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EFFECT OF INTERCROPPING OF FABA BEAN (*Vicia faba* L.) WITH SOME VEGETABLES ON THE INFECTION OF FABA BEAN WITH OROBANCHE AND SOME FUNGAL DISEASES.

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ABSTRACT

Generally, the intercropping of faba bean leads to remarkable improvement in yield and morphology compared with the sole cropping of faba bean.

Intercropping of faba bean with any of the vegetables leads to decrease the percentage of infection by chocolate spot and rust diseases and also decreases the infection by orobanche plant. Root exudates of intercropping treatment reduced the percentage of germination of orobanche seeds with different degrees and also reduced the growth of the tested pathogenic fungi.

The analysis of root exudates declared that, the highest concentrations of total and free phenolic compounds were observed in the root exudates of horse radiesh which has the lowest content of total sugars and non-reduced one.

The total free amino acids in root exudates of faba bean was found to be the highest compared with the other vegetable.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important food legume crop in Egypt as a source of plant protein and carbohydrates. The parasitic weed orobanche (*Orobanche crenata* Farsk.), complex root rot, chocolate leaf spots and rust bean are the most important diseases affected on faba bean in Egypt. Orobanche caused large losses in faba bean; it considered one of major factors limiting cultivation of faba bean in Delta region (Sawsan, 1975 and Khalaf *et al.*, 1992). Orobanche seeds is surviving over 18 years and a single plant is estimated to produce from 0.5 to 1 million seeds / mintue seeds. The seeds only germinate when its contact with roots of host plant during flowering period, (Hiron, 1973 and Darwish, 1992).

The diseases of leaf spots, rust and complex root rot are very serious fungal diseases in Egypt which destroyed all crop, especially in Delta region. Disease severity under natural infection might reach 100% infection (Mohamed, 1982). Chocolate spot caused by *Botrytis faba* is the most important disease that attacks the foliage of the plant in Egypt (Mohamed *et al.*, 1982, Solh, 1995, Ismail, 1994 and Ismail *et al.*, 2003).

Root exudates of faba bean at flowering stage played principle role in germination of orobanche seeds (Whitney, 1979 and Abd El Hafeez 1995). So, this study was designed to investigate:

1-Effect of intercropping of faba bean with Turnip (*Brassica rapa* L.); Radish (*Raphanus sativus* L.); Horseradish (*Armoracia rustieana* Lam.); Onion (*Allium cepa* L.); Leek (*Allium porum* L.) and garlic (*Allium sativum* L.) on the natural infection of faba bean by orobanchea, chocolate spot and rust diseases as well as morphological and yield characteristics of faba bean.

2-Effect of root exudates for all tested plants at flowering stage on orobanche seeds germination and growth of *Fusarium oxysporum, Fusarium solani, Macrophomina phaseoli* and *Rhizoctonia solani.*

3-Determination the variations of phenolic, sugars and amino acids in root exudates of tested plants at flowering stage.

MATERIALS AND METHODS

This experiment was carried out during the two winter growing seasons of 2003 and 2004 at Tag Elezz Agricultural Research station., A.R.C., under natural infection with orobanche and other studied diseases.

Three replicates for each treatment were arranged in split-split plot design according to Sendecor and Cochran (1969). Each plot was 3 X 5.6 meters (1/250 feddan) with 5 ridge, every ridge had 20 trenches for each was sown with faba bean cv. Giza 3 in east side of ridge while the west side was sown with alternative vegetable crops by the same method, normal cultural practices were followed. Disease incidence was recorded as a percentage of infection and disease severity to complex root rot, wilt, chocolate spot and rust disease were recorded as well as percentage of infection and severity with *Orobanche* sp., morphological and yield characteristics of faba bean crop were also recorded. All data were statistically analysed according to Gomez and Gomez (1983).

Root exudates:

Root exudates of faba bean cv. Giza 3, radiesh cv. balady, horseraish cv. Balady, Turnip cv. balady, Onion cv. Giza 6 improved, Leek cv. balady and Garlic cv. balady were extracted by the method described by Ismail (1994). 0.01 gm of orobache seeds was plated on 3 layers of filter papers in sterile Petri dishes. Three Petri dishes were used for each treatment. Seven treatments were studied as following: Each Petri dish irrigated with 10 ml of faba bean root exudates. All other treatments were treated with 5 ml faba bean root exudates and 5 ml. of alternative crops root exudates. Three Perti dishes were irrigated with ten ml. sterilized water as control. The plates were incubated at 20 ± 2°C for 7 days. Plates were examined under stereoscopic binocular. Percentage of germination of seeds were determined.

