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(ICARDA)

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COVER PHOTO: A faba bean accession at ICARDA having closed flower trait.

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Selection for Seed Yield in Faba Bean (Vicia faba L.)

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Abstract

Effectiveness of family selection for seed yield was assessed in two generations of faba bean variety Giza 2. Some of the means of the selected families exceeded those of the base population (Giza 2) and the check variety (Giza 402). The C_1 families possessed considerable genotypic and phenotypic variability for all the studied traits, and consequently, estimates of heritability were high. However, the variability between C_2 families was lower for all traits except plant height, thus reflected in low estimates of heritability. Genotypic and phenotypic correlations for various traits showed that pods/plant and plant height were the traits mainly determining seed yield/plant. The realized gain in seed yield after two generations was 24% and 7% over the base population and check variety, respectively.

Introduction

A program to improve yields of faba bean (*Vicia faba* L.) is underway in Egypt where the crop is an important food in the Egyptian diet, and an essential source for livestock feed. Theoretically, the program could take several approaches because faba bean is partially outcrossed by insect pollinators (Robertson 1983). Changing the crop to obligate autogamous plants would make genetic improvement easier (Kambal *et al.* 1976; Poulsen 1976; Lawes 1980). Selection to increase the frequencies of desirable alleles and gene combinations has been investigated in faba bean by Guen and Berthelem (1986), who obtained good results with family selection. Nassib *et al.* (1979) described populations set up for recurrent selection in faba bean but later reported that the populations gave few lines with good performance (Nassib and Khalil 1982). Brinkhorst-Van der Swan and De Vries (1986) compared three selection procedures, i.e., direct selection for seed yield, index selection, and independent culling for yield index and high protein content. They found that index selection seemed to be slightly superior to direct selection for yield and direct selection for yield superior to selection for independent culling levels.

The objective of this study was to investigate the potential of family selection to improve yields of a commercial variety (Giza 2) of faba bean. Our aim was to determine family means, variances, heritability, response, and correlated response to selection for yield and other traits.

Materials and Methods

In 1984/85, at the Experimental Farm of Assiut University, seeds of Giza 2 (commercial variety) were sown in 160 rows (80 subplots), 4 m long, 60 cm wide, with 20 cm between hills. Seedlings were thinned to one plant per hill and the plots were kept weed free, and were maintained at optimum levels for maximum productivity.

The best plant in each subplot (80 plants) was saved. In 1985/86, the base population (Giza 2), check cultivar (Giza 402), and seeds from each of the 80 selected plants (first cycle of selection; C_1) were evaluated in a randomized complete block design with three replications. Each family of the base population, and the check cultivar were sown in single-row plots 2.5 m long, 60 cm wide, with 20 cm between hills. Seedlings were thinned to one plant per hill, and cultural practices were designed to promote optimal yields. At maturity, plant height, number of branches, number of pods, and seed yield/plant were recorded. The 100-seed weight for each test was determined and, the best eight plants from the best eight families (combined selection) were saved (second cycle of selection; C_2). In the 1986/87 season, the base population (C_0), check variety (Giza 402), and

C_2-selected families were evaluated and data were recorded as in the 1985/86 season. The first cycle (C_1) could not be reevaluated in the 1986/87 season because of insufficient seed.

Analysis of variance was performed, and the expected mean squares for each trait at each cycle of selection were calculated as outlined by Miller *et al.* (1958). The genotypic ($\sigma^2 g$) and phenotypic ($\sigma^2 p$) variances were calculated according to Al-Jibouri *et al.* (1958). Phenotypic (PCV) and genotypic (GCV) coefficients of variability were calculated according to Burton (1952), and heritability (h^2) was estimated as

$$h^2 = (\sigma^2 g / \sigma^2 p) 100$$

The predicted response from selection in seed yield/plant from C_1 families, the response to selection of the 10% superior plants in C_2 families, and the response of a trait to selection for seed yield/plant were calculated according to Falconer (1960).

Results and Discussion

Variability among families

Mean squares of the studied traits of the 80 families revealed significant or highly significant differences among the families selected during the first cycle (Table 1), whereas families from the second cycle of selection differed significantly only in height.

In cycle 2, the overall means for the selected families exceeded those for the base population (Giza 2) and the check variety (Giza 402) in plant height, pods/plant, seed yield/plant, and 100-seed weight (Table 2). Of the 80 families, in cycle 1, 17 surpassed significantly or highly significantly the base population in seed yield/plant, whereas only 3 families (29, 45, and 46) exceeded the check cultivar (Giza 402) highly significantly in seed yield/plant (Table 3).

Table 1. Mean squares of the studied traits in both the first and the second cycles of selection of faba bean families.

Sources of variability	Selection cycle	Plant height	Number of branches/ plant	Number of pods/plant	Seed yield/ plant	100-seed weight
Replications	C_1	122.5**	0.76	19.81**	202.07**	0.34
	C_2	84.94	0.18	5.28	17.25	0.43
Families	C_1	168.01**	0.84*	11.98**	49.53**	93.43**
	C_2	136.26**	0.32	9.50	28.30	24.34
SE ±	C_1	21.67	0.59	3.21	9.29	2.95
	C_2	29.53	0.21	6.48	16.03	14.77

*, ** Significant at 5% and 1% level of probability, respectively.

Table 2. Means of the studied traits in Giza 2 (base population), Giza 402 (check variety), and selected families in first and second cycles of selection.

Item	Plant height (cm)	Number of branches/ plant	Number of pods/plant	Seed yield/ plant (g)	100-seed weight (g)
First cycle (C_1)	123.44	2.77	13.91	26.32	62.49
Base population	119.67	2.67	12.00	23.77	60.67
Check variety	113.67	3.47	14.40	27.53	61.67
Second cycle (C_2)	94.84	2.84	11.44	25.60	60.50
Base population	89.00	2.60	8.77	20.67	59.33
Check variety	85.70	3.37	10.50	23.97	60.33

Table 3. Mean seed yields/plant for 80 families in the first cycle of selection (C_1). for the base population (Giza 2) and for the check variety (Giza 402).

Family	Seed yield/ plant (g)	Family	Seed yield/ plant (g)	Family	Seed yield/ plant (g)	Family	Seed yield/ plant (g)	Family	Seed yield/ plant (g)	Family	Seed yield/ plant (g)
1	17.33	16	30.37**	31	21.93	46	++42.33**	61	23.43	76	24.50
2	20.77	17	25.27	32	27.13	47	22.27	62	21.27	77	26.47
3	26.93	18	23.40	33	22.33	48	22.70	63	32.27**	78	25.23
4	23.40	19	29.40*	34	22.57	49	22.53	64	25.40	79	26.03
5	27.93	20	26.93	35	22.03	50	28.47	65	25.97	80	29.97*
6	31.70**	21	24.10	36	26.67	51	22.57	66	23.43	G-2	23.77
7	31.53**	22	26.83	37	22.00	52	25.83	67	28.60	G-402	27.53
8	23.17	23	26.07	38	23.27	53	29.77*	68	28.07		
9	28.90*	24	22.30	39	25.83	54	25.03	69	27.53		
10	23.50	25	31.50**	40	26.67	55	24.80	70	30.23		
11	27.37	26	23.80	41	22.67	56	27.43	71	28.87*		
12	28.10	27	27.20	42	30.77**	57	26.83	72	21.27		
13	21.87	28	28.27	43	24.40	58	26.27	73	21.07		
14	23.00	29	++35.77**	44	28.10	59	26.43	74	26.10		
15	26.63	30	31.10**	45	++41.13**	60	25.17	75	29.17**		

*, ** Significant at 5% and 1% level of probability, respectively, compared with the base population (Giza 2).
+, ++ Significant at 5% and 1% level of probability, respectively, compared with the check variety (Giza 402).

Of the eight selected families in cycle 2 (Table 4) all had yields higher than the base population (Giza 2) but only three (6, 29 and 45) significantly outyielded the base population by 134.49, 135.46, and 136.28%, respectively. Because of the large experimental error obtained, yields had to be more than 130% of base yields to be significant. Six of the selected families were also superior to the check variety (Giza 402) in seed yield/plant (Table 4). We believe that these should be evaluated in different agroclimatic zones, and could be useful as a source to improve yielding ability for well-adapted cultivars. These results are in general agreement with those reported by Nassib and Khalil (1982) and Guen and Berthelem (1986).

Genetic variance components and heritability

The genetic components of variance, genotypic (GCV), and phenotypic (PCV) coefficients of variability and the heritability estimates are shown in Table 5. The C_1 families possessed considerable genotypic and phenotypic variability for all the studied traits, and consequently the estimates of heritability for them were high compared with those for families in cycle 2

Table 4. Mean seed yields/plant of the eight selected families in cycle 2 and their percentages of yield from the base population and the check variety.

Family	Seed yield		
	Mean (g)	Mean as a percentage of the yield from	
		Giza 2	Giza 402
6	27.80*	134.49*	115.98
7	27.00	130.62	112.64
25	25.87	125.17	107.93
29	28.00*	135.46*	116.81
30	21.07	101.94	87.90
45	28.17*	136.28*	117.52
46	25.93	125.45	108.18
63	20.93	101.26	87.32
Giza 2	20.67		
Giza 402	23.97		
LSD 5%	6.87	33.24	28.66

* Exceeded the base population (Giza 2) at 5% level of probability.

