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INVESTIGATIONS ON FABA BEANS, *Vicia faba* L. 33. BULK *vs*. INDIVIDUAL SELECTION IN VARIETY CAIRO 25 GROWN UNDER *Orobanche* STRESS AND FREE FIELD

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ABSTRACT

Individual-plant and bulk selection, with different intensities, were practiced in the faba bean variety Cairo 25. It is a blended variety from different genotypes and tolerant to *Orobanche*. Selection and evaluation occurred under *Orobanche*–stress and free fields. Significant differences occurred between the orthogonal comparisons (Individual *vs*. bulk selections and bulks against each other) in both free and infested plots. Genotypes and populations behaved differently in their yield and yield components within each condition, but generally individual selections had better performance than bulk selections. All characters, except the number of branches/plant, decreased for plants grown under *Orobanche* infestation compared to sister plants grown in healthy plots. Although many individual selections performed better than bulks, some bulk selections had better performance than some individual selections. Selection under *Orobanche* stress condition can not be absolutely effective under stress and non stress conditions.

Key words*: bulk selection, faba beans ,individual selection, Orobanche , selection intensity,Vicia faba.*

1.INTRODUCTION

Faba bean (*Vicia faba* L.) is the most important pulse human food crop in Egypt. It is also important leguminous crop in the intensive crop rotation. Its green and dry seeds are used in preparing many popular local dishes because of its high nutritive value (Abdalla *et al*., 1976).

Concerning the inability to develop hybrid faba bean varieties, in addition to the need to explore the useful heterosis apparent in this crop, some authors recommended the development of blended and synthetic varieties (Bond, 1982 and Abdalla and Fischbeck, 1992). Cairo 25 faba bean variety is a product of such experience. It is also an *Orobanche* tolerant variety (Abdalla and Darwish, 2008).

Orobanche crenata (Forsk.) is an annual parasitic plant that causes heavy losses to the faba bean host. Its seed lives in soil for many years until germinated by host stimulant excreted from roots (Tewfic 1956).

Selection is a breeding method to develop new variation. It can be practiced on bulk and individual–plant basis. Therefore the aim of this study was to evaluate the effect of bulk and individual selection on the heterogeneous variety Cairo 25 when grown under free and *Orobanche*-infested fields.

2. MATERIALS AND METHODS

2.1.Location of the study and plant materials

The material used in this study is the variety Cairo 25. It is a synthetic *Orobanche* tolerant and registered as commercial variety from the Agronomy Department, Faculty of Agriculture, Cairo University.

The trials were carried out at the Agricultural Experiments and Research Station,Faculty of Agriculture, Cairo University, Giza, under two conditions (naturally *Orobanche* -infested field and *Orobanche*-free field) during the two seasons 2008/2009 and 2009/2010.

The chosen *Orobanche* field is known for its high infestation by broomrape seeds since almost 35 years ago.

In 2008/2009 season, seeds of variety Cairo 25 were planted under two field conditions *(Orobanche*-free and infested). Each plot consisted of 55 ridges, each ridge was 3 m long

and 60 cm apart. Seeds were hand planted on one side of the ridge as doubled seeds hills at 20 cm distance.At harvest the best 160 plants (based on pod-set visual selection and the general appearance of plants) were selected during maturity stage.

After harvesting, the best 150 yielding plants of the 160 selected in field were divided into 4 groups based on pods and seed yield/plant [(the best 20 plants (Pop 1), the best 50 plants (Pop 2), the best 100 plants (Pop 3) and all the 150 plants (Pop 4)] with selection intensities of 1.33, 3.33, 6.67 and 10%, respectively. Five seeds from each plant were taken and blended to synthesize the four selected bulks of seeds. Also at harvest, 30 plants were taken at random and their seeds were blended to constitute the bulk unselected stock (Pop 5) (Fig.1).

In addition, the remnant seeds of the best 20 individual harvested plants were used for evaluation as individual plant selections in addition to their bulk use (Pop1).

During 2009/2010 season the 20 individual selected plants, the 4 selected bulks (Pop 1, Pop 2, Pop 3 and Pop 4) in addition to the unselected one (Pop 5) were sown for evaluation under *Orobanche*-free (25 selections and populations) and *Orobanche*-infested field conditions (25 sister selections and populations).

2.2. Experimental design and crop management

The experiment was laid out in a randomized complete blocks design with two replications. The experimental plot consisted of 3, 2, 2, 2, 1 and 1 ridge for each Pop 5, Pop 1, Pop 2, Pop 3 and Pop 4 and each of the 20 individual selected plants, respectively. Each ridge was 3 m long and 60 cm apart. Seeds were sown at one side of the ridge at 20 cm distance using single seed per hill. Sowing date took place on 18th of November of 2009. All agronmic practices were kept normal and uniform for all the treatments.

2.3. Data collection:

2.3.1.The following data were recorded on all individual plants of each plot

1. Plant height (cm).
2. Plant dry weight (g).
3. Number of branches/host plant.
4. Number of pods/host plant.
5. Number of seeds /host plant.
6. Seed yield/host plant (g).
7. Percentage of podded hosts /ridge (% podded plants).
8. Number of *Orobanche* spikes/ridge at maturity.
9. Seed index, 100 seeds (g).

2.4.Statistical analysis

Data recorded for different parameters were compiled and tabulated in proper form for statistical analysis. The collected data were analyzed using "Analysis of variance technique" with the help of computer package program MSTATC and Duncan's Multiple Range Test (DMRT) following (Gomez and Gomez, 1984) was used to judge the significance of mean difference. Appropriate transformations (logarithmic, square root, arc sin) were performed when necessary.

3. RESULTS AND DISCUSSION

Products of individual selection and bulk (mass) selection of variety Cairo 25 practiced in 2008/ 2009 were evaluated in 2009/2010 season.

3.1.Populations selected under free conditions and evaluated under free and *Orobanche* infestation

3.1.1. Analysis of variance and significance of variances due to the 25 free selections and populations

Table (1) summarizes the significance of mean squares due to different sources of variation for the studied traits under *Orobanche* and free conditions during 2009/2010 season. Highly significant differences ($p \leq 0.01$) were recorded between different genotypes for all traits, except the number of pods/plant which was significant at ($p \leq 0.05$) under infested condition.

