

Effects of Radish and Turnip Intercropping with Faba Bean on Growth and Yield for these Crops under Assiut conditions

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Abstract

The current study evaluates the efficiencies of faba bean, turnip and radish grown as sole crops and when radish and turnip intercropped with faba bean on growth, yield and quality characteristics. A field experiment was carried out during 2014- 2015 and 2015-2016 seasons at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt. Intercropping of turnip and radish with faba bean resulted in significantly higher yields of both crops (turnip and radish) as compared with their sole cropping. All other characteristics (plant growth and yield components) of all the two crops which indicate yielding efficiency enhancement as a result of intercropping. Analysis of intercropping treatments revealed that faba bean intercropping with turnip increased the yield of turnip by (50.87- 51.13%) when planting were done in sprinkle and by (18.18- 19.35%) when planting were done in hills as compared with sole crops in the first and second seasons respectively. However intercropping radish with faba bean resulted in the highest yield in radish by (66.74- 67.48%) when planting were done in sprinkle and by (75.27-81.55%) when planting were done in hills as compared with sole crops in the first and second season respectively. Yield of faba bean increased when intercropped with radish by (9.82-13.16%) rather than intercropping with turnip or sole cropping. Land equivalent ratio (LER) of faba bean-radish intercropping was, on average, 2.7 for both years. With regard to faba bean- turnip intercropping, (LER) was, on average, 2.6 for both years.

Keywords: Crop quality, main crop, secondary crop, sustainable agriculture, yield components.

Introduction

Increased agricultural production through intercropping with minimal cost is needed to feed increasing human population. In order to increase the yield in vegetable production, the yield obtained per unit area should be increased. Intercropping is the practice of growing two or more crops together so that they interact agronomically (Vandermeer, 1989) In general intercropping means growing at least two different crops at the same cultivation season and in the same area (Kizilsimsek and Erol,

2000). The increasing concern over agricultural sustainability favors the maintenance of intercropping systems due to its positive effect on soil conservation and improvement of soil fertility (Jarenyama *et al.*, 2000). Additionally, more stable yields of intercropped systems use natural resources more effectively (Horwith, 1985). Intercropping with legumes makes effective use of land and other resources and results in reduced cost of production There are many studies on intercropping. But the information is very scanty on intercropping with

faba bean in vegetable production. Faba bean was used as the main crop and radish and turnip were used as an intercrop for two years under field conditions. The reported work evaluates the efficiencies of faba bean, turnip and radish grown as sole crops and when radish and turnip intercropped with faba bean during 2014-2015 and 2015-2016 seasons. Intercropping involving legumes has been found to be most useful (Adeniyi, 2011) as it improves soil fertility and gives better yields and economic returns (Lithourgidis *et al.*, 2011). In another study, it was determined that radish and turnip adversely affected plant growth and reduced yield in cabbage and increased yield in peas and faba beans (Sharma *et al.*, 1988).

Materials and Methods

This study was carried out at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt, during 2014-2015 and 2015-2016 winter seasons. Faba bean (*Vicia faba* L.) was used as the main crop. Radish (*Raphanus sativus* L.) and turnip (*Brassica rapa* var. *rapa*) were grown alone and also in combination as secondary crops with faba bean. The experiment was conducted using three replications as randomized complete-block design.

The experiment consisted of 27 plots in total (9 treatments and 3 replications) as follows: 1) faba bean with radish (sprinkle), 2) faba bean with radish (in hills), 3) faba bean with turnip (sprinkle), 4) faba bean with turnip (in hills), 5) faba bean alone, 6) radish alone (sprinkle), 7) radish alone (in hills), 8) turnip alone (sprinkle), 9) turnip alone (in hills).

Planting was carried out in the second week of October in both years. Faba bean planting was done 30 cm apart on the northern side of the ridge, while radish and turnip planting were done either in sprinkle or in hills on both sides of row. Three ridges (70 cm apart and 3 m long) were included in each plot. Sprinkle plants were thinned after 15 days from sowing at 3 cm apart (95 plants /m²). Plants that grown in hills were at 5 cm apart (58 plants /m²). The plants were fertilized with 15-20 kg/fed ammonium nitrate (33.5% N), 150 kg/fed calcium superphosphate (15.5% P₂O₅) and 50 kg/fed potassium sulfate (48% K₂O). Half of these fertilizers amount was added during soil preparation. Other agricultural practices of irrigation, pest control..., etc, were applied as recommended for faba bean production (Hassan, 1991).