Effect of faba bean and alternative crops root exudates on fungal growth:

Ten ml portions of faba bean root exudates as well as 10 ml portions of root exudates of alternative crop were added to 10 ml conical flasks containing autoclaved 100 ml of liquid Richard medium. In control treatment, root exudates were replaced by distilled sterilized water. Three replicates were used for each treatment. Flasks were inoculated with 5 mm agar discs bearing from 5 days old culture of previously isolated fungi (*Fusarium oxysporum, Fusarium solani, Macrophomina phaseoli* and *Rhizoctonia solani*) individually and inocubated at 28°C. After 7 days the fungal mat was gathered and dried at 70°C for 48 hours to obtain the dry weight of fungal growth.

Chemical components of root exudates:

Ten ml. of each root exudates was taken from each particular treatment and evaporated till dryness in rotary evaporator at 45°C. The residues were dissolved in 6 ml. of 10 % Isopropyl alcohol and stored at 4°C, to determin phenolic, sugar and amino acids content.

1-phenolic components determination:

Total and free phenols in root exudates were colourimetrically determined as described by Snell and Snell (1953).

2-Sugar determination:

Sugar content (reducing and non-reducing) was determined according to Trevelan *et al* (1950) and Block *et al* (1958).

3-Amino acids determination:

Amino acids were determined chromatography according to the methods described by Smith (1958) as well as Ambe and Toppel (1961).

RESULTS AND DISCUSSIONS

Concerning the effect of intercropping faba bean with certain vegetable crops *i.e.* radiesh, horse radiesh, turnip, onion, leek and garlic on merphological characters and yeild components of faba bean, data in Table (1) show that cultivation sole faba bean gave the lowest values in all morphological characters as well as yield and components. While all intercropping systems led to increase in those parameters compared with the sole cultivation of faba bean. Intercropping faba bean with Turnip was the most effective in increasing faba bean plant height (cm), number of shoots/plant, number of leaves/plant, wieght of 100 seeds(gm) and yield/plant (gm). Moreover, the highly increase in fresh and dry weights/plant (gm) occurred under intercropping of faba bean with horse radiesh following by the intercropping with garlic. Also, intercropping faba bean with garlic gave the highest values of number of seeds/plant. However, the same treatment was found to be similar to that of the sole faba bean on weight of 100 seeds. Improving faba bean morphological characters and yield components under intercropping condition compared with faba bean sole cropping might be due to reduction in germination of orobanche and reduction infection with other fungal diseases. These results are in harmony with results obtained by Botros (1988), El-Gantiry *et al.*, (1993) and Ismail (1994).

The effects of intercropping systems of faba bean with some vegetable crops on the infecting of faba bean by wilt, chocolate spot and rust diseases as well as orobanche during the two growing seasons of 2002/2003 and 2003/2004 are presented in Table (2).

The data show clearly that, intercropping of faba bean with any of the vegetables used decreased the percentage of faba bean wilt, chocolate spots and rust diseases as well as the infection with arobanche plant compared with the sole cultivation faba bean.

The intercropping of faba bean with horse radiesh, turnip, onion and garlic caused complete reduction of faba bean wilt disease.

Table (1). Effect of intercropping of some vegetable crops with faba bean on morphological characteristics and yield components.

Treatments.	Plant height (cm)		No. of branches/ plant		No. of leaves/plant		Fresh weight/ plant(gm)		Dry weight/ plant(gm)		No. of seeds/pod		Weight of 100 seeds		Yield/plant (gm)	
	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04
Sole faba bean	82	100	4.66	5.33	76	79	168	166	34.00	32.66	3.66	3.00	38.5	36.4	25.3	20.22
Faba bean + Radiesh	140	145	7.00	8.66	116	121	425	443	75.33	80.66	4.66	5.00	43.4	41.6	152.6	158.00
Faba bean + House radiesh	147	145	7.33	7.00	100	98	546	532	85.33	84.66	5.00	4.33	46.5	48.3	200.0	218.00
Faba bean + Turnip	156	167	10.00	10.66	119	124	466	438	80.66	77.33	5.00	5.00	48.4	47.2	236.0	235.00
Faba bean + Onion	128	120	7.66	9.00	102	100	448	421	77.00	73.66	4.00	4.33	46.3	45.5	198.0	200.00
Faba bean + Leek	120	115	5.00	4.66	78	89	315	356	50.66	54.66	4.33	4.66	40.0	41.0	82.0	96.00
Faba bean + Garlic	152	149	10.33	10.00	115	110	500	510	83.66	84.00	5.00	5.66	38.5	36.4	55.6	48.50
L.S.D at 5%	8.35	7.40	2.46	2.21	9.86	10.30	23.60	25.86	9.18	9.11	2.12	2.51	3.15	3.01	18.79	15.69