The data in Table (1) presented four orthogonal comparisons; individual selections *vs.* 5 bulks, Pop 1 *vs.* Pop 2, Pop 3 *vs.* Pop 4 and 4 selected populations' *vs.* unselected one (Pop 5). The first comparison, selections *vs.* bulks indicated highly significance for all studied traits, except for seed index under free field while, showed high significance for podded plants and *Orobanche*/ridge under infested field. The other three comparisons showed significance for podded plants % only, in addition to significance recorded for number of *Orobanche* spikes/ridge for Pop1 *vs.* Pop2.

3.2. Performance of selected individual plants, selected and unselected populations (free condition) grown under *Orobanche*-free and infested conditions

The mean performance of genotypes under *Orobanche* free field and infested one was variable for all the studied traits. The results in Table (2) indicated that, materials ranked differently from individual selection to another, individual to bulks and bulk to bulk. Also,

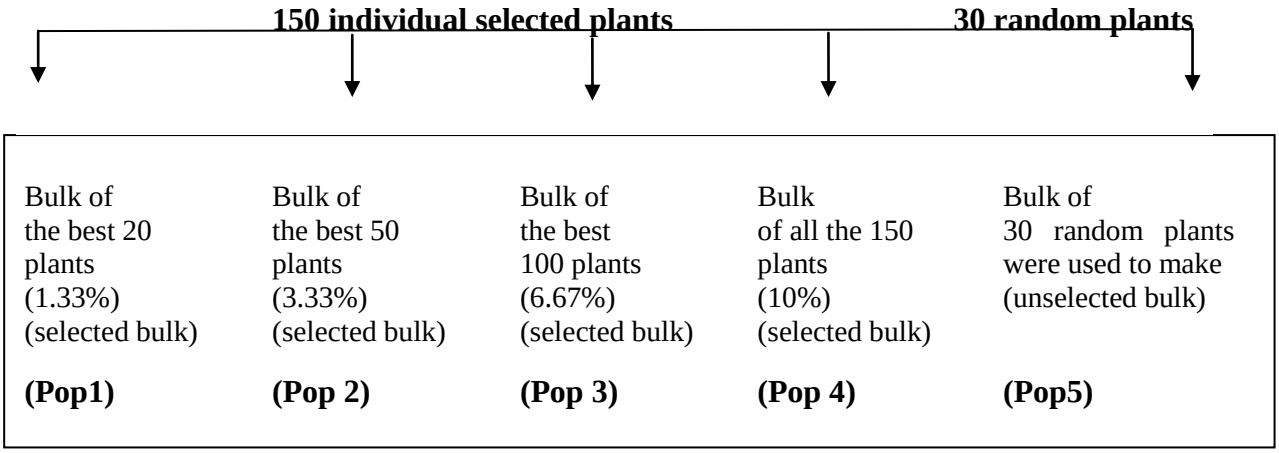

Fig (1): Constituents of the five studied populations

Table (1): Significance of mean squares of variety Cairo 25 selections and populations (25 from free field) under *Orobanche*-free (Free) and infested (Infested) conditions during 2009/2010 season

S.O.V.	df	Mean squares							
		Plant Height (cm)		Plant dry weight (g)		No. branches/plant		No. pods /plant	
		Free	Infested	Free	Infested	Free	Infested	Free	Infested
Seed materials	24	134.40 **	109.59 **	596.81 **	127.83 **	1.11 **	1.17 **	33.60 **	7.60 *
Selections *vs.* bulks	1	490.75 **	1.67 ns	3996.97 **	11.64 ns	3.21 **	0.80 ns	244.89 **	0.86 ns
Pop1 *vs.* Pop2	1	73.50 ns	21.09 ns	94.80 ns	33.70 ns	0.09 ns	0.38 ns	3.74 ns	0.84 ns
Pop3 *vs.* Pop4	1	0.09 ns	45.38 ns	5.65 ns	56.92 ns	0.03 ns	0.54 ns	0.04 ns	2.34 ns
Pop1, 2, 3, 4 *vs.* Pop5	1	0.04 ns	1.53 ns	26.02 ns	5.95 ns	0.19 ns	0.02 ns	0.73 ns	0.15 ns
Residual	20	133.06**	128.03**	510.00**	147.99**	1.16ns	1.32ns	27.85**	8.91**
Error	24	36.700	27.630	46.900	59.900	0.110	0.310	3.380	3.650
S.O.V.	df	No. seeds /plant		Seed yield/plant		Seed index		Podded plants	*Oro.*/ ridge
		Free	Infested	Free	Infested	Free	Infested	Infested	Infested
Seed materials	24	179.83 **	60.82 **	116.40 **	24.57 **	91.95 **	191.80 **	302.94 **	0.02 **
Selections *vs.* bulks	1	1555.69 **	7.27 ns	988.92 **	24.57 ns	44.21 ns	113.47 ns	48.77 *	0.03 **
Pop1 *vs.* Pop2	1	39.63 ns	0.02 ns	25.34 ns	5.13 ns	26.71 ns	98.66 ns	750.45 **	0.03 **
Pop3 *vs.* Pop4	1	12.62 ns	0.00 ns	5.13 ns	4.03 ns	10.06 ns	126.68 ns	569.27 **	0.00 ns
Pop1, 2, 3, 4 *vs.* Pop5	1	3.12 ns	0.14 ns	0.61 ns	0.87 ns	30.72 ns	38.88 ns	262.69 **	0.00 ns
Residual	20	135.24**	72.61**	88.68**	27.75**	104.76**	211.28**	281.97**	0.02ns
Error	24	18.990	22.240	8.910	11.060	35.680	40.880	11.653	0.001

ns, *, ** = not significant, significant at 0.05 and 0.01 levels of probability, respectively. *Oro.*/ridge = *Orobanche* spikes/ridge

Table (2): Mean plant characters of selected genotypes and populations from variety Cairo 25 (20 individual selections and 5 populations free field) under *Orobanche*- free (Free) and infested (Infested) conditions during 2009/2010 season.