Data collection and analysis: Data were recorded on the following traits for radish and turnip crops: plant height(cm), number of leaves per plant, root diameter (cm), dry matter of vegetative parts (%), dry matter of roots (%) and total crop yield (ton/feddan). For faba bean the follows traits were recorded: plant height (cm), pod length (cm), pod diameter (cm), number of branches per plant, number of seeds per pod, total pulse crop yield (ton/ feddan). Data of each season were grouped in each season separately as affected with intercropping crop. The treatments were grouped for analysis of variance according to the target (Mohamed *et al.*, 2007). The first ANOVA was for faba bean as follows: 1) faba bean with radish

(sprinkle), 2) faba bean with radish (in hills), 3) faba bean with turnip (sprinkle), 4) faba bean with turnip (in hills), 5) faba bean alone. The second ANOVA was for radish as follows: 1) faba bean with radish (sprinkle), 2) faba bean with radish (in hills), 3) radish alone (sprinkle), 4) radish alone (in hills). The third ANOVA was for turnip as follows: 1) faba bean with turnip (sprinkle), 2) faba bean with turnip (in hills), 3) turnip alone (sprinkle), 4) turnip alone (in hills). They were subjected to analysis of variance according to Snedecor and Cochran (1980). Based on homogeneity of error variance, the two seasons combined data were used in combined analysis of variance. Means of the treatments were compared using the Least Significant Difference (LSD) test at 0.05 probability level.

Intercropping Efficiency parameters

Land Equivalent Ratio (LER) was determined according to Willey (1979) where:

$LER = (\text{intercropping yield of main crop} / \text{monocrop yield of main crop}) + (\text{intercropping yield of second crop} / \text{monocrop of a second crop})$.

Results

Influence of intercropping each of radish and turnip on growth and yield parameters of faba bean:

Data (in Table 1) showed that, intercropping radish that grown in hills with faba bean resulted to higher values in plant height, pod length, number of seeds in pod and number of branches per plant for faba bean plants, Yield of faba bean increased when intercropped with radish. However, the differences

among intercropping treatments were found to be statistically significant for all the parameters (Table 1). The maximum yield was recorded when radish was planted in hills as intercrop with faba bean .

Influence of intercropping with faba bean on growth and yield parameters of radish:

Data (in Table 2) for Root diameter gave the highest value when radish was intercropped with faba bean in hills than either when radish intercropping with faba bean (sprinkle) or when radish crop grown as sole crop. On the other hand, number of leaves per plant and dry matter percentage for each of vegetative parts or root parts gave the highest value when radish crop was intercropped with faba bean.

Intercropping of radish with faba bean resulted in significantly higher yields of radish whether in hills or sprinkle as compared with their sole cropping. All other characteristics (plant growth and yield components) of radish which indicate yielding efficiency enhancement as a result of intercropping. In Table (2), analyses of intercropping treatments revealed that radish intercropping with faba bean resulted in the highest yield in radish by (66.74- 67.48%) when planting were done in sprinkle and by (75.27-81.55%) when planting were done in hills as compared with sole crops in the first and second season respectively.

Influence of intercropping with faba bean on growth and yield parameters of turnip:

Data of different growth and yield characteristics for turnip were

subjected to statistical analysis, which indicated significant differences among the intercropping treatments for all the parameters (Table 3). The maximum plant height, number of leaves per plant, dry matter percentage of root parts and root diameter for turnip crop were the maximum when turnip intercropping with faba bean. Also, Intercropping of faba bean with turnip resulted in significantly higher yields of turnip as compared with their sole cropping. The maximum yield was recorded when turnip intercropping with faba bean (sprinkle). The treatment means revealed that faba bean intercropping with turnip increased the yield by (50.87-51.13%) when planting were done in sprinkle and by (18.18-19.35%) when planting were done in hills as compared with sole crops in the first and second seasons respectively. In Table 4, Land equivalent ratio (LER) of faba bean-radish intercropping was, on average, 2.7 for both years. With regard to faba bean-turnip intercropping, (LER) was, on average, 2.6 for both years.

