Studies on *Orobanche crenata* control in Faba bean

M. A. F. Abd El-Ghafar*, M. H. M. Fayed, M. S. E. Osman, and E. A. E. Mesbah.

Department of Agronomy, Faculty of Agriculture, Al Azhar University, Cairo, Egypt.

* Corresponding author E-mail: mohamedabedalghafaar.3724@azhar.edu.eg (M. Abd El-Ghafar)

ABSTRACT

Two field experiments were conducted at Sadat region, Minufiya Governorate, Egypt during 2020 – 2021 and 2021-2022 seasons, to study allelopathic influence of inter-cropping system five teen with faba bean on broomrape control, yield and its components under naturally infested soil conditions. Results indicated that the differences between inter-cropping systems for broomrape and faba been traits were significant in the two season. The best values for broomrape, spikes number / m², fresh weight g/m² and dry weight g/m² were obtained from faba bean + radish, followed by faba bean + fenugreek , than faba bean + flax in the first and second seasons, respectively, while, the best values for faba bean traits, branch number / plant, pods number / plant, seed number/plant and seed yield kg / fed., were obtained from the same inter-cropping systems compared with sole faba bean in the first and second seasons. From the previous results showed that faba bean with all inter-cropping especially, radish, fenugreek or flax decrees broomrape traits increase faba bean yield, its components and land equivalent ratio under naturally infested soil conditions, compared with sole faba bean system in sandy soils.

Keywords: Faba bean, broomrape, inter-cropping, Radish Fenugreek Flax, Lupin, wheat, Barley and lentil.

INTRODUCTION

One of the most important winter legumes crops for human consumption in Egypt is the faba bean (*Vicia faba L.*). Dried seeds are an excellent source of energy, also faba been contain an average of 58% carbohydrate, from 24 - 35 % protein, consequently, is an in expensive source of protein for much of the population. Broad beans play an important role in crop rotation in Egypt, that because it can nitrogen fixation from throw root nodule bacteria, which plays important role in increasing soil fertility Kopke and Nemecek, (2010).

Broomrape (*Orobanche crenata,* Forsk.) is an annual herb that is an obligate parasite of secondary roots of broad bean plants and other susceptible hosts in Egypt and Mediterranean region. Broomrape causes in significant losses to the host and in severe cases leads to crop failure. Yield loss depending on host genotype, level of parasitism, planting date, and many other factors. For most crops, there are few options for broomrape control due to the complexity of mechanical control and the lack of reliable and selective herbicides. There is no specific method that provides sufficient control. Combining different management methods can lead to improved weed control in broomrape Goldwasser *et al*. (2003).

Although Bayoumi *et al.* (2014) stated that there are different ways to combat broomrape, and is no consistent and sustainable method to combat broomrape in Egypt., Abbes *et al.* (2019) indicated that seeds of this parasitic weed may be remain dormant in the soil for many years, until germination is stimulated by root exudates from the host plant and climatic conditions become favorable.

Masteling *et al*. (2019) found that faba bean roots release signaling molecules (i.e. strigolactones) that stimulate germination of root-parasitic weed seeds at the soil interface, in addition to, historium establishes a vascular connection with the xylem and /or xylem and phloem for water uptake and photosynthesis by the host plant.

Several studies have been conducted on this topic, Ghobashy, (1997) showed that broomrape parasitism of faba bean plants significantly reduced dry weight g /m², plant height cm, number of branches / plant , number of pods / plant and seed yield / fed.

Also, in this regard, Abbes *et al*. (2008) indicated that flax and fenugreek as trap crops after observing the germination of broomrabe on their crops.

At the same time, Abu-Shall and Ragheb (2014) revealed that planting radish with peanut resulted in the maximum productivity for peanut and reduced susceptibility to broomrape compared with planting peanut alone, due to certain chemicals secreted by the roots of radish, garlic, and fenugreek.