Code	Plant height (cm)			Plant dry weight (g)			No. branches/plant		
	Free	Infested	Mean	Free	Infested	Mean	Free	Infested	Mean
ISF1	84.42a-e	76.25a-d	**80.3**	50.77b-e	43.50a-c	**47.1**	3.58a-d	4.75a	**4.2**
ISF2	87.92a-c	71.04b-f	**79.5**	50.38c-e	37.53a-d	**44.0**	3.17c-h	2.79b-f	**3.0**
ISF3	89.50ab	71.25b-f	**80.4**	66.59ab	30.61a-d	**48.6**	4.17ab	3.00b-f	**3.6**
ISF4	81.00b-f	63.13ef	**72.1**	59.10a-c	31.93a-d	**45.5**	3.70a-c	4.00ab	**3.9**
ISF5	95.86a	68.75b-f	**82.3**	68.05a	26.38cd	**47.2**	3.43b-e	3.75a-d	**3.6**
ISF6	76.88b-f	67.50c-f	**72.2**	40.88d-g	42.48a-c	**41.7**	2.75e-i	3.87a-c	**3.3**
ISF7	81.88a-f	72.92b-f	**77.4**	54.54a-d	24.69cd	**39.6**	3.00c-i	3.42a-f	**3.2**
ISF8	83.08a-f	61.88f	**72.5**	50.52c-e	31.56a-d	**41.0**	3.20c-g	3.33b-f	**3.3**
ISF9	72.50d-f	74.00b-f	**73.3**	41.08d-g	37.98a-d	**39.5**	2.63f-i	3.50a-f	**3.1**
ISF10	82.00a-f	64.67d-f	**73.3**	60.93a-c	32.27a-d	**46.6**	3.40c-f	2.63c-f	**3.0**
ISF11	82.50a-f	77.92a-c	**80.2**	55.04a-d	39.75a-c	**47.4**	4.20a	3.75a-d	**4.0**
ISF12	75.25a-f	67.50c-f	**71.4**	30.61a-i	46.33ab	**38.5**	2.85d-i	4.00ab	**3.4**
ISF13	72.50d-f	74.17b-f	**73.3**	36.95e-i	32.10a-d	**34.5**	3.17c-h	2.17f	**2.7**
ISF14	81.00b-f	62.50f	**71.8**	42.38d-f	19.45d	**30.9**	2.83d-i	2.50d-f	**2.7**
ISF15	86.04a-d	68.33b-f	**77.2**	39.20d-h	33.60a-d	**36.4**	2.33ij	3.83a-d	**3.1**
ISF16	78.50b-f	80.00a-c	**79.3**	30.26f-i	33.05a-d	**31.7**	2.37h-j	2.30a-f	**2.3**
ISF17	68.75f	75.83a-e	**72.3**	23.07hi	34.77a-d	**28.9**	2.33ij	3.54a-e	**2.9**
ISF18	75.73b-f	71.25b-f	**73.5**	33.39f-i	35.84a-d	**34.6**	2.55g-j	3.75a-d	**3.2**
ISF19	70.07ef	87.50a	**78.8**	35.48e-i	28.90b-d	**32.2**	2.39h-j	2.75b-f	**2.6**
ISF20	83.88a-e	80.42ab	**82.2**	25.67g-i	48.18a	**36.9**	1.78j	2.83b-f	**2.3**
Mean	**80.46**	**71.84**	**76.2**	**44.74**	**34.55**	**39.6**	**2.99**	**3.32**	**3.2**
Pop1	70.33ef	71.88b-f	**71.1**	28.62f-i	36.50a-d	**32.6**	2.33ij	3.13**b-f**	**2.7**
Pop2	77.33b-f	68.13b-f	**72.7**	20.67i	31.76a-d	**26.2**	2.57g-j	2.63c-f	**2.6**
Pop3	74.13c-f	76.00a-d	**75.1**	30.63f-i	36.70a-d	**33.7**	2.68e-i	3.58a-e	**3.1**
Pop4	74.38c-f	70.50b-f	**72.4**	28.69f-i	30.54a-d	**29.6**	2.54g-j	2.98b-f	**2.8**
Mean	**74.04**	**71.63**	**72.8**	**27.15**	**33.88**	**30.5**	**2.53**	**3.08**	**2.8**
Pop5	74.17 **c-f**	70.83b-f	**72.5**	23.86hi	32.30a-d	**28.1**	2.25 **ij**	3.00b-f	**2.6**
G. Mean	79.18	71.77	**75.5**	41.09	34.35	**37.7**	2.89	3.27	**3.1**