(28.57, 73.51, 81.40, and 96.86% compared with 11.11, 9.27, 28.15, and 50.05% for branches/plant, pods/plant, seed yield/plant, and 100-seed weight, respectively). These results were expected because the selected families in cycle 2 were only eight. Low heritability in C_2 families is in agreement with findings by Brinkhorst-Van Der Swan and De Vries (1986).

Correlations among traits

Genotypic and phenotypic correlations between pairs of traits in the C_1 and C_2 families are listed in Table 6. The genotypic correlation between seed yield/plant and number of pods/plant was high, and the correlation increased from 0.772 in cycle 1 to 1.601 in cycle 2.

Table 5. Genotypic ($\sigma^2 g$), phenotypic ($\sigma^2 p$) variances, coefficients of variation, and heritability estimates for studied traits in first (C_1) and second (C_2) cycles of selection of faba bean families.

Trait	Selection cycle	Genotypic		Phenotypic		h^2
		σ^2	Coefficient of variation (%)	σ^2	Coefficient of variation (%)	
Plant height	C_1	48.67	5.65	56.06	6.07	86.82
	C_2	31.96	5.96	43.46	6.95	73.54
Number of branches/plant	C_1	0.08	10.19	0.28	19.07	28.57
	C_2	0.01	3.52	0.09	10.57	11.11
Number of pods/plant	C_1	2.97	12.39	4.04	14.45	73.51
	C_2	0.28	4.63	3.02	15.19	9.27
Seed yield/ plant	C_1	13.70	14.06	16.83	15.59	81.40
	C_2	2.48	6.15	8.81	11.60	28.15
100-seed weight	C_1	30.88	8.89	31.88	9.04	96.86
	C_2	5.07	3.72	10.13	5.26	50.05

Table 6. Genotypic (above diagonal) and phenotypic (below diagonal) correlations among traits of the first (C_1) and second (C_2) cycles of selection of faba bean families.

Trait	Selection cycle	Plant height	Number of branches/ plant	Number of pods/ plant	Seed yield/ plant	100-seed weight
Plant height	C_1		0.423	0.321	0.312	-0.035
	C_2		-0.207	1.450	0.916	0.780
Number of branches/plant	C_1	0.164		1.020	0.668	0.148
	C_2	-0.130		-1.070	-0.301	-0.571
Number of pods/plant	C_1	0.235	0.549		0.772	-0.037
	C_2	0.436	0.272		1.601	0.355
Seed yield/ plant	C_1	0.256	0.415	0.751		0.151
	C_2	0.377	0.266	0.841		-0.053
100-seed weight	C_1	-0.043	0.084	-0.038	0.133	
	C_2	0.384	-0.181	-0.142	-0.097	

The phenotypic correlation between these two traits behaved similarly and was increased from 0.751 in cycle 1 to 0.841 in cycle 2. Likewise, the genotypic correlation between seed yield/plant and plant height increased from 0.312 in cycle 1 to 0.916 in cycle 2. The corresponding phenotypic correlations were small compared to the genotypic ones. This could be because of the large experimental error for plant height. On the contrary, correlations between seed yield/plant with each of 100-seed weight and number of branches/plant were small and were decreased from cycle 1 to cycle 2. It could be concluded that both traits, number of pods/plant and plant height, were the most important characters affecting seed yield/plant.

These results for correlations generally agreed with those reported by Abdalla (1976) and Salem (1983).

Expected and realized gains from selection

Expected gains from selection for seed yield/plant were large in C_1 families (Table 7) and after two generations, realized gains for seed yield/plant were about 24% and 7% over the base population and check variety, respectively (Table 7). The expected gain from selection among C_2 families dropped from 44% to 7% because the genetic variability among the eight superior families was much narrower than among the 80 C_1 families. The realized gains from selection for seed yield/plant reached 6% in plant height, 9% in number of branches/plant, 30% in number of pods/plant, and 2% in 100-seed weight after two generations.

Comparing the results of expected and realized gains from selection, we noted good agreement between predicted and realized gains in plant height and number of pods/plant in both C_1 and C_2 families. The discrepancies between predicted and realized gains for the other traits could have been caused by the inflation of the genotypic variance by genotype x environmental interaction. Byth *et al.* (1969) concluded that actual gains computed across environments were the only accurate criterion when genotype x environmental interaction exists. Our results support the conclusion as the estimates of genetic parameters were unreliable because of environmental effects, i.e., experimental error. Brim *et al.* (1959) reported similar results for soybeans, as did Mahdy (1983) for cotton.

The gains we demonstrated, however, could be quickly reversed, according to Brinkhorst-Van der Swan and De Vries (1986) because of the extent of outcrossing. As the most heterozygous plant will be found in the offspring of cross-fertilized plants, selection of heterozygotes may render the selection rather ineffective.

Table 7. Expected and realized gains from selection in units of measurement and in percent (%) of the base population (Giza 2) and check variety (Giza 402).

Trait	Selection cycle	Expressed gain			Realized gain*			
		Units	Base	Check variety	Units	Base (%)	Units	Check variety (%)
Plant height	C_1	3.30	2.76	2.90	3.77	3.15	9.77	8.60
	C_2	4.82	5.42	5.62	5.84	6.56	9.14	10.67
Number of branches/plant	C_1	0.29	10.86	8.36	0.10	3.75	-0.70	-20.17
	C_2	-0.03	-1.15	-0.89	0.24	9.23	-0.53	-15.73
Number of pods/plant	C_1	2.02	16.83	14.03	1.91	15.92	-0.49	-3.40
	C_2	0.79	9.01	7.52	2.67	30.44	0.94	8.95
Seed yield/plant	C_1	10.52	44.39	38.21	2.55	10.73	-1.21	-4.40
	C_2	1.47	7.11	6.13	4.93	23.85	1.63	6.80
100-seed weight	C_1	1.27	2.09	2.06	1.82	3.00	0.82	1.33
	C_2	-0.11	-0.19	-0.18	1.17	1.97	0.17	0.28

* Realized gain was calculated for $C_1 = [(C_1 - C_0)/C_0]\ 100$; and for $C_2 = [(C_2 - C_0)/C_0]\ 100$, where C_0 = Base population (Giza 2 in C_1) or check variety (Giza 402 in C_2).

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الانتخاب للغلة البذرية في الفول (Vicia faba L.)

ملخص

جرى تحديد كفاءة الانتخاب العائلي أو ضمن الفصيلة family Selection لصفة الغلة البذرية على امتداد جيلين ، من خلال زراعة صنف الفول جيزة 2 . ان بعض قيم متوسطات الفصائل المنتخبة تجاوزت تلك الخاصة بالعشيرة الاساسية (جيزة 2) ، والصنف الشاهد (جيزة 402) . وقد تمتعت فصائل الدورة الاولى للانتخاب (C_1) بوجود تنوع وراثي وظاهري كبير في جميع الصفات المدروسة ، وكانت تقديرات القابلية للتوريث بالتالي عالية. ومن ناحية ثانية كان التباين بين فصائل الدورة الثانية للانتخاب (C_2) اقل في جميع الصفات باستثناء طول النبات ، وبذا فقد انعكس ذلك بالتقديرات المتدنية في القابلية على التوريث . وقد اظهرت قيم الارتباطات الوراثية والمظهرية لمختلف الصفات ان عدد القرون/النبات وطول النبات كانتا الصفتين المحددتين اساسا للغلة البذرية/ النبات . وكانت الزيادة المحققة في الغلة البذرية بعد الجيلين اعلى بـ 24 % و 7 % من العشيرة الاساسية والصنف الشاهد على التوالي .

Variation, Correlations, and Path-Coefficient Analysis for Some Characters in Collections of Faba Bean (Vicia faba L.)

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Abstract

Nineteen accessions collected from farmers' fields and two commercial cultivars (Giza 2 and Giza 402) of faba beans *Vicia faba* L. were evaluated during the 1986 and 1987 seasons. Some of the collected accessions were superior than both commercial cultivars in all the characters studied. The environmental variance exceeded the genetic variance for all traits. Heritability reached 16.87, 33.33, 44.90, 44.70, and 39.36% for plant height, number of branches, number of pods/plant, seed yield/plant, and 100-seed weight, respectively. Both phenotypic and genotypic correlations among traits showed positive relationship for seed yield/plant with number of branches and number pods/plant, and also between plant height and number of pods/plant. However, seed yield/plant was negatively correlated with plant height. Path coefficient analysis revealed that number of pods/plant had the highest positive direct effect on seed yield/plant, followed by 100-seed weight and number of seeds/pods.

Introduction

In Egypt, faba bean *Vicia faba* L. is considered one of the most important sources of protein. During the past few years, plant breeders have paid special attention to world or local collections of different species including faba bean to maximize genetic variability and to identify superior genotypes for breeding programs.

The variability in various faba bean plant characters has been reported by several authors. They evaluated and characterized the germplasm accessions that could be utilized in breeding programs (Abdalla 1976; Bianco *et al.* 1979; Polignano *et al.* 1979; Porceddu *et al.* 1979; Chapman 1981; Polignano and Olita 1981; Polignano and Uggenti 1984). The studies reported on the association between different traits and path-coefficient analysis have been very useful in determining selection criteria suitable for genetic improvement of yield (Yassin 1973; Abdalla 1976; Mahmoud *et al.* 1978; Bianco *et al.* 1979; De Pace 1979; Vries 1979; Poulsen and Knudsen 1980; Hebetinek *et al.* 1982; Salem 1982; Naidu *et al.* 1985; and Sindhu *et al.* 1985).