Table (2). effect of faba bean intercropping with some vegetable crops on its infection with some patogenes fungi.

Treatments.	% of wilt		Infection chocolate spot				Infection with rust						Infection with orbanche					
			% of infection		Disease severity		% of infection		Disease severity		No. of Pa /cm		% of infection		Fresh weight plant		No. of shoots	
	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04	02/03	03/04
Sole faba bean	22.00	18.0	30.00	32.00	3.66	3.00	22.33	17.66	3.66	4.00	36	30	100	100	155.00	142.00	6.66	7.00
Faba bean + Radiesh	4.33	3.0	25.66	21.33	1.66	1.66	16.00	14.66	1.66	1.66	12	10	15	12.66	98.00	75.00	1.66	1.33
Faba bean + House radiesh	0.00	0.0	18.33	15.66	2.33	2.00	15.00	13.33	1.66	2.00	8	9	8	9.00	28.00	26.00	1.00	1.00
Faba bean + Turnip	0.00	0.0	15.33	12.66	1.33	1.00	12.00	12.66	1.33	1.66	22	18	5	8.00	28.66	33.66	1.33	1.66
Faba bean + Onion	0.00	0.0	20.00	17.00	2.33	3.66	10.00	9.33	2.00	2.00	22	26	23	28.00	60.66	70.00	3.66	4.00
Faba bean + Leek	5.66	7.0	30.00	29.66	3.00	3.33	12.00	12.66	2.66	3.00	13	15	35	38.00	59.00	68.00	3.00	3.66
Faba bean + Garlic	0.00	0.0	26.00	21.33	2.33	2 66	14.00	10.33	2.00	2.00	9	8	5	7.00	46.00	36.00	1.00	1.66
L.S.D at 5%	3.61	2.93	6.71	5.42	1.03	0.94	3.32	2.81	0.87	0.98	5.82	6.22	8.91	9.35	12.36	11.71	2.31	2.76

Decreasing percentage of infection with wilt under intercropping condition might be due to root exudates of various used vegetable crops which caused change in total count microflora in rhizosphere region (Keswani *et al.*, 1977, Botros, 1988 and Ismail, 1994). Moreover, the highly decrease in the percentage of infection and disease severity of chocolate spot occurred under faba bean intercropping with turnip, while intercropping with leek had no effect. The same effect was showed in disease severity of rust, but the intercropping faba bean with onion was the most effective in reducing the percentage of infection by rust. The lowest value of number of pastul/cm^2 occurred under intercropping faba bean with horse radiesh in the first season and with garlic in the second one.

Regarding the infection of orobanche plant, data in the same table indicate that, the intercropping of faba bean with garlic gave the highest reduction in the percentage of infection in the two growing seasons. Moreover, intercropping of faba bean with horse radiesh gave the highest reduction in orbanche fresh weight and number of shoots. It's worthy to mention that, sowing faba bean as a sole gave the highest values in the above parameters. Reduction on the percentage of chocolate spot and rust under intercropping condition might be due to change in total count of microflora in phelosphere compared with total count of microflora in phelosphere region in sole cropping (Ismail *et al.*, 2000). There are two plants, one of them host to pathogenic fungi and the other non host, and this lead to reducing total count of spores of pathogenic fungi can not reach to inoculum potential (Ismail.1994 and Ismail *et al.*, 2000).

With respects to the relation between plant root exudates and germination of orabanche seeds and dry weights of some soil borne fungi data in table 3 show clearly that, all intercropping treatments reduced the percetage of germination of orobanche seeds with different degrees. These results might be due to interaction of root exudates of faba bean with root exudates of alternative plants which lead to reduction in germination of orobanche seeds. These results are in harmony with Ismail (1994).