Table (2): Continued I

Code	No. pods/plant			No. seeds/plant			Seed yield/plant (g)		
	Free	**Infested**	**Mean**	**Free**	**Infested**	**Mean**	**Free**	**Infested**	**Mean**
ISF1	12.67b-e	9.63a-	**11.2**	25.33b-g	20.63a-e	**23.0**	17.51f-i	15.55a-d	**16.5**
ISF2	13.67a-d	7.33a-d	**10.5**	31.08a-d	21.88a-e	**26.5**	24.61a-e	16.63ab	**20.6**
ISF3	17.08a	8.00a-d	**12.5**	41.28a	18.75b-e	**30.0**	30.40a	12.10b-d	**21.3**
ISF4	13.50a-d	8.75a-d	**11.1**	31.30a-d	19.50b-e	**25.4**	26.46a-c	12.93a-d	**19.7**
ISF5	15.20ab	5.00cd	**10.1**	34.33ab	13.50c-e	**23.9**	27.43ab	11.43b-d	**19.4**
ISF6	11.25b-f	8.40a-d	**9.8**	23.13c-i	24.27a-c	**23.7**	19.15d-g	16.98ab	**18.1**
ISF7	14.13a-c	5.17cd	**9.7**	32.38a-c	12.25de	**22.3**	25.66a-d	8.28d	**17.0**
ISF8	11.80b-e	7.92a-d	**9.9**	28.17b-e	22.83a-d	**25.5**	23.58a-f	15.20a-d	**19.4**
ISF9	10.13c-h	7.90a-d	**9.0**	26.75b-f	21.15a-e	**24.0**	19.64c-g	17.20ab	**18.4**
ISF10	14.90ab	8.73a-d	**11.8**	31.90a-d	20.87a-e	**26.4**	27.03ab	16.31a-d	**21.7**
ISF11	12.60b-e	8.83a-d	**10.7**	34.00ab	23.75a-d	**28.9**	23.85a-f	15.20a-d	**19.5**
ISF12	10.80b-g	11.38a	**11.1**	23.40c-h	31.50a	**27.5**	15.22g-j	20.49a	**17.9**
ISF13	9.00e-i	6.50b-d	**7.8**	20.17e-j	16.17b-e	**18.2**	16.92f-i	14.33a-d	**15.6**
ISF14	11.20b-f	4.50d	**7.9**	29.25b-e	10.50e	**19.9**	22.85b-f	8.40cd	**15.6**
ISF15	9.44d-i	7.83a-d	**8.6**	24.48b-h	20.08a-e	**22.3**	18.42e-h	14.92a-d	**16.7**
ISF16	8.80e-i	8.75a-d	**8.8**	21.66d-j	16.50b-e	**19.1**	15.31g-j	14.25a-d	**14.8**
ISF17	6.83f-i	7.54a-d	**7.2**	15.56g-j	19.08b-e	**17.3**	11.69h-j	14.92a-d	**13.3**
ISF18	7.30f-i	10.75ab	**9.0**	20.18e-j	26.25ab	**23.2**	14.53g-j	18.34ab	**16.4**
ISF19	6.61g-i	6.75a-d	**6.7**	23.88b-h	17.25b-e	**20.6**	17.30f-i	11.25b-d	**14.3**
ISF20	6.20hi	9.00a-d	**7.6**	12.73ij	24.92a-c	**18.8**	11.08ij	16.63ab	**13.9**
Mean	**11.16**	**7.93**	**9.5**	**26.55**	**20.08**	**23.3**	**20.43**	**14.57**	**17.5**
Pop1	6.68g-i	8.25a-d	**7.5**	17.42f-j	22.75a-d	**20.1**	12.86g-j	17.51ab	**15.2**
Pop2	5.10i	9.00a-d	**7.1**	12.28j	22.63a-d	**17.5**	8.75j	15.66a-d	**12.2**
Pop3	7.08f-i	8.50a-d	**7.8**	14.48h-j	19.10b-e	**16.8**	11.18ij	15.99a-d	**13.6**
Pop4	7.25f-i	7.25a-d	**7.3**	17.38f-j	19.15b-e	**18.3**	13.03g-j	14.35a-d	**13.7**
Mean	**6.53**	**8.25**	**7.4**	**15.39**	**20.91**	**18.2**	**11.46**	**15.88**	**13.7**
Pop5	7.08f-i	8.00a-d	**7.5**	14.25h-j	20.67a-e	**17.5**	10.95ij	16.48a-c	**13.7**
G. Mean	10.25	7.99	**9.1**	24.27	20.24	**22.3**	18.62	14.85	**16.7**

Table (2): Continued-II

Code	Seed index (g)			Podded plants (%)	*Oro.*/ridge
	Free	Infested	Mean	Infested	Infested
ISF1	69.13cd	81.48a-d	**75.3**	88.9bc	29.67i
ISF2	79.91a-d	76.87a-g	**78.4**	88.8bc	30.00h
ISF3	73.51a-d	64.36g	**68.9**	100.0a	34.00c
ISF4	84.29ab	65.32e-g	**74.8**	96.1ab	38.00b
ISF5	79.99a-d	84.89ab	**82.4**	89.3bc	34.00c
ISF6	84.47ab	69.75b-g	**77.1**	79.1de	30.00h
ISF7	78.92a-d	67.59d-g	**73.3**	100.0a	31.00g
ISF8	82.14a-c	66.44d-g	**74.3**	100.0a	23.00n
ISF9	73.91a-d	80.74a-e	**77.3**	100.0a	28.00l
ISF10	84.72ab	78.21a-g	**81.5**	100.0a	31.67f
ISF11	73.47a-d	64.57fg	**69.0**	100.0a	20.00p
ISF12	65.80d	65.61e-g	**65.7**	100.0a	23.00n
ISF13	85.00ab	89.00a	**87.0**	100.0a	31.67f
ISF14	77.57a-d	83.67s-c	**80.6**	100.0aa	20.00p
ISF15	75.18a-d	73.81a-g	**74.5**	100.0a	22.00o
ISF16	70.76b-d	86.97a	**78.9**	100.0a	29.00j
ISF17	75.11a-d	78.27a-g	**76.7**	100.0a	27.00m
ISF18	72.04b-d	69.85b-g	**70.9**	77.8e	34.00c
ISF19	72.44a-d	66.74d-g	**69.6**	100.0a	28.00l
ISF20	86.99a	63.56g	**75.3**	95.8ab	32.67d
Mean	**77.27**	**73.89**	**75.6**	**95.79**	**28.83**
Pop1	75.43a-d	77.25a-g	**76.3**	100.0a	28.67k
Pop2	71.21b-d	69.14c-g	**70.2**	85.2cd	40.67a
Pop3	77.24a-d	83.71a-c	**80.5**	100.0a	28.67k
Pop4	74.65a-d	74.52a-g	**74.6**	88.9bc	32.00e
Mean	**74.63**	**76.16**	**75.4**	**93.53**	**32.50**
Pop5	78.21a-d	80.18a-f	**79.2**	100.0a	30.00h
G. Mean	76.88	74.50	**75.7**	95.64	29.47

ISF1, ISF2, ISF3 = Individual selection number one, two and three, respectively under free field of the previous season 2008/2009. G. Mean = Grand mean. *Oro.*/ridge = *Orobanche* spikes/ridge.
Means followed by the same letter(s) in the same column are not significantly different.

genotypes behaved differently in their yield and yield components within each condition but individual selections had better performance than bulk selection. This may be due to the significance of selection effects on the performance of this variety and *Orobanche* characters.

Wider variability was observed within the individual selections compared to bulks and within bulks. The individual selection from the free field, ISF3 gave higher values for plant dry weight, pods/plant and seeds/plant (means of 48.69g,12.54 pods and 30.02seeds, respectively), while the individual selection ISF10 recorded the highest yield (21.67 g) and ISF13 had the heaviest seed index (87.09 g) as average of the two conditions. On the other hand, Pop 2 had the least plant dry weight and seed yield/plant (26.22 g and 12.21 g) as average of the two *Orobanche* conditions. Also, the selected individual ISF19 was the least one for pods/plant (6.68 pods), Pop 3 for seeds/plant (16.79 seeds) and ISF 12 for seed weight (65.70 g).