The objective of the present work was to study the genetic variability in yield and other important characteristics in a local collection of faba bean. Phenotypic and genotypic correlations between pairs of characters, path-coefficient analysis of seed yield and its contributing variables were also studied.

Materials and Methods

Nineteen accessions of faba bean *Vicia faba* L. collected from farmers, who usually use their own seeds year after year in Assiut and Sohag governorates, Egypt, and two commercial cultivars, i.e. Giza 2 and Giza 402 were evaluated at the Experimental Farm of Assiut University during the 1985/86 and 1986/87 seasons. In both seasons, sowing was made during the second half of November using a randomized complete block design with three replications. Seeds were sown in 3-row plots each 3.5 m long, with 60 cm between rows and 15 cm between hills. After complete emergence, seedlings were thinned to two plants per hill. The recommended cultural practices for faba bean production were adopted throughout the growing season.

In each plot, plant height, number of primary branches, number of pods/plant, and seed yield/plant were recorded for 10 randomly selected plants. The analysis of variance was performed on plot mean basis.

Combined analysis of variance was performed as outlined by Snedecor and Cochran (1967) and the genotypic and phenotypic variances were calculated according to the equations given by Al-Jibouri *et al.* (1958).

Phenotypic and genotypic coefficients of variability were calculated and heritability (broad sense) was estimated according to Burton (1952). The phenotypic and genotypic correlations were estimated according to Miller *et al.* (1958).

Phenotypic path coefficient analysis was carried out for yield and its components over the two seasons by solving the simultaneous equations as done by Dewey and Lu (1959).

Results and Discussion

Mean, variance, and heritability

The results of the analysis of variance are presented in Table 1. Combined analysis of variance revealed significant differences among the accessions for all the studied traits. The interactions between accessions and years were significant for plant height, pods/plant, seed yield/plant, seeds/pod, and 100-seed weight. This indicates that it is essential to evaluate such traits for a number of environments (years and locations). However, number of branches/plant did not show significant interaction with years, indicating that years may not affect this trait.

Comparisons between the commercial cultivars and the other accessions (Table 2) showed that the accession number 6 was significantly shorter than the commercial cultivars over two seasons. However, the accessions number 12, 14, and 16 were significantly taller than the checks. The genetic variability in plant height is reported by Porceddu *et al.* (1979) and Polignano and Spagnolettizeuli (1985).

With respect to number of pods and seed yield/plant, only the accession number 9 had significantly outyielded both the commercial cultivars. Whereas accession number 7 had significantly heavier 100-seed weight than the checks.

Genotypic and phenotypic variances, their coefficients of variation, and broad sense heritability are presented in Table 3. The influence of environment on plant height, number of branches/plant, number of pods/plant, seed yield/plant, and 100-seed weight was estimated to be 83.13, 66.67, 55.10, 55.30, and 60.64%, respectively. In general, phenotypic coefficient of variation was higher than genotypic one for all the characters except for number of seeds/pod. Genotypic coefficient of variation estimates for each season in all the characters were markedly higher compared to the combined estimate obtained over the two seasons. This could be due to the over estimated genetic variance in separate analysis which confounded the accession x year interaction. Consequently, higher estimates of heritability in broad sense were obtained from the separate analysis compared to that obtained from the combined analysis.

Heritability was lower for plant height, number of branches, 100-seed weight, seed yield/plant, and number of pods/plant indicating that these characters were largely influenced by the environmental factors.

Scarascia-Mugnozza and De Pace (1979) evaluated variability for number of pods, seed weight, and seed yield in a sample of 600 accessions from the Bari *Vicia faba* collection and found a wide genetic variability. Also, Porceddu *et al.* (1979) found genetic variability of seed yield and 1000-seed weight in 158 Italian accessions of *Vicia faba* L. Bianco *el al.* (1979) found much variation in a collection of faba beans from many countries. Chapman (1981) has listed the genetic variation within *V. faba* which is at present available to breeders. Recently, results were also reported by Salem (1982) and Polignano and Spagnolettizeuli (1985) over genetic variability in faba bean. The great genetic variability in *Vicia faba* populations may partly be due to the fact that its breeding system is intermediate between autogamy and allogamy (Picard 1979).

Phenotypic and genotypic correlations

Phenotypic and genotypic correlation coefficients between pairs of traits for the 19 accessions and the 2

Table 1. Combined analysis of variance for different traits of 19 accessions and 2 commercial cultivars of *V. faba* L. during the 1986-1987 seasons.

Source of variation	d.f.	Mean squares					
		Plant height	Number of branches/ plant	Number of pods/ plant	Seed yield/ plant	Number of seeds/ pod	100-seed weight
Years	1	18409.00**	1.22	657.37**	1479.80*	0.82	224.00**
Rep/year	4	90.97	1.82	30.40	156.02	0.23	3.09
Accessions	20	149.03**	0.71*	17.67**	63.35**	0.28**	108.86**
Accessions x year	20	123.91**	0.47	9.74**	35.04**	0.38**	66.04**
Error	80	26.91	0.35	4.35	15.25	0.07	3.84

*, ** significant at 0.05 and 0.01 levels of probability, respectively.

Table 2. Means and their percentages from the check cultivars during the 1986-1987 seasons.

Accession no.	Plant height (cm) Mean	% from		No. of branches/plant Mean	% from		No. of pods/plant Mean	% from		Seed yield/plant (g) Mean	% from		No. of seeds/pod Mean	% from		100-seed weight (g) Mean	% from	
		Giza 2	Giza 402		Giza 2	Giza 402		Giza 2	Giza 402		Giza 2	Giza 402		Giza 2	Giza 402		Giza 2	Giza 402
1	97.0	93.0*	97.3	2.37	90.1	69.5**	9.60	92.5	77.1*	19.77	98.0	76.8**	3.83	105.2	110.1*	54.0	90.0**	88.5
2	105.7	101.3	106.0*	2.63	100.0	77.1*	9.48	91.3	76.1*	19.45	87.5	75.5**	3.38	92.9	97.1	58.5	97.5	95.9*
3	100.3	96.2	100.6	2.58	98.1	75.7*	9.70	93.5	77.9*	19.55	88.0	75.9**	3.30	90.7*	94.8	63.0	105.0*	103.3
4	104.3	100.0	104.6	2.83	107.6	83.0	12.57	121.1	101.0	25.60	15.2	99.4	3.25	89.3	93.4	62.8	104.7*	103.0
5	100.8	96.6	101.1	2.83	107.6	83.0	12.83	123.6*	103.1	26.90	21.1*	104.5	3.91	107.4	112.4**	55.5	92.5**	91.0**
6	92.8	89.0**	93.1*	2.70	102.7	79.2*	12.20	117.5	98.0	26.17	17.8	101.6	3.72	102.2	106.9	56.2	93.7**	92.1**
7	97.8	93.8*	98.1	3.12	118.6	91.5	12.42	119.7	99.8	24.80	11.6	96.3	3.22	88.5**	92.5	65.0	108.3**	106.6**
8	103.3	99.0	103.6	2.42	92.0	71.0**	9.57	92.2	76.9*	20.03	90.1	77.8*	3.69	101.4	106.0	57.2	95.3**	93.8**
9	96.7	92.7*	97.0	3.53	134.2**	03.5	15.50	149.3**	124.5*	32.35	45.6**	125.6**	3.43	94.2	98.6	62.2	103.7	102.0
10	104.0	99.7	104.3	2.93	111.4	85.9	13.03	125.5*	104.7	25.12	13.1	97.6	3.71	101.9	106.6	53.2	88.7**	87.2**
11	109.2	104.7	109.5**	2.20	83.7	64.5**	11.48	110.6	92.2	21.88	98.5	85.0	3.60	98.9	103.5	53.5	89.2**	87.7**
12	112.7	108.1**	113.0**	2.57	97.7	75.4*	14.08	135.7**	113.1	25.75	15.9	100.0	3.41	93.7	98.0	53.7	89.5**	88.0
13	103.5	99.2	103.8	2.37	90.1	69.5**	12.40	119.5	99.6	23.73	06.8	92.2	3.32	91.2*	95.4	60.8	101.3	99.7
14	110.3	105.8*	110.6**	3.03	115.2	88.9	14.80	142.6**	118.9	27.80	25.1*	108.0	3.30	90.7*	94.8	57.5	95.8*	94.3**
15	102.7	98.5	103.0	2.80	106.5	82.1	11.40	109.8	91.6	20.88	94.0	81.1*	3.66	100.6	105.2	51.0	85.0**	83.6**
16	110.8	106.2*	111.1**	2.47	93.9	72.4**	12.17	117.2	97.8	23.40	05.3	90.9	3.77	103.6	108.3	51.2	85.3**	83.9**
17	105.7	101.3	106.0*	2.47	93.9	72.4**	14.30	137.8**	114.9	25.07	12.8	97.4	3.22	88.5**	92.5	54.7	91.2**	89.7**
18	105.0	100.7	105.3	2.43	92.4	71.3**	12.12	116.8	97.4	20.82	93.7	80.9*	3.29	90.4*	94.5	52.2	87.0**	85.6**
19	103.5	99.2	103.8	2.73	103.8	80.1*	12.62	121.6	101.4	24.60	10.7	95.5	3.55	97.5	102.0	53.7	89.5**	88.0**
Giza 2	104.3	100.0	104.6	2.63	100.0	77.1*	10.38	100.0	83.4	22.22	00.0	86.3	3.64	100.0	104.6	60.0	100.0	98.4
Giza 402	99.7	95.6	100.0	3.41	129.7*	00.0	12.45	119.9	100.0	25.75	15.9	100.0	3.48	95.6	100.0	61.0	101.7	100.0
General mean	103.34			2.72			12.15			23.89		3.51			56.99			
LSD (5%)	6.0	5.8	6.0	0.68	25.9	19.9	2.40	23.1	19.3	4.49	20.2	17.4	0.30	8.24	8.62	2.3	3.8	3.8
LSD (1%)	7.9	7.6	7.9	0.90	34.2	26.4	3.18	30.6	25.5	5.95	26.8	23.1	0.40	11.0	11.5	3.0	5.0	4.9

*, ** significant at 0.05 and 0.01 levels of probability, respectively.