Also, Aksoy *et al*. (2016) found that flax was the most effective treatment, with a decrease of 52% - 71% in number of branches / plant and from 26 - 55% in dry weight of broomrape plant in the two seasons, in legume field crops. In the same time, Zeid and Komeil, (2019) showed that planting fenugreek with the varieties of faba bean Giza 843 and Misr 3 reduced the germination of broomrape seeds by approximately 30% while this percentage reached 73% when planting radish with Misr 3 only. They indicated that percentage some of organic acids in the root zone of internally cultivated faba beans may be play an important in tolerating broomrape infection through selecting the appropriate inter-cropping system.

Fernández *et al.* (2010) found that intercropping of fenugreek, berseem, flax and oats on legumes reduces broomrape infection, that allelopathy main ingredient for the reduction.

They indicated that oat and fenugreek roots may be secrete substances to inhibit the germination of broomrape seeds. These was compounds are trigoxazonan from fenugreek and benzoxazolinone from oat root secretions, which may be responsible for inhibiting the germination of broomrape seeds.

Consequently, these the study aimed to investigate allelopathic effect of inter-cropping fourteen crops with faba bean on broomrape control, yield and its components of crops.

MATERIALS AND METHODS

Two field experiments were conducted at Sadat region, Minufiya Governorate, Egypt during, 2020 – 2021 and 2021-2022 seasons ; to study allelopathic influence of inter-cropping system with faba bean on broomrape control, yield and its components under naturally infested soil conditions.

A completely randomized was used, and there twenty nine treatments with four replications:

planting faba bean (Nubaria 1) alone.

planting fenugreek alone.

planting lupin alone.

planting garlic alone.

planting radish alone.

planting fennel alone.

planting coriander alone.

planting rocket salad alone.

planting parsley alone.

planting turnip alone.

planting wheat alone.

planting barley alone.

planting oat alone.

planting flax alone.

planting lentil alone.

Inter-cropping fenugreek + faba bean.

Inter-cropping lupin + faba bean.

Inter-cropping garlic + faba bean.

Inter-cropping radish + faba bean.

Inter-cropping fennel + faba bean.

Inter-cropping coriander + faba bean.

Inter-cropping rocket salad + faba bean.

Inter-cropping parsley + faba bean.

Inter-cropping turnip + faba bean.

Inter-cropping wheat + faba bean.

Inter-cropping barley + faba bean.

Inter-cropping oat + faba bean.

Inter-cropping flax + faba bean.

Inter-cropping lentil + faba bean.

Preparing the land for agriculture:

Mechanical and chemical analysis of the soil on the experimental site according to standard method of Arnold, (1986) are presented in Table (2). Faba bean seeds were inoculated with root nodule bacteria and during soil preparation prior to planting, super calcium phosphate containing 15.5% P2O5 was applied at a rate of 200 kg per feddan for phosphorus fertilization. Additionally, ammonium nitrate with a nitrogen content of 33.5% N was applied at a rate of 200 kg per feddan for nitrogen fertilization was added in two doses the first before planting and the second before the first irrigation. Other municipal bean farming practices were implemented in accordance with the recommendations of the Egyptian Ministry of Agriculture for the production of faba bean in this area. The pilot plot has an area of 10.5 m2 (3.50 m length and 3.00 m width), and consisting of 5 ridges with 60 cm inter-row spacing. Seeds of faba bean and enter-crops were planted on 15th November 2020-2021 and 2021-2022 seasons except garlic (*Allium sativum, L.*) was sown 30 days earlier than faba bean under sole and intercropping system. .

Faba bean seeds wear planted on one sides of ridge (60 cm) width (two plants/hill spaced at 15 cm) and were later thinned to 12 plants per one meter and the intercropping plant density reached 50% of the recommended density for individual crops.

Sole faba bean

Faba bean seeds wear planted in both sides of ridge (60 cm) width (two plants/hill spaced at 15 cm) and were later thinned to 16 plants per one meter.