The same trend can be clearly observed on dry weight of all tested pathogenic fungi compared with cultivation of faba bean as a sole plant when faba bean was intercropped with Turnip, the lowest values of percentage of germination seeds (10) as well as dry weights of different pathogenic fungi (*Fusarium oxysporum* (40), *F.solani* (43), *Macrophomine phaseole* (56) and *Rhizoctonia solani* (63) were reduced compared with other treatment. On the other hand, the sole cultivation of faba bean resulted in the highest values of percentage of orobanche seeds germination and dry weight of tested fungi. Faba bean + leek treatment gaves the highest values of the studied parameters compared with other intercropping treatments, but less than the cultivation of faba bean alone.

Reduction in dry weight of tested fungi with intercropping root exudates might be due to some of these root exudates contained inhibitory substances such as phenolic substances. Similar results were obtained by Khalaf *et al.*, (1992) and Ismail (1994).

Table (3): Effect of root exudates on germination of orobanche seeds and growth of some pathogenic fungi.

Root exudates	Germination % of orobanche seeds	*Fusarium oxysporum*	*Fusarium solani*	*Macrophomina phaseoli*	*Rhizoctonia solani*
Faba bean	98	166	175	185	183
Faba bean + Radiesh	35	64	55	75	63
Faba bean+ horseradiesh	30	53	65	68	75
Faba bean +Turnip	10	40	43	56	63
faba bean + Onion	40	83	75	99	103
Faba bean + Leek	45	85	73	109	116
Faba bean + Garlic	45	76	75	101	102
Control	0	23	27	38	36
L.S.D at 5%	10.36	15.63	12.60	14.98	16.22

* = Dry weight of the mycellial mat (mg).

As shown in table (4) the highest concentrations of total and free phenolic contents in plant root exudates (14.61 and 8.20, respectively, were observed in root exudates of horse radish followed by turnip and Garlic without any significant differences. Moreover, turnip plant root exudates gave the highest content of conjugated phenolic (6.82).

Table (4). Phenolic contents of some tested plant root exudates.

Plant	Root exudates (mg / 100 cm)		
	Total	Free	Conjugated
Faba bean	5.31	3.39	1.92
Radiesh	11.91	6.59	5.32
Horse Radiesh	14.61	8.20	6.41
Turnip	12.83	6.01	6.82
Onion	9.81	5.45	4.36
Leek	10.53	6.72	3.81
Garlic	12.36	5.83	6.53
L.S.D at 5%	4.76	2.75	1.97

On the other hand, faba bean root exudates were lower in their concentrations in free and conjugated as well as total phenolic contents. Increasing phenolic contents in horse radish, turnip, Garlic and radies root exudates compared with phenolic contents of faba bean root exudates explain the ability of vegetable tested plants in controlling orobanche seed germination and soil borne fungi. These results were in agreement with those obtained by Hiron (1973) and Ismail (1994).

Data in Table (5). show that, the root exudates of horse radiesh has the lowest content of total sugars (30.64 mg/100 ml) and non-reduced sugar (16.80 mg/100 ml) compared with all other plant root exudates, but the reduced sugar in the root exudates of turnip is lower than all other treatments (11.65) followed by horse radiesh root exudates (13.84). However, root exudates of faba bean and Garlic gave much more amount of total sugars without significant differences (70.80 and 70.63 mg/100 ml) compared with other plant root exudates. It is also clear that, the difference between sugar contents ion root exudates of all other tested vegetable plants and faba bean were significant.

Table (5): Sugar contents of some tested plants root exudates mg/100 cm root exudates

Root exudates	mg / 100 cm.		
	Total	Reduced	Non-reduced
Faba bean	70.8	25	45.80
Radiesh	48.53	17.71	31.62
Horse Radiesh	30.64	13.84	16.80
Turnip	38.16	11.65	26.51
Onion	64.35	23.72	40.63
Leek	68.71	29.75	38.96
Garlic	70.63	21.72	48.91
L.S.D at 5%	9.35	4.85	6.34

The determination of free amino acids in tested plant root exudates at flowering stage are presented in table (6).Data show that, the highest content of total free amino acids was found in faba bean root exudates (15.655 mg/100 cm) compared with all other root exudates with significant differences. While, the low concentration of total free amino acids were found in leek root exudates (5.024 mg/100 cm). The increase of total free amino acids in root exudates of faba bean due to the increase in amino acids of cysteine, asparatic, serine, glycine, leucine and isoleucine. Increasing amount of sugar contents and amino acids in faba bean root exudates compared to the other tested plants might be explain the ability of faba bean root exudates to break dormant stage of orobache seeds (Sawsan, 1975 and Abd-El Haffeez, 1995).