Table 3. Heritability estimate (H), genotypic (G) and phenotypic (P) variances and their respective coefficients of variability (GCV and PCV) from the combined data.

Trait	Estimate				
	P	G	PCV (%)	GCV (%)	H (%)
Plant height	24.84	4.19	4.82	1.98	16.87
Number of branches/plant	0.12	0.04	12.74	7.35	33.33
Number of pods/plant	2.94	1.32	14.11	9.46	44.90
Seed yield/plant	10.56	4.72	13.60	9.09	44.70
Number of seeds/pod	0.05		6.37		
100-seed weight	18.14	7.14	7.47	4.69	39.36

commercial cultivars over the two seasons are presented in Table 4. Number of branches, and number of pods/plant had a positive correlation with seed yield/plant. Positive correlation was also observed between number of branches/plant and 100-seed weight. However, number of branches/plant and seed yield/plant were negatively correlated with plant height. These results are in line with those reported by Yassin (1973), Abdalla (1976), Bianco *et al.* (1979), De Pace (1979), Vries (1979), Aristarkhova and Demina (1980), Poulsen and Knudsen (1980), Salem (1982), Madupuri *et al.* (1985), and Sindhu *et al.* (1985).

Path-coefficient analysis

Path-coefficient analysis was used to determine the direct and indirect effects of the number of pods/plant, number of seeds/pod, and 100-seed weight on seed yield/plant. The number of pods/plant was the major component which showed highest direct effect (1.02) on seed yield (Table 5), followed by 100-seed weight (0.458) and number of seeds/pod (0.414). However, the indirect effect of number of pods on seed yield via number of seeds/pod was negative (-0.12), the other indirect effect via 100-seed weight was very small (-0.009). These results reflect the observations obtained on the phenotypic correlation because, the number of pods/plant showed high positive correlations with seed yield/plant and small negative correlations with each of number of seeds/pod and 100-seed weight. However, the low negative phenotypic correlation (-0.11) between seed yield/plant and number of seeds/pod could be interpreted by the intermediate direct effect of number of seeds on seed yield (0.414) which was cancelled by the negative indirect effects via number of pods (0.296) and via 100-seed weight (-0.229). Likewise, the low phenotypic correlation observed between seed yield and 100-seed weight (0.23) could be due to the negative indirect effect of 100-seed weight via number of seeds (-0.207) versus moderate direct effect (0.458) on seed yield.

The residual analysis indicated that 0.9679 of the variability in seed yield could be attributed to the direct and indirect effects of the yield components

Table 4. Phenotypic (above) and genotypic (below) diagonal correlation coefficients among different traits of 19 accessions and 2 commercial cultivars of *Vicia faba* L. during the 1986 and 1987 seasons.

Trait	Plant height	No. of branches/ plant	No. of pods/ plant	Seed yield/ plant	No. of seeds/ pod	100-seed weight
Plant height		-0.38	0.16	-0.13	-0.17	-0.40
Number of branches/plant	-1.5		0.51	0.69	-0.13	0.47
Number of pods/plant	0.32	0.09		0.89	-0.29	-0.02
Seed yield/plant	-0.93	0.69	0.88		-0.11	0.23
Number of seeds/pod						-0.50
100-seed weight	-2.50	0.69	-0.59	-0.05		

Table 5. Phenotypic path coefficient analysis of the 19 accessions and the two commercial cultivars of *Vicia faba* L. during the 1986-1987 seasons.

Path way of association	
Seed yield/plant vs. number of pods/plant:	
Phenotypic correlation	0.890
Direct effect	1.020
Indirect effect via number of seeds/pod	-0.120
Indirect effect via 100-seed weight	-0.009
Seed yield/plant vs. number of seeds/pod:	
Phenotypic correlation	-0.110
Direct effect	0.414
Indirect effect vi number of pods/plant	-0.296
Indirect effect via 100-seed weight	-0.229
Seed yield/plant vs. 100-seed weight:	
Phenotypic correlation	0.230
Direct effect	0.458
Indirect effect via number of pods/plant	-0.020
Indirect effect via number of seeds/pod	-0.207
Residual effect	0.179

studied, whereas the remaining 0.0320 could be attributed to other factors. These results suggest the presence of some other important agronomic characters contributing to yield, which were not included in this study.

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التباين والارتباطات وتحليل معامل Path لبعض الصفات في مجاميع من الفول (Vicia faba L.).

ملخص

تم تقييم تسعة عشر مدخلا جمعت من حقول المزارعين بالاضافة الى صنفين تجاريين من الفول Vicia faba L. هما (جيزة 2 وجيزة 402) ، وذلك خلال موسمي 1986 و 1987 . وقد تفوقت بعض المدخلات التي تم جمعها على كل من الصنفين التجاريين في جميع الصفات المدروسة. ان التباين البيئي تجاوز التباين الوراثي بالنسبة لجميع الصفات . وقد وصلت نسبة القابلية للتوريث الى 16.87 ، 33.33 ، 44.90 ، 44.70 و 39.36 % لكل من طول النبات ، وعدد الفروع ، وعدد القرون/النبات ، والغلة البذرية/النبات ، ووزن المئة حبة على التوالي . كما اظهرت الارتباطات المظهرية والوراثية بين الصفات قيما موجبة للغلة البذرية/النبات ، مع عدد الفروع والقرون/ النبات، وكذلك بين طول النبات وعدد القرون/النبات . من ناحية ثانية أظهرت الغلة البذرية/ النبات ارتباطا سلبيا مع طول النبات . وأوضح تحليل معامل Path أن عدد القرون/ النبات كان له أعلى تأثير مباشر وايجابي على الغلة البذرية/ النبات يليها وزن المئة حبة ، وعدد البذور/القرن .

Inheritance of Dwarf Growth Habit, Induced in Vicia faba L. var major by Ethyl Methane Sulphonate (EMS)

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Abstract

The inheritance of dwarf growth habit was studied in a *Vicia faba* L. cross. The original variety (Aquadulce, major type, 100 seed weight = 200 g), the dwarf mutant and their F_1 and F_2 generations were grown at Valenzano, Bari, Italy in the 1984-86 seasons. The F_1 plants were normal and the F_2 segregated into three normal phenotypes to one dwarf, indicating that the dwarfness is controlled by a single recessive gene. Dark green leaf character seemed to be associated with reduced plant height.

Introduction

Mutagenesis is a tool to increase genetic variability in species where natural variation is not large or, as often happens, is not composed by phenotypes useful to plant breeders because they have disappeared due to their poor competition ability in natural conditions (Ricciardi *et al.* 1982).

Vicia faba L. has been used to study the mutagenic effect of some chemical compounds (Wolff and Read 1952; Read 1954; Read and Kihlman 1956; Read 1961; Wakoning-Vaartaja and Read 1962; Kumar and Natarajan 1965; Filippetti and De Pace 1986), visible light (Kilhman 1959), or fast neutrons, and X and gamma rays (Gray and Scholes 1951; Thoday 1951; Evans *et al.* 1959; Filippetti and De Pace 1983; 1986).