Sole inter-crops

Seeds of fenugreek at a rate of 50kg / fed., lupine at a rate of 40 kg / fed. , garlic at a rate of 120 kg / fed., radish at a rate of 8 kg / fed., fennel at a rate of 5 kg / fed., coriander at a rate of 9 kg / fed., rocket salad at a rate of 7 kg / fed., parsley at a rate of 8 kg / fed., turnip at a rate of 5 kg / fed., wheat at a rate of 50 kg / fed., barley at a rate of 50 kg / fed., oat at a rate of 50 kg / fed., flax at a rate of 75 kg / fed., and lentil at a rate of 40 kg / fed.

Studied traits :

Broomrape weeds traits

Before harvesting the faba bean and after 140 days of planting the faba bean, the following qualities were measured:

Number of broomrape (Spikes/ m^2). It was calculated per square meter and referred to as the number of emerged broomrape spikes that appeared per host plant in each treatment (Rubiales *et al.,* 2006).

Fresh weight of broomrape spikes (g / m^2).

Dry weight of broomrape spikes (g / m^2).

Faba bean seed yield and its attributes

After 175 days of planting, samples were collected from five plants randomly from each plot to estimate the following parameters:

Number of branches / plant.

Number of pods / plant.

Seed yield kg / fed.

Inter-crop yield

At harvest, fenugreek seeds yields per fed., at 140 days, lupine seeds at 160 days, garlic bulbs at 180 days, radish seeds at 130 days, fennel seeds at 160 days, coriander seeds at 160 days, rocket salad seeds at 130 days, parsley seeds at 140 days, turnip roots at 120 days, wheat seeds at 160 days, barley seeds at 160 days, oat seeds at 160 days, flax seeds at 160 days, lentil seeds at 120 days from planting.

Land equivalent ratio (LER):

It is defined as the ratio of the area required under sole cropping to that needed under intercropping, both managed at the same level, in order to achieve an equivalent yield. This definition was proposed by **Willey, (1985)**. It is calculated as follows:

LER = (Yab/Yaa) + (Yba/Ybb)

Yaa = Net yield of crop a (faba bean)

Ybb = Net yield of crop b (Inter-crops)

Yab = Intercrop yield of crop a (faba bean)

Yba =Intercrop yield of crop b (Inter-crops)

Statistical analyses

The data of each experiment were statistically analyzed as a factorial experiment according to the methods described by ***Little*** and ***Hills, (1978)***. The combined analysis of the data of all experiments followed both seasons (experiments), and the treatments means were compared by least significant differences (LSD) at the 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of inter-cropping systems on faba bean for broomrape parasitic weeds traits, yield, its components and land equivalent ratio (LER) in means 2020-2021 and 2021-2022 seasons are presented in Tables 2 ,3 and 4.

Results indicated that the differences between inter-cropping systems for broomrape traits, spike number / m^2, fresh weight in g / m^2 and dry weight in g /m^2 were significant in means the two seasons. The best values for these traits were obtained from inter-cropping systems with faba bean + radish, faba bean + fenugreek and faba bean + flax in means both seasons. All inter-cropping systems gave reduction % in broomrap traits, 74.71 , 75.07 and 75.96% from faba bean + radish inter-cropping system followed with faba bean + fenugreek, 60.92,62.23 and 62.3 % , then faba bean + flax, 58.62, 60.73 and 61.15 % respectively compared with the control (sole faba bean). The positive effect of faba bean + radish inter-cropping system in broomrap reduction may be due to certain chemicals secreted from radish in faba bean rhizosphere (faba bean roots region) such as citric, maleic and salicylic acids, which led to reduced broomrape infestation, also, the presence of organic acids in faba bean root zone may be play an important in tolerating faba bean of broomrape infection through selecting the appropriate inter-cropping systems.

Also, the previous results indicated that fenugreek and flax substances chemicals secrete inhibition from the germination of broomrape seeds, that fenugreek secreted of oxalic acid and trigoxazonan may be responsible for inhibiting the germination of broomrape seeds, in addition to, that flax plants roots exudates and ascorbic acid concentrations in faba bean rhizosphere are chemicals allelopathic substances that had a negative effect on the germination of broomrape seeds. These results were in agreement with Hussain *et al*., (2009), Parker (2009), Fernandez *et al.* (2010), Abu-shall and Ragheb (2014), El-khayat *et al*. (2015), Abdel-Wahab and Abdel-Wahab (2021).

