSuper dukat.

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