Few studies however, have been undertaken to experiment with and compare mutagenic agents for their ability to induce useful new genetic variability in *Vicia faba* L. (Sojodin 1971; Abdalla and Hussein 1977). A review of the new variants induced in *Vicia faba* L. for simple inherited characters has been made by Chapman (1981, 1986), and for quantitative variation by Abdalla and Hussein (1977). Such studies demonstrate the potentiality of mutagenesis in enlarging the genetic variability in the available seed stocks. Unfortunately, this practice was limited to the botanical group *minor*, which prevents the rapid utilization of those mutants, especially in areas where cultivars belonging to the botanical group *major* are mainly grown, (i.e., the Mediterranean region). The transfer of the useful mutants from one botanical group to the other through conventional breeding methodology is a long process. Therefore, a breeding program to improve *Vicia faba* var *major* through mutagenesis was started in 1978 (Filippetti and De Pace 1981; 1986). The aim was to induce in the *major* types the same spectrum of genetic variability available in *minor* types, and also to identify variants, i.e., determinate growth habit, new leaf characteristics, drought tolerance, high and balanced protein content, etc., which could be used for solving specific problems of the crop in the Mediterranean region. One of the new mutants induced in *Vicia faba* L. var *major* showed dwarf growth habit (Fig. 1). However, literature shows that four dwarf mutants have previously been isolated in *Vicia faba* var *minor:* by Bond from var Compacta, gene dw-1; spontaneous mutant at Svalof, gene dw-2; spontaneous mutant from a double restorer line HG 115C at

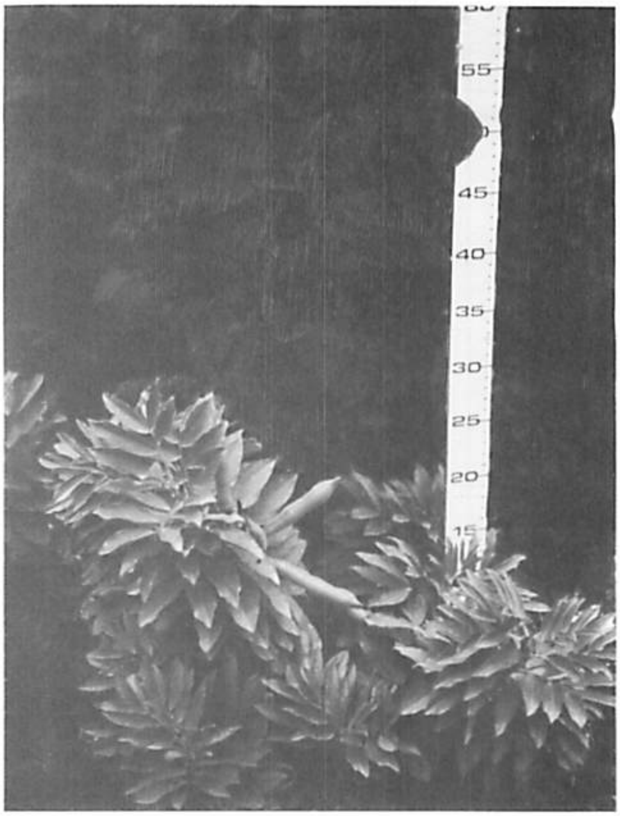

Fig. 1. Dwarf mutant.

INRA (France), gene dw-3; X-ray mutant from cv Fribo, by Dietrich gene dw-4 (Chapman 1986).

This paper reports the agronomic characters of dwarf mutant and mode of inheritance of the dwarfness.

Materials and Methods

Following the procedure already described by Filippetti (1986), 3500 seeds of the faba bean cultivar Aquadulce were treated with ethyl methane sulphonate (EMS). The progeny from each M_1 plant was sown in separate rows with 20 cm between seeds and 50 cm between rows. When the 13,000 M_2 plants were large enough to distinguish variation in plant size and growth habit, the mutants directly visible as aberrant types were selected. One of these mutants showed dwarf growth habit (Fig. 1).

Table 1 shows the fertility parameters of the M_2 dwarf plant progeny in our experiment. The parental plants (Aquadulce and the M_2 dwarf mutant) were grown in the field at Valenzano, Bari, Italy in the 1984 season and crossed using the technique described by Bond *et al.* (1980).

The F_1 plants were grown in the 1985 season. The F_2 plants were grown in the 1986 season and used to estimate the segregation ratio for dwarf growth. All material (parents, F_1, and F_2) was protected from outcrossing.

Results and Discussion

The F_1 plants showed tall growth habit: dominance of tall over dwarf growth habit was confirmed. The segregation in the F_2 generation is shown in Table 2. A significant 3 tall to 1 dwarf ratio of segregation was established. The dwarf character was found to be monogenic and recessive. Dark green leaf character seemed to be associated with dwarf growth habit.

Table 1. Performance of dwarf M_2 progeny plants and the standard tall check (Aquadulce) in preliminary evaluation at Valenzano, Italy 1984.

Mutant plants	Plant height (cm)	Number of stems*	Number of pods/plant	Number of seeds/plant	Number of seeds/pod	Seed yield/ plant (g)	Seed weight (g)
1	25	2	5	14	2.8	18	1.3
2	25	3	9	21	2.3	29	1.4
3	30	2	5	17	3.4	29	1.7
4	30	3	7	29	4.1	33	1.1
5	25	3	5	13	2.6	18	1.4
6	25	3	5	15	3.0	18	1.2
7	25	3	8	26	3.3	38	1.5
8	25	3	8	27	3.4	34	1.3
9	30	2	7	27	3.9	36	1.3
10	30	3	7	25	3.6	31	1.2
11	30	3	6	19	3.2	23	1.2
12	30	4	8	22	2.8	26	1.2
13	30	3	6	22	3.7	28	1.3
14	30	2	6	20	3.3	25	1.3
15	30	4	10	48	4.8	60	1.3
16	30	3	9	25	2.8	39	1.6
17	25	3	6	19	3.2	29	1.5
18	25	4	10	25	2.5	32	1.3
19	20	4	12	29	2.4	40	1.4
20	25	4	12	27	2.3	35	1.3
Mean	27.3	3.1	7.6	23.0	3.0	31.1	1.33
Aquadulce	70.4	3.0	15.4	61.6	4.0	123.2	2.0

* Axis + secondary stems

Table 2. Segregation for dwarf grown habit in F_2 progenies of cross between Violetta di Policoro (parental variety) and the dwarf mutant.

Parent/ F_1 and F_2	Field number of segregating families	Observed segregation			Expected genetic ratio	X^2	P value
		Tall (normal)	Dwarf (mutant)	Total			
1. Dwarf mutant			20	20			
2. Violetta di Policoro x Dwarf mutant							
F_1 (1985)		32		32			
F_2 (1986)	1	22	13	35	3:1	2.752	0.10-0.05
	2	35	6	41	3:1	2.349	0.25-0.10
	3	13	7	20	3:1	1.067	0.50-0.25
	4	14	6	20	3:1	0.267	0.75-0.50
	5	22	11	33	3:1	1.223	0.50-0.25
	6	102	25	127	3:1	1.913	0.25-0.10
	7	33	16	49	3:1	1.531	0.25-0.10
	8	12	7	19	3:1	1.421	0.25-0.10
	9	28	12	40	3:1	0.533	0.50-0.25
	10	58	18	76	3:1	0.071	0.90-0.75
	11	23	9	32	3:1	0.167	0.75-0.50
	12	25	5	30	3:1	1.111	0.50-0.25
	13	29	11	40	3:1	0.133	0.75-0.50
	14	31	11	42	3:1	0.032	0.90-0.75
	15	32	6	38	3:1	1.719	0.25-0.10
	16	23	10	33	3:1	0.495	0.50-0.25
	17	20	5	25	3:1	0.333	0.75-0.50
	18	28	9	37	3:1	0.009	0.95-0.90
	19	58	10	68	3:1	3.843	0.05-0.02
	20	26	4	30	3:1	2.177	0.25-0.10
	21	32	6	38	3:1	1.719	0.25-0.10
	22	17	8	25	3:1	0.653	0.50-0.25
	23	19	8	27	3:1	0.309	0.75-0.50
	24	26	8	34	3:1	0.039	0.90-0.75
	25	14	4	18	3:1	0.075	0.90-0.75
	26	36	11	47	3:1	0.064	0.90-0.75
	27	23	8	31	3:1	0.011	0.95-0.90
	28	45	15	60	3:1	0.000	
	29	28	8	36	3:1	0.145	0.75-0.50
	30	8	6	14	3:1	2.381	0.25-0.10
	31	8	5	13	3:1	1.256	0.50-0.25
	32	31	8	39	3:1	0.419	0.75-0.50
Mean of F_2		921	296	1217	3:1	0.299	0.75-0.50

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توريث صفة النمو المتقزم المستحدَث او المستحث في الفول Vicia faba L. var major باستخدام Ethyl Methane Sulphonate (EMS) .

ملخص

درس توريث صفة النمو القصير على هجين الفول Vicia faba L. • وقد زرع الصنف الاصلي (Aquadulce طراز كبير الحبة ، وزن المئة حبة 200 غ) ، والطافر المتقزم ، وجيلاهما الاول F_1 والثاني F_2 في فالينزانو، باری بايطاليا ، وذلك في الموسمين 1984 - 1986 . وكانت نباتات الجيل الاول طبيعية ، اما نباتات الجيل الثاني فقد انعزلت بنسبة ثلاث طرز شكلية طبيعية الى طراز متقزم واحد ، مما يشير الى ان صفة التقزم يتحكم فيها مورثة متنحية واحدة • ويبدو ان صفة لون الورقة الاخضر الداكن متلازمة مع انخفاض طول النبات •

Physiology and Microbiology

الفيزيولوجيا والأحياء الدقيقة

Effect of Stem Termination on Some Metric Traits in Faba Bean

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Abstract

One hundred and twenty single plant F_3 families originating from 51 crosses between topless and semitopless or indeterminate genotypes were evaluated in field for their yield and yield attributes. Topless plants yielded lowest because of large number of reproductive branches, lower number of podded nodes, poor podding, empty poddedness and lower number of seeds/pod when compared to semitopless and indeterminate plants. There is a need for further improvement in productivity of the topless types before they can be of commercial interest.

Introduction

Considerable interest has been expressed by faba bean breeders in determining the potential for using stem termination in varietal improvement. Thus, the present study was planned with the object of measuring yield-related traits in faba bean lines that were topless (determinate), semitopless, and indeterminate and determining their significance in breeding for determinate plant type in faba bean.