Similar results appeared in the selected bulks (Table 2), the Pop 3 showed high performance for plant height, plant dry weight, branches/plant, pods/plant and seed index (75.06 cm, 33.67 g, 3.13 branches, 7.79 pods and 80.48 g, respectively) and low performance for seeds per plant (16.79 seeds) in spite of the intermediate level of infestation (28.67 *Orobanche* spikes). On the other hand, Pop 1

had highest number of seeds and seed yield per plant (20.08 seeds and 15.19 g). The high level of infestation in Pop 2 (40.67 spikes) may have been reflected in the lowest values for plant dry weight, pods/plant, seed yield/plant and seed index (26.22 g, 7.05 pods, 12.21 g and 70.18 g, respectively). Also, the results showed that Pop1 recorded the shortest plant height (71.11 cm) and an intermediate level of infestation with Pop 3 (28.67 spikes).

The comparison between traits of the plants grown under *Orobanche* infestation to traits of sister plants grown under free field showed the effects of *Orobanche* stress. Relative values of traits of plants under stress (compared to plants grown in healthy field) were 90% for plant height, 83.6% for plant dry weight, 113.1% for branches per plant, 78% for pods/plant, 83.4% for seeds/plant, 79.6% for seed yield/plant and 96.9% for seed index. Effect of *Orobanche* parasitism occurred in different characters but not on the number branches per plant. The effects of *Orobanche* were slightly more in variety Cairo 25 than Cairo 4 and Cairo5 varieties (Abdalla *et al.*, 2014 and Shafik *et al.*, 2014). Similar results on *Orobanche* effects were reported by other authors (Abdalla, 1982, Fischbeck *et al.* 1986, Radwan *et al.*, 1988, Ahmed *et al.* 2001, Manschadi *et al.*, 2001 and Morsy and Attia, 2002).

The materials selected (2008/2009 season) were developed from the plants grown in the healthy field, but were evaluated in 2009/2010 under both free field and *Orobanche* infested one. Except for the number of branches/plant that was higher in the *Orobanche* field, all characters for plants grown under *Orobanche* stress decreased. With fair accuracy, one may assume that selection under *Orobanche*-free plots-in the present materials of genotypes tolerant to *Orobanche* will result in populations suitable to be grown under free conditions and also under *Orobanche* stress. Under the stress conditions, one may expect to sacrifice not more than about 15% of seed yield/plant (data not presented). However, this situation may be limited only for one generation of seed multiplication. Who knows what may happen if

Table (3): Significance of mean squares of variety Cairo 25 selected genotypes and populations (25 selected from infested field) under *Orobanche*-free (Free) and infested (Infested) conditions during 2009/2010 season.

S.O.V.	df	Mean squares							
		Plant Height (cm)		Plant dry weight (g)		No. branches/plant		No. pods /plant	
		Free	Infested	Free	Infested	Free	Infested	Free	Infested
Seed materials	24	161.02 **	159.78 **	550.80**	863.10 **	0.77 **	0.91 **	28.67 **	15.95 **
Selections *vs.* bulks	1	364.45 **	414.96 **	3654.87**	2478.14 **	1.25 **	0.05 ns	181.77 **	0.12 ns
Pop1 *vs.* Pop2	1	62.60 ns	8.43 ns	8.21 ns	6115.23**	0.21 ns	2.34 **	3.07 ns	4.08 ns
Pop3 *vs.* Pop4	1	156.37 *	6.74 ns	107.61 ns	182.16 ns	0.14 ns	0.33 ns	3.60 ns	1.59 ns
Pop1, 2, 3, 4 *vs.* Pop5	1	5.10 ns	13.57 ns	27.95 ns	978.57*	0.17 ns	0.05 ns	0.03 ns	4.60 ns
Residual	20	163.80**	169.55**	471.03**	548.02**	0.84ns	0.95ns	24.98**	18.62**
Error	24	32.990	16.320	48.870	168.460	0.080	0.200	3.260	3.080
S.O.V.	df	No. seeds /plant		Seed yield/plant		Seed index		Podded plants (%)	*Oro.*/ ridge
		Free	Infested	Free	Infested	Free	Infested	Infested	Infested
Seed materials	24	145.40 **	72.46 **	109.08 **	72.93 **	83.59 **	290.36 **	272.16 **	0.020 **
Selections *vs.* bulks	1	1000.61 **	48.67 ns	831.77 **	47.38 ns	385.24 **	37.91 ns	433.90 **	0.05 **
Pop1 *vs.* Pop2	1	40.72 ns	5.59 ns	12.79 ns	2.50 ns	45.05 ns	2.38 ns	0.00 ns	0.00 ns
Pop3 *vs.* Pop4	1	9.98 ns	3.38 ns	8.64 ns	15.07 ns	11.76 ns	118.28 ns	63.25 **	0.03 **
Pop1, 2, 3, 4 *vs.* Pop5	1	0.11 ns	14.44 ns	3.43 ns	22.99 ns	187.97**	75.67 ns	6.33 ns	0.01 *
Residual	20	121.91 **	83.35 **	88.07 **	83.12 **	68.81 **	336.72 **	301.42 **	0.02 ns
Error	24	21.920	19.430	14.710	13.160	20.580	39.850	6.179	0.002

ns, *, ** = not significant, significant at 0.05 and 0.01 levels of probability, respectively. *Oro.*/ridge = *Orobanche* spikes/ridge.

multiplication occurred for more generations.

3.3. Populations selected under infested condition and evaluated under free and infested conditions (Table 3).

3.3.1. Analysis of variance and significance of variances due to 25 selections and populations

Significance of mean squares due to different sources of variation for the studied traits under the two conditions during 2009/2010 season is presented in Table (3). Highly significant ($p \leq 0.01$) variances were recorded for "genotypes" for all traits under *Orobanche*-free and infested field.