Also, results indicated that the differences between inter-cropping systems for yield, its components and land equivalent ratio (LER) were significant in means both seasons. The maximum values for most traits were recorded from inter-cropping systems faba bean + radish, faba bean + fenugreek and faba bean+ flax in means both seasons.

Inter-crapping systems on faba bean increased number of branches / plant ranged between 9.09 - 54.45 % , pods number / plant from 18.42 - 50 % , seed number / plant from 0.89 - 38.39% and seed yield kg / fed. from 29.05 -187.21%. The positive effect to inter-cropping systems on yield, its components and land equivalent ratio attributed to secreted radish, fenugreek and flax concentration from allelopathic chemical substances such as salicylic, oxalic, citric and ascorbic acids in faba bean rhizosphere, which, reduced number of spike /m^2, and dry weight / m^2 compared with the control (sole faba bean) and land equivalent ratio of faba bean and inter-cropping systems.

Also, results indicated that the land equivalent ratio ranged from 3.34 of intercropping faba bean with radish to 1.57 of intercropping faba bean with wheat.

Also, inter-cropping systems especially, with radish, fenugreek and flax increased yield, its components and LER due to improve endogenous plant hormones, which, positively reflected on internodes length and its number, in addition to that, salicylic acid activated the consumption of soluble carbohydrates to form a mechanism against broomrape infestation and the germination of seeds, as well as, the same the mechanism of ascorbic acid concentrations. these results are in agreement with Smolinska *et al*. (2003), Watson *et al*. (2006), Velasco *et al.* (2007), Abbes *et al.* (2008), Aksoy *et al*. (2016), and Zeid and Komeil (2019). They indicated that radish, fenugreek and flax planted with faba bean varieties reduced germination of broom rape from 30 - 73% and increased yield and its components of inter-cropping systems with faba bean.

CONCLUSION

From the previous results discussion showed that inter-cropping systems in this the study on faba bean, especially, radish, fenugreek and flax significantly reduced broomrape traits and increased faba bean seed yield, its components and land equivalent ratio under naturally infested soil conditions compared with sole faba bean system in sandy soils. Growing radish, fenugreek or flax intercropping faba bean could be an integrated control strategy to increase faba bean productivity, land usage under soil infested with broomrape.

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Table 1: Mechanical and chemical analysis of experimental soil in 2020- 2021 and 2021-2022 seasons.

Mechanical analysis	2020- 2021 seasons	2021-2022 seasons
Sand %	94.1	93.6
Silt %	4.0	4.2
Clay %	1.9	2.2
Texture Class	Sand	Sand
Chemical analysis		
PH	8.2	8.3
EC (mlos /cm.)	1.25	1.30
Ca Co_3 %	5.80	4.70
Available N (ppm)	9	12
Available P (ppm)	16	18
Available K (ppm)	36.7	38.2

Table 2 : Effect of intercropping systems on broomrape traits means for faba bean in 2020- 2021 and 2021-2022 seasons.

Intercropping system	Broomrape traits		
	Spikes No./ m2	Fresh weight g/m2	Dry weight g/m2
Alone Faba bean	21.75	141.33	100.97
Faba Bean + Fenugreek	8.50	53.38	38.06
Faba Bean+ Lupin	11.25	73.08	51.65
Faba Bean+ Garlic	10.00	53.53	38.01
Faba Bean+ Radish	5.50	35.23	24.27
Faba Bean+ Fennel	15.50	101.45	71.45
Faba Bean+ Coriander	14.25	93.30	66.46
Faba Bean+ Rocket Salad	9.75	58.03	44.43
Faba Bean+ Parsley	10.50	67.70	47.92
Faba Bean+ Turnip	10.50	68.35	48.20
Faba Bean+ Wheat	15.25	92.08	66.90
Faba Bean+ Barley	14.50	87.13	63.33
Faba Bean+ Oat	13.50	80.13	58.38
Faba Bean + Flax	9.00	55.50	39.23
Faba Bean+ Lentil	10.00	65.38	46.64
LSD at 0.5%	3.093	19.792	15.220

Table 3: Effect of intercropping systems on faba bean seed yield and its components means in 2020/ 2021 and 2021/ 2022 seasons.