Materials and Methods

In the 1987 spring-summer season, 120 single plant F_3 families, originating from 51 crosses (including some reciprocals) between topless and semitopless genotypes on the one hand and indeterminates on the other were evaluated in the field. Seeds were sown in single rows 2 m long, with 50 cm between rows and 20 cm between plants within row. At maturity, the plants were scored (1 = poor; 5 = excellent) for pod-bearing ability, and observations were recorded for: nature of stem termination, i.e., topless (determinate), semitopless, and indeterminate; plant height; tillers/plant; fruiting nodes/plant; pods/plant; pods/node; pod length; seeds/pod; 100-seed weight; and seed yield/plant.

Individual families or the plants within segregating families were grouped into three classes according to the nature of stem termination. Average values of each group for different characters were compared and the significance of the difference was tested by the Student's t test.

Results and Discussion

Topless (determinate) plants tended to produce 3 to 5, and sometimes more, side tillers, and generally had poor pod filling, especially on the side tillers. Many of the pods were empty, and often on the side tillers not even one pod was fully developed. They produced fewer seeds/pod than did the other two groups, although the difference was not significant. The topless plants often had branches rather than basal tillers. Their flowering and, hence, pod bearing was confined to a comparatively smaller area -- the upper half of the canopy. In the semitopless group, the fruiting was limited to the lower to central part of the canopy, whereas the indeterminate plants produced pods that were distributed throughout the canopy.

Topless plants were short; indeterminate tall (some were more than 150 cm); and semitopless were intermediate, 90 to 115 cm. Within-family variation for plant height among the semitopless group was low. Both topless and semitopless plants were resistant to lodging, whereas the indeterminate lodged easily (Table 1).

The indeterminate plants significantly ($P < 0.01$) outyielded the topless and semitopless ones and the difference between topless and semitopless was also significant (Table 1). These differences are clearly a reflection of the number of pods/plant and 100-seed weight. Differences for plant height were also

Table 1. Average performance of topless, semitopless, and indeterminate faba bean lines for some metric traits.[1]

Character	Topless	Semi-topless	Indeterminate
Plant height (cm)	80.7a	105.2b	125.9c
Tillers/plant	3.5	2.8	2.7
Nodes/plant	14.2	15.6	21.6
Pods/plant	27.7A	29.1B	40.9c
Pods/node	1.9	1.9	1.9
Pod bearing score	2.7	2.9	3.1
Pod length (cm)	5.5	6.6	6.5
Seeds/pod	2.9	3.2	3.3
100-seed weight (g)	56.8a	78.4b	68.2c
Seed yield/plant (g)	37.2a	64.5b	71.4c

1. Means followed by different letter(s) are significantly different at 1% (small) and 5% (capitals) levels of probability.

significant. These results agree with those of Steuckardt *et al.* (1982), Brimo (1983), Bailey (1984), Khalid and Nassib (1986), Kittlitz (1986), and Steuckardt and Dietrich (1986). Nevertheless, determinate plants have frequently been described as potentially valuable in faba bean breeding programs (Sjoedin 1971; Nagl 1979; Chapman 1981; Frauen and Brimo 1983; Filipetti and Marzano 1984). We support this view for several reasons as discussed below.

Indeterminate growth habit has been cited as one of the few characters causing comparatively poor yields in grain legumes including faba bean. It has been stated that legumes show apical dominance where the vegetative and reproductive growth phases overlap considerably for a long period. Thus, part of the energy of the plant is utilized in unproductive vegetative parts rather than in the reproductive sink. In highly productive species like cereals, the transition between vegetative and reproductive phases of the plant is clearcut and thus all the plant energy is diverted to produce grain. Therefore, we expected that the determinate forms of legumes could be more productive. With this view, the mutants with different degrees of stem termination have been isolated. However, none of them so far has been found as productive as their indeterminate counterparts. In contrast, the determinate forms in tomato, cucumber, soybean, common bean (*Phaseolus vulgaris*), cowpea, and pigeonpea have been a commendable success and now occupy a sizable area in the cultivation of these crops.

The determinate forms of faba bean are superior to indeterminates in terms of reduced plant height, synchronous maturity, and early ripening. Above all, they produce a more compact plant canopy than do the indeterminates and, thus, may respond to increased plant population -- a possible means of compensating for, to some extent, their low yields per plant. Also, because of early maturity, they may be cropped twice in one season (Chapman 1981) and their per-day yields may be more than or at par with, those of indeterminates. Their reduced plant height is desirable as it reduces lodging, and the genes for stem termination may offer a good means of manipulating plant height. Finally, their relative photoinsensitivity may permit flexibility in sowing time.

The differences for number of fruiting nodes, seeds/pod and pod length were not statistically significant in the three groups of plants, but the values for topless plants were lowest and appear to act additively to reduce seed yield. From the results of our study, we conclude that the genetic base of *ti* gene population should be broadened so that breeders can develop productive forms of determinate faba beans. Rigorous selection for productivity in general and for increased numbers of pods/plant and 100-seed weight in particular would be a first step in advancing such populations. Simultaneously, breeders should select for low number of tillers. The result should be the desired improvement in determinate faba beans, opening the way for adoption similar to what has been achieved in other species.

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تأثير الساق المحدود النمو على بعض الصفات المترية metric traits في الفول

ملخص

جرى تقييم حقلي للغلة ومكوناتها على 120 نبتة منفردة من الفول تنتمي الى الجيل الثالث (F_3) ، ومنحدرة من 51 هجينا بين طرز وراثية محدودة النمو (غير قمية) ، وشبه محدودة النمو أو غير محدودة النمو . وقد أعطت النباتات محدودة النمو أدنى غلة بسبب اعطائها لاكبر عدد من الفروع الثمرية ، وأقل عدد من العقد الثمرية ، وضعف تشكل القرون ، واعطاء قرون فارغة مع أقل عدد من البذور/القرن مقارنة بالنباتات شبه محدودة النمو وغير محدودة النمو .وثمة حاجة لاجراء مزيد من التحسين على انتاجية الطرز الوراثية المحدودة النمو قبل أن تصبح ذات أهمية تجارية .

Leaf Water Potential and Stomatal Resistance Variations in Vicia faba L.

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Abstract

In a breeding program for improving drought resistance in *Vicia faba* the water status of four highly homozygous genotypes of faba bean was studied in field in southern Italy, throughout the growing period of the crop. One of the genotypes was of *major* type (Aguadulce) and the other three (Manfredini, Vesuvio and Maris Bead) were of *minor* type. Leaf water potential and diurnal pattern of stomatal resistance were studied together with stomatal and trichome anatomic and physiological features. No significant differences in any of the characters were observed amongst the varieties and therefore no inferences on the relationships between water status of plant and drought tolerance could be drawn.

Introduction

Water stress is one of major factors responsible for low unstable yield of faba bean in the Mediterranean region (Hawtin and Hebblethwaite 1983). Therefore, new breeding strategies are being directed to enable development of genotypes tolerant or resistant to drought (Nerkar *et al.* 1981; van der Wal 1981).

In the Plant Breeding Institute of Bari such studies were carried out to identify the morphological, physiological, and biochemical parameters most sensitive to water stress so that they may help in selection of genotypes that are resistant to drought. Parameters which can reflect the variations in the water status of the plant such as leaf water potential and stomatal resistance (Hsiao and Acevedo 1974; Elston *et al.* 1976; Karamanos 1978), and stomatal and trichome morphology (Ciha and Brun 1975; Sapra *et al.* 1975; Tanzarella *et al.* 1984) are important in this regard.

This paper reports variations in these characteristics for four field grown genotypes of faba bean with a view to ascertain differences in their tolerance to drought.

Materials and Methods

This field study was carried out at the Agricultural Plant Breeding Institute, Valenzano (Bari), in 1984.

The soil was well structured sandy-clay, about 50 cm deep. It had a total available water of 13% (on weight basis) with a bulk density of 1.3 g/cm^3. At sowing (24 Nov 1983) 100 kg/ha of P_2O_5 was added to the soil.

One *major* (Aguadulce) and three *minor* (Manfredini, Vesuvio, and Maris Bead) type genotypes of faba bean were grown in 32m^2 plots with a plant density of 10 plants/m^2 in a randomized block design with three replications. The genotypes used were highly homozygous.

The variations in the soil water potential were followed through the gravimetric method. A previously drawn soil moisture release curve was used to determine the matric potential.

The diurnal patterns of the leaf water potential and the stomatal resistance were measured periodically on the fully expanded leaves at different layers, along the whole plant height. The leaf water potential was measured with pressure chamber on six plants per replication, whereas the stomatal resistance was measured on both sides of the leaf with LI-COR 1600 steady-state porometer. The stomatal and trichome density was measured. The morphological analysis of the stomatal apparatus was made by observing optical fields of 2.56 mm^2 with a magnification of 100 X. The size of the stomata was measured by a graduated micrometer with a magnification of 400 X choosing 5 stomata per optical field. The stomata were counted in 5 optical fields for each side of the leaf sampled from 5 plants per replication.

Weather Conditions

Fig. 1 shows the reference evapotranspiration, estimated through the class "A" pan, and the thermopluviometric patterns during the growing cycle of the faba bean. The minimum temperature with a value of about 5°C, was recorded in Feb, when the maximum precipitation occurred. The daily average temperature gradually increased to reach the maximum in June (30°C), whereas the rainfall during this month was negligible. The total rainfall (440 mm between Jan and June) had a distribution typical of the Mediterranean climate. Water deficit started occurring from late Apr when crop was at post-flowering stage.