Table (6). Free amino acids of some tested plant root exudates as mg/100 cm. root exudates.

Root exudates	Cysteine	Lysine	Histidine	Arginine	Asparatic serine glycine	Glutamic threonine	Alanine	Tyrosine	Trypto-phan	Methioni-ne valine	Phenyl-alanine	Leucine isoleucine	Total
Faba bean	3.610	0.463	0.863	0.236	2.931	1.963	0.234	0.453	0.536	1.184	0.842	2.34	15.655
Radiesh	1.640	---	0.415	---	1.684	0.834	0.162	---	0.176	0.364	0.324	1.242	6.841
Horse radiesh	0.712	0.187	0.213	0.193	0.962	0.731	0.148	0.407	0.341	0.253	0.256	0.864	5.267
Turnip	0.367	0.253	---	---	1.672	0.532	---	0.351	0.213	0.164	0.631	0.931	5.114
Onion	0.815	0.421	0.163	0.612	0.853	0.234	0.416	0.232	0.348	0.568	0.354	1.864	6.871
Leek	0.345	0.217	0.342	0.311	0.963	0.367	---	0.220	0.673	0.493	0.135	0.958	5.024
Garlic	0.468	0.356	0.163	0.219	1.234	0.572	0.236	0.446	0.682	0.598	0.211	1.321	6.506
L.S.D at 5%	0.134	0.120	0.139	0.154	0.213	0.178	0.148	0.213	0.254	0.264	0.193	0.312	4.10

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تأثير تحميل الفول البلدى مع بعض محاصيل الخضر على إصابة الفـول البلـدى بالهالوك وبعض الأمراض الفطرية.

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أدى تحميل الفول البلدى مع كلا من الفجل والجرجير واللفت والبصل والكرات والثوم إلى قلـة نسبة وشدة الإصابة بمرض الذبول وكذلك التبقع الشيكولاتى والصدأ وكذلك انخفـاض مسـتوى الإصـابة بالهالوك فى عدد الشماريخ الزهرية فى الهالوك مقارنة بالزراعة الفردية.

اتضح أن تحميل البصل والثوم مع الفول أعطى أقل نسبة إصابة بـالأمراض الفطريـة أعقبـه التحميل مع اللفت ثم التحميل مع الجرجير بينما كان التحميل مع الفجل والكـرات أكثـر إصـابة مقارنـة بالمعاملات الأخرى. كما أدى تحميل الفول مع اللفت والثوم والجرجير الى انخفاض الإصابة بالهالوك بدرجة كبيرة أعقبه التحميل مع الفجل بينما كان التحميل مع الكرات والبصل أقل تأثيرا.

أدت إفرازات جذور الفول الى ارتفاع النسبة المئوية لإنبات بذور الهالوك وعند اضافة إفرازات جذور النباتات المحملة مع الفول أدت الى انخفاض نسبة إنبات بذور الهالوك بدرجة كبيرة وملحوظة. كمـا أدت افرازات جذور اللفت إلى خفض الوزن الجاف لبعض الفطريات الممرضة فى التربة وكان أقوى هـذه الإفرازات تأثيرا إفرازات جذور اللفت أعقبه إفرازات جذور الجرجير والفجل وكان أقلها تأثيرا إفـرازات البصل والكرات والثوم.

اتضح ارتفاع المحتوى الفينولى لإفرازات جذور الجرجير واللفت والثوم عن إفرازات جذور البصـل والكرات والفجل. و من ناحية أخرى اتضح زيادة محتوى إفرازات جذور الثوم والكـرات والبصـل مـن السكريات الكلية مقارنة بإفرازات جذور اللفت والفجل والجرجير. كما اتضح أيضا ارتفاع محتوى إفرازات جذور الفول من الأحماض الأمينية بدرجة كبيرة عن بقية الخضراوات المستخدمة مع وجود تقارب شديد فى محتوى إفرازات جذور الخضراوات المحملة المستخدمة في الأحماض الأمينية.

كما أدى التحميل أيضا إلى زيادة جميع الصفات المحصولية بدرجة كبيرة مقارنة بالزراعة المنفردة.