Discussion

Intercropping has been identified as a promising system that makes effective use of land and other resources (Remison, 1982 and Mohamed *et al.*, 2007) like water and soil nutrients and results in reduced cost of production (Bijay *et al.*, 1978). It has been demonstrated that the advantages of intercropping in vegetables could lead to better land use efficiency (Mohamed *et al.*, 2007) as an important component of sustainable farming (Guvane and Yildrin, 1999). Intercropping can significantly enhance crop productivity compared to

the growth of sole crops (Midmore, 1993).

Advantages of intercropping with legumes have been demonstrated in numerous studies; tomato or okra with cowpea (Mohamed *et al.*, 2007 and Olasantan, 1991), cucumber with cowpea (Susan and Mini, 2005), maize with cowpea (Akande *et al.*, 2006), cassava with cowpea (Mohammed *et al.*, 2006). These studies have indicated that intercropping was more productive than sole cropping because of the completion effect of intercrops. Leguminous plants currently present a promising opportunity in sustainable maintenance of soil fertility. Intercropping involving legumes has been found to be most useful (Adeniyi, 2011) as it improves soil fertility and gives better yields and economic returns (Lithourgidis *et al.*, 2011). Common beans are poor fixers (less than 56 kg ha⁻¹ per growing season) and fix less than their nitrogen needs. Other grain legumes, such as peas, peanuts, cowpeas, soybeans and faba beans are good nitrogen fixers and can fix all of their nitrogen needs other than that absorbed from the soil. These legumes may fix up to 280 kg N ha⁻¹ and are not usually fertilized with N (Lindemann and Glover, 2003). Almost all of the fixed nitrogen goes directly into the plant and little leaks into the soil for neighboring non-legume plants. Eventually, nitrogen returns to the soil for following crops when vegetation (roots, leaves, fruits) of the legume dies and decomposes (Lindemann and Glover, 2003; Rahman *et al.*, 2009). Since excessive use of inorganic fertilizers contribute to environmental damage

such as nitrate pollution; yield is increased because growth resources such as light, water and nutrients are more efficiently absorbed and converted to crop biomass by the intercropping. The "LER" of the faba bean-radish intercropping and faba bean-turnip intercropping were

greater than 1.0 indicating a higher combined yield was produced than for mono-cropped faba bean. However, net benefit to the grower was higher in case of faba bean intercropping with radish, followed by faba bean intercropping with turnip.

Table 1. Effects of intercropping of some characters in faba bean main crop grown in 2014-2015 and 2015-2016 winter seasons⁽¹⁾.

Cropping system		Plant height (cm)	Pod length (cm)	Pod diameter (cm)	Number of branches/plant	Number of seeds/pod	Total yield (ton/fed)
Main crop	Secondary crop	2014 – 2015					
Faba bean	Radish(sprinkle)*	99.3 c	8.1 d	1.4 c	5.7 b	3.0 d	2.566 ab
	Radish(in hills)**	120.6a	10.4 a	1.6 a	6.3 a	4.2 a	2.650 a
	Turnip(sprinkle)	108.3 b	10.1 b	1.4 bc	4.9 c	3.9 b	2.533 b
	Turnip(in hills)	110.6 b	9.7 c	1.5 b	5.0 c	3.5 c	2.423 c
Sole crop		120.6 a	9.7 c	1.5 ab	5.8 ab	3.8 b	2.413 c
2015 – 2016							
Faba bean	Radish (sprinkle)	99.7 c	8.1 c	1.3 d	5.8a	3.1 d	2.550 ab
	Radish (in hills)	120.7 a	10.4 a	1.6 a	6.3 a	4.4 a	2.700 a
	Turnip (sprinkle)	107.7 b	10.2 a	1.4 cd	4.9 b	4.0 b	2.590 a
	Turnip (in hills)	109.7 b	9.7 b	1.4bc	4.9 b	3.4 c	2.420 b
Sole crop		119.6 a	9.7 b	1.5 b	5.9 a	3.8 b	2.386 b
Source of variation	d.f	Mean Squares					
Year	1	1.633	0.023	9.66×10^{-4}	0.0003	0.0116	1.41×10^{-3}
Rep (within year)	4	12.15	0.017	2.32×10^{-4}	0.072	6.45×10^{-3}	3.315×10^{-3}
Treat	4	475.45	4.48	0.0414	2.226	1.414	0.0769
Treat × year	4	0.55	0.007	7.1×10^{-5}	0.004	0.0269	2.163×10^{-3}
Error	16	11.29	0.034	6.75×10^{-4}	0.14	0.0279	2.08×10^{-4}

(1) means within column followed by the same letter(s) are not significantly different at 0.05 level of probability.