Results and Discussion

The soil water potential remained at about -0.08 MPa from sowing until early April. Later on, in less than 20 days, at the end of April, it went down to -0.7 MPa.

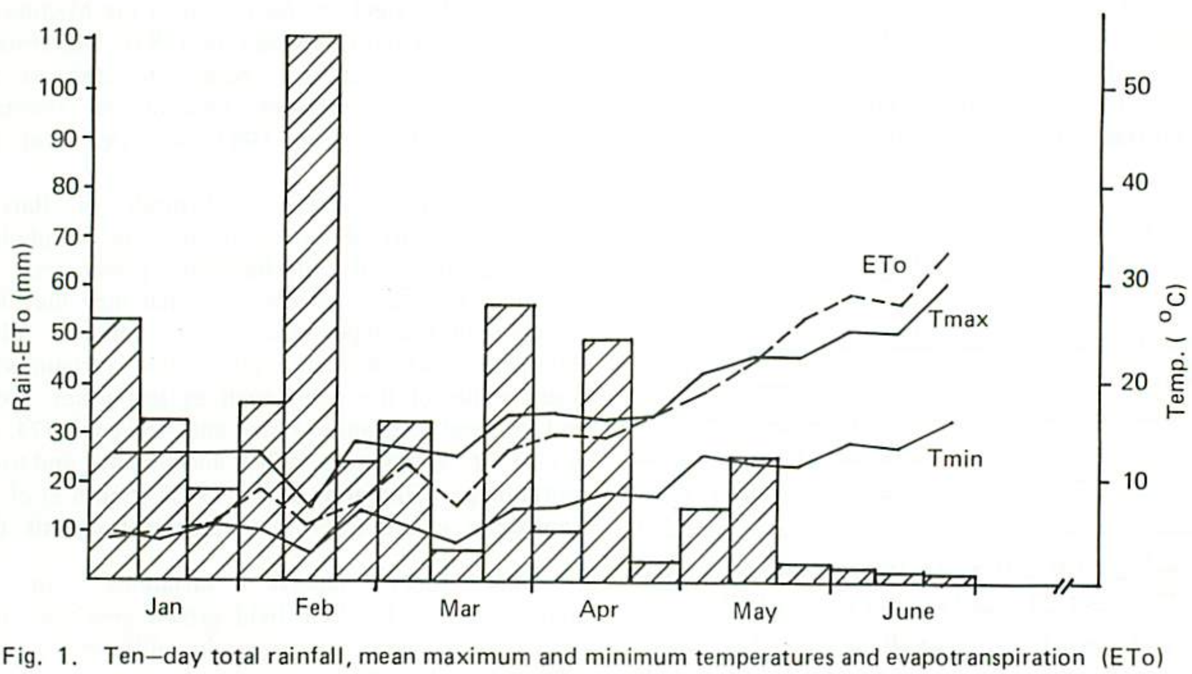

Fig. 1. Ten–day total rainfall, mean maximum and minimum temperatures and evapotranspiration (ETo) during the faba bean growing season in 1984 at Valenzano.

Due to a rainfall of about 50 mm, the soil water potential went up again to -0.035 MPa and then it continued to go down and reached -0.7 MPa in mid May and at -1.5 MPa by the end of May.

Because of the great variability in cloudiness during the crop cycle, the diurnal measurements, at hourly frequency became impossible. On Mar 28, Apr 19, Apr 26, and May 18, when the sky was open, the diurnal leaf water potential and the stomatal resistance were measured. The minimum values of leaf water potential, measured at the hours of peak evaporation demand (at about 1:00 P.M. solar time), ranged on the average from -0.7 to -1.3 MPa.

The average pattern of the leaf water potential during the day time showed no significant difference between the faba bean genotypes during both the periods of high (ψ_m= -0.08 MPa) and low soil water potential (ψ_m= -0.7 MPa).

A behaviour parallel to that of the leaf water potential was shown by the stomatal resistance to the transport of water vapor. Since faba bean leaves have a rather high stomatal density on both sides, the stomatal resistance was measured separately on the two sides trying to detect any difference in their behaviour. No genotypic differences could be observed. Moreover, the morphological analysis of leaves for stomata and trichome density also revealed no significant difference among the above varieties (Table 1). The evaluation of the stomatal resistance and of the leaf water potential along the profile of the plant canopy (subdivided into 4 layers) further confirmed the absence of significant difference among the varieties.

Although belonging to different botanic varieties with clear-cut morpho-physiological variations in agronomic characters, the four genotypes did not differ in their stomatal and transpiration behaviour which responded according to the dynamic conditions of the water status within the soil-plant-atmosphere system. This agrees with the observation of Nerkar (1981) who also worked with different genotypes but under controlled environments. Thus, the use of these parameters for the selection of genotypes resistant to drought may be of limited use. As for some reproductive traits and yield of the four genotypes (Table 2), there were significant differences but no relationship with the measured leaf parameters was detected. From the results obtained in this trial, the difficulties in selecting genotypes resistant, or tolerant, to drought are quite evident. These difficulties, already stressed by various authors (Blum 1987; Monti 1987), are to be related to the lack of easily detectable physiological, morphological and/or biochemical parameters that can be used for early screening of materials. The use of porometer and pressure chamber is not convenient for routine work on many genotypes. Moreover, stomatal resistance, as well as other parameters observed at leaf level is insufficient to define any resistance to drought which is the result of several quite complex factors related to the dynamic availability of the water. Therefore, in agreement with Dantuma and

Table 1. Leaf morphological analysis of the four faba bean genotypes.

Genotype	Leaf side	Leaf area (cm^2)	Stomatal density (n/mm^2)	No. stomata/ leaf (10 000)	Stomatal length (μm)	Stomatal width (μm)	Trichome density (n/mm^2)	No. trichome/ leaf (1000)
Aguadulce	Lower	20.2±1.62	42.7±2.04	8.60±0.76	54.5±0.77	31.9±0.41	2.86±0.33	6.30±1.17
	Upper		34.8±1.74	6.85±0.55	50.2±0.79	29.4±0.46	5.39±0.41	11.3±1.52
Manfredini	Lower	13.8±1.72	43.2±1.51	5.80±0.36	55.4±0.72	31.6±0.39	2.35±0.19	3.35±0.38
	Upper		34.9±0.90	4.75±0.31	50.2±0.59	28.3±0.48	3.64±0.25	5.22±0.56
Vesuvio	Lower	17.9±1.26	48.1±1.87	8.75±0.69	49.3±0.64	31.1±0.39	2.59±0.23	4.72±0.51
	Upper		37.7±1.52	6.77±0.47	45.0±0.84	29.9±0.42	4.66±0.48	8.46±0.95
Maris Bead	Lower	15.7±1.51	51.6±2.05	7.92±0.74	51.6±0.83	31.2±0.43	2.14±0.19	3.26±0.37
	Upper		37.1±1.13	5.73±0.52	48.0±0.49	28.4±0.36	4.07±0.41	6.57±0.92

Table 2. Yield components and yield of the four faba bean genotypes.

Genotype	No. pods/ plant	No. seeds/ pod	100-seed weight	Grain yield/plant (g)	Days from sowing to flowering
Aguadulce	7.4±2.70	3.5±0.91	173.1±22.7	43.7±17.5	99
Manfredini	15.9±7.17	2.7±0.42	59.2±9.74	24.9±10.5	107
Vesuvio	17.6±6.17	2.7±0.41	41.6±10.5	20.2±9.81	117
Maris Bead	6.8±3.73	2.0±0.64	41.1±16.1	5.9±3.04	122

Thompson (1983), an integrated analysis of several parameters should be done and, in future, studies should deal with the analysis of the whole crop response to the water availability occurring during the crop cycle.

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كمون ماء الورقة واختلافات مقاومة الثغور في الفول Vicia faba L.

ملخص

ضمن برنامج تربية هادف الى تحسين المقاومة للجفاف عند الفول ، تمت دراسة الحالة المائية في أربعة طرز وراثية نقية من الفول في حقل بجنوب ايطاليا ، وذلك خلال فترة نمو المحصول • كان أحد الطرز الوراثية Aquadulce من الطراز الكبير الحبة ، أما الثلاثة الباقون Manfredini و Vesuvio و Maris Bead فمن الطراز الصغير الحبة. وقد درس كمون ماء الورقة والنمط النهارى لمقاومة الثغور ، بالاضافة الى الخواص الفيزيولوجية والتشريحية للثغور والزوائد السطحية • ولم يلاحظ وجود فروق معنوية في أى من هذه الصفات بين الاصناف ، لذا فانه لا يمكن الخروج باستنتاجات حول العلاقة بين حالة الماء في النبات ومدى تحمله للجفاف •

Effect of Ethyl Methane Sulphonate (EMS) and Diethyl Sulphate (DES) on Germination, Growth, Fertility, and Yield of Vicia faba L.

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Abstract

Seeds of *Vicia faba* var *minor* were treated with the solutions of ethyl methane sulphonate (EMS) at 0.05%, 0.125%, and 0.25% and diethyl sulphate (DES) at 0.25%, 0.50%, and 0.75%. Germination, seedling growth, pollen fertility, time to maturity, and survival were adversely affected by both mutagens. Plant height, branching, number of leaves, pods and seeds as well as yield per plant showed varying responses to different concentrations of the mutagens. However, DES at all doses and EMS only at the highest dose had adversely affected these traits. Whereas, the lower doses of EMS had either no effect or a slight promoting effect.