Four orthogonal comparisons are shown in Table (3), selections *vs.* bulk (populations) Pop 1 *vs.* Pop2, Pop3 *vs.* Pop4 and the 4 selected bulks (Pop 1, Pop 2, Pop 3 and Pop 4) *vs.* unselected one (Pop 5). The first comparison, selections *vs.* bulks was highly significant for all the studied traits except branches/plant, pods/plant, seeds/plant, seed yield/plant and seed weight under *Orobanche*-infested field. Pop1 *vs.* Pop2 showed highly significance for plant dry weight and number of branches/plant under infested field while Pop 3 *vs.* Pop4 was significant for plant height, podded plants% and *Orobanche* spikes/ridge under infested field. The other comparison (selected *vs.* unselected) showed significance for plant dry weight and *Orobanche*/ridge under infested field and seed weight under free one. The Pop 1 *vs.* Pop 2 exhibited the highest mean squares for all studied traits except branches/plant, pods/plant and seed weight under *Orobanche*-infested field.

Table (4): Mean characters of selected genotypes and populations from variety Cairo 25 (25 from infested field) under *Orobanche*- free (Free) and infested (Infested) conditions during 2009/2010 season.

Code	Plant height (cm)			Plant dry weight (g)			No. branches/plant		
	Free	Infested	Mean	Free	Infested	Mean	Free	Infested	Mean
ISI1	91.50a	68.75e-i	**80.1**	60.95ab	30.77c	**45.9**	3.60ab	2.92g	**3.3**
ISI2	83.33a-f	67.92e-i	**75.6**	46.70b-g	33.95c	**40.3**	3.00c-f	4.67ab	**3.8**
ISI3	87.17a-c	72.50d-g	**79.8**	57.38a-c	47.74bc	**52.6**	3.62ab	4.10a-d	**3.9**
ISI4	77.92c-h	72.50d-g	**75.2**	59.38a-c	46.80bc	**53.1**	3.58a-c	4.75a	**4.2**
ISI5	86.38a-d	64.17g-i	**75.3**	46.01c-h	36.02c	**41.0**	2.43f-h	3.50c-g	**3.0**
ISI6	76.00c-i	87.50a	**81.8**	41.68d-i	66.35b	**54.0**	3.33b-d	4.08a-e	**3.7**
ISI7	82.29a-f	65.00f-i	**73.6**	53.11a-e	35.02c	**44.1**	2.79d-g	3.58c-g	**3.2**
ISI8	77.00c-h	73.13c-f	**75.1**	62.67a	64.64b	**63.7**	4.10a	3.83a-g	**4.0**
ISI9	84.38a-f	85.21ab	**84.8**	55.06a-d	47.12bc	**51.1**	3.21b-e	3.08fg	**3.1**
ISI10	90.00ab	82.92ab	**86.5**	59.73a-c	41.18bc	**50.5**	2.80d-g	3.17e-g	**3.0**
ISI11	83.10a-f	68.33e-i	**75.7**	41.54d-i	36.31c	**38.9**	3.00c-f	3.93a-f	**3.5**
ISI12	79.63b-g	70.00e-h	**74.8**	37.60f-k	27.10c	**32.4**	2.60fg	3.00g	**2.8**
ISI13	84.79a-e	62.50hi	**73.6**	51.81a-f	32.47c	**42.1**	3.29b-d	3.67c-g	**3.5**
ISI14	82.74a-f	62.50hi	**72.6**	39.77e-j	23.48c	**31.6**	2.48f-h	3.08fg	**2.8**
ISI15	74.58d-i	65.00f-i	**69.8**	32.70g-l	36.10c	**34.4**	2.42f-h	4.00a-f	**3.2**
ISI16	64.50i	66.25e-i	**65.4**	25.36j-l	22.63c	**24.0**	2.56fg	3.17e-g	**2.9**
ISI17	73.50e-i	70.42d-h	**72.0**	25.77j-l	40.33bc	**33.1**	2.50f-h	3.96a-f	**3.2**
ISI18	72.88f-i	61.25i	**67.1**	31.87h-l	34.88c	**33.4**	2.63e-g	3.75b-g	**3.2**
ISI19	68.33g-i	65.00f-i	**66.7**	34.23g-l	33.55c	**33.9**	2.45f-h	4.33a-c	**3.4**
ISI20	66.88hi	64.58g-i	**65.7**	22.92l	27.43c	**25.2**	1.95h	3.00g	**2.5**
Mean	**79.35**	**69.77**	**74.6**	**44.31**	**38.19**	**41.3**	**2.92**	**3.68**	**3.3**
Pop1	76.46c-h	81.00a-c	**78.7**	26.67j-l	40.83bc	**33.8**	2.75d-g	4.60ab	**3.7**
Pop2	70.00g-i	78.63b-d	**74.3**	29.01i-l	104.68a	**66.8**	2.38gh	3.35d-g	**2.9**
Pop3	78.96b-g	73.50c-e	**76.2**	31.48i-l	45.96bc	**38.7**	2.88d-g	3.55c-g	**3.2**
Pop4	68.75g-i	71.38d-g	**70.1**	23.01l	34.94c	**29.0**	2.58fg	3.08fg	**2.8**
Mean	**73.54**	**76.13**	**74.8**	**27.54**	**56.60**	**42.1**	**2.65**	**3.65**	**3.2**
Pop5	75.00d-i	73.75c-e	**74.4**	24.13kl	36.41c	**30.3**	2.38gh	3.50c-g	**2.9**
G. Mean	78.24	70.95	**74.6**	40.82	41.07	**40.9**	2.85	3.67	**3.3**