* Sprinkle plants were thinned after 15 days from sowing at 3 cm apart (95 plants /m 2).

** Plants that grown in hills were at 5 cm apart (58 plants /m 2).

Table 2. Effects of intercropping on some characters of radish secondary crop in 2014-2015 and 2015-2016 winter seasons ⁽¹⁾

Cropping system		Plant height (cm)	Number of leaves/plant	Root diameter (cm)	Dry matter of vegetative parts (%)	Dry matter of root (%)	Total yield (ton/fed)
Secondary crop	Main crop	2014- 2015					
Radish(sprinkle)	Faba bean	88.3a	7.0 a	5.3 b	40.40 a	53.57 a	6.870 a
Radish(in hills)		86.3a	7.3a	5.7 a	41.37 a	49.23 b	6.450b
Sole crop (sprinkle)		60.3 b	5.3 c	4.8 d	12.23 c	34.20 d	4.120c
Sole crop (in hills)		65.1 b	5.7 bc	5.0 c	23.3 b	37.67 c	3.680d
		2015- 2016					
Radish(sprinkle)	Faba bean	87.5 a	7.0 a	5.3b	40.18 a	53.57a	6.830 a
Radish(in hills)		86.8 a	7.6a	5.7 a	42.49 a	49.33 b	6.347 b
Sole crop (sprinkle)		60.8b	5.4b	4.8 d	11.83 c	33.83 c	4.078 c
Sole crop (in hills)		67.0 b	5.9 b	4.9 c	20.40 b	36.30 c	3.496 d
Source of variation	d.f	Mean Squares					
Year	1	1.606	0.109	1.616×10 ⁻³	2.169	1.001	0.052
Rep (within year)	4	15.04	0.088	3.75×10 ⁻³	0.889	0.302	2.144×10 ⁻³
Treat	3	1177.9	5.74	0.959	1267.45	534.306	15.936
Treat × year	3	1.868	0.018	3.036×10 ⁻³	4.235	0.667	7.019×10 ⁻³
Error	12	19.43	0.24	0.0127	7.648	3.436	0.013

⁽¹⁾ means within column followed by the same letter(s) are not significantly different at 0.05 level of probability.

Table 3. Effects of intercropping of some characters in turnip secondary crop in 2014-2015 and 2015-2016 winter seasons

Cropping system		Plant height (cm)	Number of leaves	Root diameter (cm)	Dry matter of vegetative parts (%)	Dry matter of root (%)	Total yield (ton/fed)
Secondary crop	Main crop	2014-2015					
Turnip (sprinkle)	Faba bean	87.2 a	6.4 a	7.1a	22.40c	52.80 a	8.283 a
Turnip (in hills)		91.8 a	6.7a	7.2 a	36.50 a	55.90a	6.266 b
Sole crop (sprinkle)		62.7 b	6.2a	6.3 b	27.76 b	46.93 b	5.490 c
Sole crop (in hills)		57.3 b	5.4 b	5.6 c	14.00 d	46.56 b	5.250 c
		2015 – 2016					
Turnip (sprinkle)	Faba bean	86.0 a	6.5 a	6.8 ab	22.10 c	52.69 a	8.290 a
Turnip (in hills)		91.2 a	6.7 a	7.0 a	35.68 a	55.30a	6.143 b
Sole crop (sprinkle)		62.7 b	6.1 b	6.3 b	27.52 b	46.17 b	5.485 c
Sole crop (in hills)		56.3 b	5.3 c	5.4 c	12.51 d	45.27 b	5.198 c
Source of variation	d.f	Mean Squares					
Year	1	3.003	1.66×10^{-3}	0.177	3.048	2.87	0.011
Rep (within year)	4	7.426	0.929	0.018	0.858	7.456	0.019
Treat	3	1774.58	2.047	3.141	550.71	134.48	11.55
Treat × year	3	0.402	0.0117	0.025	0.498	0.363	6.17×10^{-3}
Error	12	13.92	0.0716	0.0475	4.726	7.129	0.03

⁽¹⁾means within column followed by the same letter(s) are not significantly different at 0.05 level of probability by using the Duncan Multiple Range Test

Table 4. Average "Land Equivalent Ratio" values for faba bean-radish and faba bean-turnip intercropping when radish and turnip planted simultaneously with faba bean.