Intercropping system	Faba bean traits			
	Branch no. /plant	Pods no./plant	Seeds no. /plant	Seed yield (kg/fed)
Alone Faba bean	2.75	9.50	28.00	493.13
Faba Bean + Fenugreek	4.00	13.75	35.50	1056.13
Faba Bean+ Lupin	3.75	13.50	33.25	855.52
Faba Bean+ Garlic	4.00	13.25	34.25	986.43
Faba Bean+ Radish	4.25	14.25	38.75	1416.31
Faba Bean+ Fennel	3.00	12.75	31.75	760.10
Faba Bean+ Coriander	3.00	13.00	32.50	778.05
Faba Bean+ Rocket Salad	3.75	13.50	35.75	768.50
Faba Bean+ Parsley	3.00	13.00	32.75	715.07
Faba Bean+ Turnip	3.25	12.75	32.00	707.94
Faba Bean+ Wheat	2.75	11.25	28.25	636.41
Faba Bean+ Barley	3.00	12.00	28.50	646.95
Faba Bean+ Oat	3.00	12.25	29.00	668.90
Faba Bean + Flax	4.00	13.75	34.75	1009.49
Faba Bean+ Lentil	3.50	12.75	32.00	743.68
LSD at 0.5%	0.630	1.346	10.104	280.690

Table 4: Relative yields mean and LER of cropping system between faba bean and fourteen crops under study in 2020/ 2021 and 2021/ 2022 seasons.

Intercropping system	Faba bean	Intercrop yield kg /fed.		Relative yield		LER
	Seed yield kg /fed.	Inter.	Sole	RY_f	RY_C	
Alone faba bean	493.13					
Fenugreek	1056.13	195	680	2.14	0.29	2.43
Lupin	855.52	190	850	1.73	0.22	1.96
Garlic	986.43	3170	9850	2.00	0.32	2.32
Radish	1416.31	380	820	2.87	0.46	3.34
Fennel	760.10	337	840	1.54	0.40	1.94
Coriander	778.05	483	1120	1.58	0.43	2.01
Rocket salad	768.50	199	450	1.56	0.44	2.00
Parsley	715.07	261	620	1.45	0.42	1.87
Turnip	707.94	3420	9500	1.44	0.36	1.80
Wheat	636.41	715	2580	1.29	0.28	1.57
Barley	646.95	530	1740	1.31	0.30	1.62
Oat	668.90	195	630	1.36	0.31	1.67
Flax	1009.49	250	591	2.05	0.42	2.47
Lentil	743.68	235	680	1.51	0.35	1.85

دراسات على مقاومة الهالوك في الفول البلدي

محمد أحمد عبد الغفار*، محمد هاني فايد ، محمود سيف عثمان, السيد عبد الله مصباح

قسم المحاصيل, كلية الزراعة, جامعة الأزهر, القاهرة, مصر.

*البريد الإليكتروني للباحث الرئيسي:mohamedabedalghafaar.3724@azhar.edu.eg

الملخص العربى

أجريت تجربتان لدراسة التأثير الأليلوباثى لخمسه عشر نظاماً تحميلياً على مكافحة الهالوك في الفول البلدي وكذلك على المحصول ومكوناته وكفاءة استغلال الأرض تحت ظروف الأرض الرملية المصابة طبيعيا بالهالوك، ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :- أظهرت النتائج تأثيرا معنويا لنظم التحميل على انخفاض صفات الهالوك مقارنة بالفول البلدي المنفرد . كما أظهرت النتائج أيضًا تأثيراً معنوياً موجَّبا لنظم التحميل على المحصول ومكوناته للفول البلدي وكذلك كفاءة استغلال الأرض .

الكلمات الاسترشادية: الفول البلدي, الهالوك, التحميل, الفجل, الحلبة, الكتان, الترمس, القمح, الشعير, العدس.