Table (4): Continued-I

Code	No. pods/plant			No. seeds/plant			Seed yield/plant (g)		
	Free	**Infested**	**Mean**	**Free**	**Infested**	**Mean**	**Free**	**Infested**	**Mean**
ISI1	16.60a	7.04d-g	**11.8**	30.60a-e	18.33c-f	**24.5**	24.70a-d	14.03c-h	**19.4**
ISI2	13.17a-c	7.83c-g	**10.5**	31.17a-d	20.58c-f	**25.9**	25.29 a-c	15.81c-h	**20.6**
ISI3	11.03c-f	10.93a-c	**11.0**	30.33a-f	30.17ab	**30.3**	27.71 a	21.43bc	**24.6**
ISI4	13.67a-c	5.75e-g	**9.7**	32.50ab	16.00d-f	**24.3**	24.77a-d	13.93d-h	**19.4**
ISI5	9.20d-i	8.17c-f	**8.7**	22.15d-i	19.50c-f	**20.8**	18.05 c-g	14.90c-h	**16.5**
ISI6	9.15d-i	12.79ab	**11.0**	21.30e-i	32.04a	**26.7**	17.88 c-g	27.96ab	**22.9**
ISI7	11.88c-e	7.00d-g	**9.4**	31.63a-d	19.08c-f	**25.4**	27.51 ab	16.31c-h	**21.9**
ISI8	12.80b-d	14.38a	**13.6**	33.40a	29.96ab	**31.7**	27. 25 ab	30.68a	**29.0**
ISI9	15.71ab	10.13b-d	**12.9**	33.33a	23.88a-d	**28.6**	24.93a-d	17.18c-g	**21.1**
ISI10	12.70b-e	5.92e-g	**9.3**	32.10a-c	15.92d-f	**24.0**	26.84ab	15.66c-h	**21.3**
ISI11	10.50c-g	10.03b-d	**10.3**	22.80c-i	25.10a-c	**24.0**	17.62c-g	17.50c-f	**17.6**
ISI12	10.15c-h	6.00e-g	**8.1**	25.93a-g	18.00c-f	**22.0**	19.73b-f	11.93e-h	**15.8**
ISI13	12.21b-e	8.33c-f	**10.3**	29.83a-f	19.83c-f	**24.8**	22.67a-e	14.38c-h	**18.5**
ISI14	9.38d-i	4.33g	**6.9**	20.90f-i	13.83ef	**17.4**	17.37d-g	9.79gh	**13.6**
ISI15	9.08e-i	9.00c-e	**9.0**	23.17b-i	19.50c-f	**21.3**	16.26e-g	14.63c-h	**15.4**
ISI16	7.63f-i	7.08d-g	**7.4**	15.83hi	16.92c-f	**16.4**	12.79fg	9.46h	**11.1**
ISI17	6.10i	9.75b-d	**7.9**	14.15i	22.92b-e	**18.5**	10.76g	17.71c-e	**14.2**
ISI18	7.15g-i	4.75fg	**6.0**	18.26g-i	11.50f	**14.9**	15.44e-g	10.13f-h	**12.8**
ISI19	7.78f-i	7.83c-g	**7.8**	25.25a-h	19.50c-f	**22.4**	18.53c-g	14.43c-h	**16.5**
ISI20	6.39i	8.08c-f	**7.2**	14.52i	19.00c-f	**16.8**	11.33g	12.93d-h	**12.1**
Mean	**10.61**	**8.26**	**9.4**	**25.46**	**20.58**	**23.0**	**20.37**	**16.04**	**18.2**
Pop1	5.92i	8.03c-f	**7.0**	13.92i	23.00a-d	**18.5**	11.02g	18.52c-e	**14.8**
Pop2	7.35f-i	9.68b-d	**8.5**	19.13g-i	24.93a-d	**22.0**	13.94fg	19.81cd	**16.9**
Pop3	7.63f-i	8.93c-e	**8.3**	17.33g-i	22.95a-d	**20.1**	13.29fg	19.71cd	**16.5**
Pop4	6.08i	7.90c-g	**7.0**	14.75i	21.45b-e	**18.1**	10.89g	16.54c-h	**13.7**
Mean	**6.75**	**8.64**	**7.7**	**16.28**	**23.08**	**19.7**	**12.29**	**18.65**	**15.5**
Pop5	6.63hi	7.25d-g	**6.9**	16.50g-i	20.63c-e	**18.6**	11.09g	15.55**c-h**	**13.3**
G. Mean	9.84	8.28	**9.1**	23.63	20.98	**22.3**	19.71	19.44	**19.6**

3.3.2. Performance of selected individual plants, selected and unselected populations from infested condition grown under *Orobanche*-free and infested conditions (Table 4).

The mean performance of genotypes under *Orobanche*-free and *Orobanche*-infested field differed significantly for all the studied traits. The results in Table (4) show that individual selections, selected and unselected bulks differed from one to another, individual to bulks and bulk to bulk. The selected genotypes performed differently in their yield and yield components under each condition.

The individual selection (ISI8) from the infested field gave the highest values for plant dry weight, pods/plant, seeds/plant, seed yield/plant and seed index (means of 63.66 g, 13.59 pods, 31.68 seeds, 28.97 g and 91.94 g, respectively) as average of the two conditions

Table (4): Continued-II

Code	Seed index (g)			Podded plants (%)	*Oro.*/ridge
	Free	Infested	Mean	Infested	Infested
ISI1	81.28b-e	76.69c-g	**79.0**	100.0a	30.67i
ISI2	81.18b-e	76.65c-g	**78.9**	79.9c	37.00d
ISI3	91.31a	71.12f-h	**81.2**	88.3b	30.00j
ISI4	75.73c-g	87.15bc	**81.4**	100.0a	31.00h
ISI5	82.08a-e	77.74c-g	**79.9**	100.0a	30.00j
ISI6	83.96a-c	85.48b-e	**84.7**	88.0b	31.00h
ISI7	86.63ab	85.58b-e	**86.1**	88.4b	38.67b
ISI8	79.31b-f	104.56a	**91.9**	100.0a	25.67n
ISI9	77.88b-f	70.73f-h	**74.3**	100.0a	31.67g
ISI10	83.50a-d	98.17ab	**90.8**	85.9b	43.00a
ISI11	76.97c-f	70.79f-h	**73.9**	100.0a	20.67r
ISI12	75.80c-g	66.48gh	**71.1**	90.0b	30.67i
ISI13	76.04c-g	72.89e-g	**74.5**	100.0a	21.67p
ISI14	83.09a-d	71.27f-h	**77.2**	100.0a	21.00q
ISI15	70.40fg	75.96c-g	**73.2**	100.0a	24.00o
ISI16	80.83b-e	58.52h	**69.7**	100.0a	29.00k
ISI17	76.07c-g	77.44c-g	**76.8**	89.3b	33.00f
ISI18	84.54a-c	87.04bc	**85.8**	100.0a	26.00m
ISI19	73.33e-g	74.01d-g	**73.7**	100.0a	29.00k
ISI20	78.39b-f	68.42f-h	**73.4**	100.0a	26.67l
Mean	**79.92**	**77.83**	**78.9**	**95.49**	**29.52**
Pop1	79.12b-f	80.62c-f	**79.9**	100.0a	38.67b
Pop2	73.64e-g	79.36c-g	**76.5**	100.0a	38.00c
Pop3	77.06c-f	85.92b-d	**81.5**	96.3a	36.67e
Pop4	74.26d-g	77.04c-g	**75.7**	100.0a	26.67l
Mean	**76.02**	**80.74**	**78.4**	**99.08**	**35.00**
Pop5	67.17g	75.12c-g	**71.1**	100.0a	30.00j
G. Mean	78.78	78.19	**78.5**	96.29	30.41