Treatments	Land equivalent ratio [*]					
	Faba bean-Radish					
	First season			Second season		
	Faba bean	Radish	Sum	Faba bean	Radish	Sum
Faba bean with radish(in sprinkle)	1.063	1.667	2.730	1.068	1.674	2.743
Faba bean with radish (in hills)	1.098	1.752	2.850	1.131	1.815	2.947
	Faba bean-Turnip					
	Faba bean	Turnip	Sum	Faba bean	Turnip	Sum
Faba bean with turnip (in sprinkle)	1.049	1.508	2.558	1.014	1.511	2.596
Faba bean with turnip(in hills)	1.004	1.193	2.197	1.085	1.181	2.196

*= (intercropping yield of main crop/ monocrop yield of main crop)+(intercropping yield of second crop/monocrop of a second crop).

Table 5. Productivity of each of faba bean, radish and turnip as sole crops and when radish and turnip(secondary crop) intercropped with faba bean(main crop), and the income in pounds in each case.⁽¹⁾

Treatments	Total yield(ton/fed) for main crop	Total yield(ton/fed) for secondary crop	Price in pound per ton		Total price (pound)	
			Main crop	Secondary crop	Main crop	Secondary crop
Faba bean(sole)	2.143	-	10000	-	21430	-
Faba bean with radish(sprinkle)	2.566	6.870	10000	8000	25660	54960
Faba bean with radish(hills)	2.650	6.450	10000	8000	26500	51600
Radish(sole)(sprinkle)	-	4.120	-	8000	-	32960
Radish(sole)(hills)	-	3.680	-	8000	-	29440
Faba bean with turnip(sprinkle)	2.533	8.283	10000	2000	25330	16566
Faba bean with turnip(hills)	2.423	6.266	10000	2000		12532
Turnip(sole)(sprinkle)	-	5.490	-	2000	-	10980
Turnip(sole)(hills)	-	5.250	-	2000	-	10500

⁽¹⁾Total price in pound was calculated according to the price of vegetable marketable

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تأثير تحميل الفجل واللفت مع الفول على النمو والمحصول تحت ظروف اسيوط

شرين يعقوب عطا الله ، حسن سيد عباس

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الملخص

اجريت هذه الدراسة بمزرعة التجارب البحثية - كلية الزراعة - جامعة اسيوط وذلك خلال موسمين زراعيين ، واستخدمت في هذه الدراسة ثلاث محاصيل وهى الفول والفجل واللفت وتمت الزراعة فى منتصف اكتوبر من عامى ٢٠١٤-٢٠١٥ و ٢٠١٥-٢٠١٦ . واستخدم تصميم القطاعات كاملة العشوائية مع ثلاث مكررات. وكانت الكثافة النباتية عند الزراعة بطريقة السر (٩٥ نبات/ م^٢)، و (٥٨ نبات/ م^٢) عند الزراعة فى جور. اوضحت النتائج المتحصل عليها ان تحميل الفجل او اللفت مع الفول كان اكثر فاعلية من زراعة الفول بمفرده فى هذه الدراسة، حيث ادى الى زيادة معنوية فى محصول كل من الفجل واللفت مقارنة بزراعتهم منفردين. عند تحميل الفجل مع الفول زاد محصول الفجل بنسبة (66.74- 67.48%) عندما كانت الزراعة سر، وزاد المحصول بنسبة (75.27-81.55%) عند الزراعة فى جور فى الموسم الاول والثانى على التوالى، وعند تحميل اللفت مع الفول زاد محصول اللفت بنسبة (50.87- 51.13%) عند الزراعة سر، وزاد بنسبة (18.18-19.35%) عند الزراعة فى جور. فى الموسم الاول والثانى على التوالى، ووضحت النتائج ان تحميل الفجل مع الفول ادى الى زيادة محصول الفول بنسبة (9.82-13.16%) مقارنة بتحميل اللفت او زراعتة منفردا. ويتبين من هذه الدراسة ان التحميل يعتبر طريقة فعالة لزيادة انتاجية محصول كل من الفجل واللفت والفول. وكان متوسط الكفاءة التمثيلية لاستغلال الارض للموسمين ٢،٧ عند تحميل الفجل مع الفول، ٢،٦ عند تحميل اللفت مع الفول.