ISI1, ISI2, ISI3 = Individual selection number one, two and three, respectively under infested field of the previous season 2008/2009. G. Mean = Grand mean. *Oro.*/ridge = *Orobanche* spikes/ridge.
Means followed by the same letter(s) in the same column are not significantly different.

while, the individual selection ISI10 had the taller plant mean (86.46 cm) across the two conditions and ISI4 possessed the high branches/plant (mean of 4.17). On the other hand, ISI7 had the highest *Orobanche* spikes/ridge (38.67 spikes) while the individual selection ISI11 had the least *Orobanche* spikes/ridge (20.67 spikes). The lowest values for plant height, plant dry weight, seed yield/plant and seed index (means of 65.38 cm, 24.0 g, 11.13 g and 69.67 g, respectively) were recorded for the selected individual selection ISI16. On the other hand, the individual selection ISI18 showed low performance for pods/plant and seeds/plant (means of 5.95 pods and 14.88 seeds, respectively). According to data, the selected individual ISI2 had the lowest podded percentage (79.9%).

Similar results were shown in bulks (Table 4). Pop 2 recorded high performance for plant dry weight, pods/plant, seeds/plant and seed yield per plant (66.85 g, 8.51 pods, 22.03 seeds and 16.88 g, respectively), while Pop 1 possessed the highest plant height and branches/plant (78.73 cm and 3.68 branches, respectively) as average of two conditions. In spite of the high level of infestation with the broomrape (38.67 spikes). Pop 3 had the heaviest seeds (mean 81.94 g) and lowest podded plants% (96.3%). Data revealed that the

Pop 4 exhibited lower values for plant height, plant dry weight, branches/plant and seeds per plant (means of 70.06 cm, 28.98 g, 2.83 branches and 18.10 seeds, respectively) and the lowest level of infestation (among populations) with the parasite (26.67 spikes). Also, the lowest values were recorded by Pop 5 in pods, seed yield/plant and seed index (means of 6.94 pods, 13.32 g and 71.14 g, respectively) as averages of the two conditions.

With respect to the 20 individual selections from ISI1 to ISI20, the 4 selected bulks from (Pop 1 to Pop 4) with 4 different selection intensities and the unselected bulk (Pop 5), all were selected under *Orobanche* stress during 2008/2009 and evaluated under free conditions and *Orobanche* infested field at 2009/2010. Data revealed that the comparisons between plants grown under *Orobanche* stress and those grown under normal field, the results showed that the former as percentage of the latter, were 90.7% for plant height, 100.6% for plant dry weight, 128.8 for branches/plant, 84.1% for pods/plant, 88.8% for seeds/plant, 98.6% for seed yield/plant and 99.2% for seed index.

The podded plants varied between 79.9% for the individual selection ISI2 to 100% (many selections and populations). *Orobanche* spikes per ridge averaged 30.41 and varied between 21.00 for the individual selection (ISI14) to 43.00 spikes per ridge for ISI10. A slight reduction occurred in the traits due to *Orobanche* stress.

Conclusions

On the basis of this study, the comparison between individual and bulk selections favors individual selection, but it is not absolutely against bulk selection that proves effective in different cases. Besides, not all individual plant selections performed well. Some were inferior to some selected bulks. This may be attributed to the effect of environment on faba bean plants. In addition, individual-plant selection may mistaken hybrid plants (not in this study) that will segregate (and consequently deteriorate) in the next generation. Bulk selection would therefore be a safe guard against hazards and mistakes. In most cases, the performance of the bulk populations (Pop 1, Pop 2, Pop 3, Pop 4) were above the general mean of traits. This means that bulk populations had better performance than some individual selections. The heterogeneity and heterozygosity of bulk populations will be safe guard against stresses. The question concerning selection under *Orobanche* stress and evaluation under free conditions and stress or the selection under free conditions and evaluation under both free and stress conditions did not have definite answer for all varieties.

The variety Cairo 5 (Shafik *et al.,* 2014) indicated that selection under stress will be effective under both conditions, whereas the results of this variety Cairo 25 did not support this case. May be the answer would be more accurate when selection is practiced for many generations before evaluation (see also Abdalla and Darwish, 1994).

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دراسات على الفول البلدى
33- الانتخاب الإجمالي والانتخاب الفردي في الصنف قاهرة 25 المنزرع تحت ظروف التقسية بالهالوك والحقل الخالي منه

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ملخص

تم انتخاب النباتات الفردية والانتخاب الإجمالي (بنسب مختلفة الشدة) في صنف الفول البلدي قاهرة 25. يتركب الصنف قاهرة 25 من عدد من التراكيب الوراثية المختلفة وهو يتحمل الهالوك وتم الانتخاب والتقييم تحت ظروف التقسية بالهالوك والحقول النظيفة. ظهرت فروق معنوية إحصائياً بين المقارنات الـ Orthogonal (الانتخاب الفردي ضد الإجمالي والمنتخبات الإجمالية ضد بعضها) في كل من الحقل النظيف والحقل الموبوء بالهالوك. تباينت المنتخبات الفردية وعشائر الانتخاب الإجمالي في أدائها في صفات المحصول ومكوناته تحت كلا البيئتين إلا أن الانتخاب الفردي أظهر أداء أفضل عن الانتخاب الإجمالي. كما اظهرت النتائج ان جميع الصفات – عدا عدد فروع النبات – أعطت قيما أقل في النباتات المنزرعة تحت عدوى الهالوك عنه في النباتات الأخوة في الحقل النظيف.وبالرغم من أن العديد من المنتخبات الفردية اظهرت أداء أفضل من المنتخبات الإجمالية إلا أن بعض المنتخبات الإجمالية أعطت أداءاً أفضل من بعض المنتخبات الفردية. واوضحت النتائج أن الانتخاب تحت ظروف العدوى بالهالوك لن يكون ذات كفاءة تامة تحت ظروف التقسية وعدم التقسية بالهالوك.

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