Introduction

Earlier studies have indicated that experimental mutagenesis using X-rays, gamma rays, neutrons or chemical mutagens like ethyl methane sulphonate (EMS), can be helpful in increasing genetic variability and inducing mutations in *Vicia faba* L. (Sjodin 1962; 1971; Abdalla and Hussein 1977; Filippetti and De Pace 1982; 1983; Filippetti 1986). The present work was initiated to study the effects of different doses of the chemical mutagens ethyl methane sulphonate (EMS) and diethyl sulphate (DES) on a local cultivar of *Vicia faba* L. var *minor* and to find out the mutagen effects induced in the M_1 generation.

Materials and Methods

Seeds of a local cultivar of *Vicia faba* L. var *minor* were soaked in distilled water for 6 hrs to initiate the germination process. Then the seeds were removed and soaked for another 6 hrs in solutions containing different concentrations of the mutagens ethyl methane sulphonate (0.05%, 0.125%, and 0.25%) or diethyl sulphate (0.25%, 0.50%, and 0.75%) after which the treated seeds were thoroughly washed using tap water. Two control treatments were also applied in this study (unsoaked and soaked in distilled water).

Laboratory experiment

Fifty seeds from each treatment were sown in sand in large petridishes. The data in Table 1 summarize observations made at two-day intervals on each of the three traits: percentage germination (from 5th day), seedling height (from 7th day), and leaves/plant (from 11th day).

Field experiment

One hundred and 50 seeds from each treatment were sown in the field under ideal agronomic conditions. Treatments were arranged in a randomized block design. Data were recorded on various growth and yield parameters, including: survival percentage, days to flowering, pollen sterility, plant height, branches/ plant, leaves/plant, pods/plant, seeds/plant, and seed yield/plant. All data were statistically analyzed, and values in terms of percentages of control were calculated.

Results

Laboratory experiment

Table 1 shows the effect of the different treatments on percentage germination, seedling height, and number of leaves/plant under the laboratory conditions.

Percentage germination: Seeds of the unsoaked control reached maximum germination (100%) seven days from sowing. There was a slight delay in reaching maximum germination in seeds of the soaked control and those treated with different concentrations of EMS and DES. DES at all concentrations had adversely affected germination, and the percentage of ungerminated seeds was increased with increased concentrations of the mutagen.

Seedling height: The seedlings arising from seeds pretreated with the mutagen solutions or simply soaked in distilled water were markedly taller than those of the unsoaked control. Among the EMS treatments, the

Table 1. Effects of ethyl methane sulphonate (EMS) and diethyl sulphate (DES) on germination, plant height, and number of leaves/plant in *Vicia faba* L. var *minor*.

Character	Days after sowing	Unsoaked control	Soaked control	EMS (%)			DES (%)		
				0.05	0.125	0.25	0.25	0.50	0.75
Germination (%)	5	40	28	24	44	26	16	8	12
	7	100	88	84	94	84	74	58	52
	9	100	96	96	96	100	78	76	70
	11	100	100	96	96	100	80	80	72
	13	100	100	100	100	100	88	80	76
	15	100	100	100	100	100	92	82	76
	17	100	100	100	100	100	96	82	76
	19	100	100	100	100	100	96	82	76
	21	100	100	100	100	100	96	82	76
Plant height (cm)	7	0.6	1.5	1.5	1.5	1.7	1.5	1.0	1.2
	9	2.6	4.3	4.5	4.8	4.1	5.0	3.1	3.1
	11	3.5	8.9	9.4	9.9	9.5	9.3	6.1	5.4
	13	8.9	14.4	13.3	14.6	14.4	13.2	12.4	12.3
	15	12.8	18.1	17.4	18.0	19.9	15.6	13.6	13.1
	17	16.0	21.1	19.9	19.9	20.6	17.8	18.5	19.2
	19	19.0	22.4	21.4	21.0	22.0	18.8	21.3	21.7
	21	19.8	22.6	22.9	22.2	22.9	20.9	22.2	22.2
Number of leaves/plant	11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	13	1.30	1.70	1.82	1.72	1.72	1.58	1.48	1.54
	15	1.63	1.87	1.89	1.88	1.82	1.76	1.53	1.82
	17	1.77	1.89	1.98	1.89	1.93	1.84	1.80	1.85
	19	2.00	2.31	2.14	2.34	2.40	2.14	2.26	2.38
	21	2.14	2.51	2.44	2.54	2.51	2.35	2.41	2.47

differences in height of seedlings were negligible, and they did not differ from the soaked control. However, the differences in seedling height were more pronounced among different treatments of DES, but they did not show any marked variation from that of the soaked control.

Leaves/plant: Seedlings of the unsoaked control had fewer number of leaves than all other treatments. None of the mutagens however, appeared to increase the leaf number/plant as compared to the soaked control.

Field experiment

Table 2 shows the effect of both mutagens EMS and DES and the two controls on different plant traits in the field.

Survival percentage: Soaking in water as well as in three different concentrations of EMS did not show any significant influence on the survival percentage. On the other hand, the different treatments of DES had reduced the survival percentage, and the extent of reduction was proportional to the concentration applied. However, the amount of reduction was significant only at the highest two doses of DES (0.50 and 0.75%).

Plant height: The average plant height at maturity varied among all treatments. Seeds pretreated with either of the mutagens or soaked in distilled water produced plants taller than the unsoaked control. EMS at the level of 0.125% had significantly increased the average plant height over the unsoaked control, but at 0.25% the plant height was considerably reduced. DES at all the three levels of treatment reduced

Table 2. Effects of ethyl methane sulphonate (EMS) and diethyl sulphate (DES) on survival, growth, fertility and yield of *Vicia faba* L. var. *minor*.[1]

Treatment	Survival	Plant height	Branches/ plant	Leaves/ plant	Days to flowering	Pollen sterility	Pods/ plant	Seeds/ plant	Yield/ plant	100-seed weight
Control										
Unsoaked	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Soaked	112.32	101.79	96.55	100.00	100.00	94.32	92.78	96.19	115.76	122.97
EMS (%)										
0.05	97.30	106.09	89.65	94.92	100.87	176.14	104.12	112.38	121.21	116.21
0.125	100.99	108.96	89.65	92.83	101.11	203.41	87.63	96.67	110.30	124.32
0.25	110.48	93.91	75.86	75.82	100.99	217.05	75.26	74.29	75.76	114.86
DES (%)										
0.25	88.81	85.30	65.50	63.88	101.11	132.95	61.86	59.52	72.12	124.32
0.50	71.81	85.30	79.31	63.88	101.61	202.27	60.83	56.66	64.85	116.21
0.75	66.15	91.76	75.86	70.45	102.11	235.23	74.23	75.71	85.45	114.86
L S D										
(5%)	24.72	7.20	14.79	14.02	0.31	43.86	17.78	25.43	27.27	20.13
(1%)	34.30	10.02	20.51	19.46	0.43	60.91	24.67	35.29	37.82	27.95

1. Figures for various treatments are expressed as percent of unsoaked control.

plant height significantly over the soaked and unsoaked controls.

Number of branches/plant: A reduction in the number of branches/plant was observed in all treatments as compared to the unsoaked control. However, the distilled water treatment and the two lower doses of EMS (0.05% and 0.125%) did not significantly reduce the number of branches/plant. Whereas, the highest dose of EMS (0.25%) and all the three doses of DES significantly reduced the number of branches/plant.

Number of leaves/plant: The number of leaves/plant was adversely affected by both mutagens, and it was considerably reduced as compared to both controls. However, the reduction was more pronounced in DES than in EMS treatments. DES at all the three concentrations applied and EMS only at the highest concentration (0.25%) significantly reduced the number of leaves/plant.

Days to flowering: There was no effect of soaking the seeds in water on days to flowering. However, there was a slight delay in flowering date induced by both the mutagens. The days to flowering had increased with the increase in concentrations applied, and DES brought about greater delay in flowering date as compared with EMS.

Pollen sterility: Soaking of seeds in distilled water did not have any pronounced effect on the pollen sterility. But the six mutagenic treatments induced varying degrees of pollen sterility in the treated plants. The extent of pollen sterility was increased with the increase in concentration applied. A highly significant increase in pollen sterility was noted at all EMS treatments and at the highest two concentrations of DES (0.50 and 0.75%) only.

Number of pods/plant and total number of seeds/plant: Both the total number of pods and the total number of seeds/plant were reduced in all treatments except at the lowest dose of EMS (0.05%) where a slight increase was recorded. Among the DES treatments, 0.25% and 0.50% concentrations brought about a highly significant decrease in the number of seeds/plant. However, among the EMS treatments only the highest concentration (0.25%) significantly reduced the number of seeds/plant.

Yield/plant: Seed yield/plant at the two lower doses of EMS (0.05 and 0.125%) as well as that of the soaked control showed a slight improvement over the unsoaked control. However, a marked reduction in seed yield was recorded in the highest dose of EMS and all the three treatments of DES. The reduction in seed yield over that of the unsoaked control was significant at 0.25 and 0.75% of DES only. But, when compared with the soaked control the reduction in yield was highly significant in all the three doses of DES and at the highest dose of EMS (0.25%).

100-seed weight: An increase in the 100-seed weight over the unsoaked control was recorded among all the treatments. However, this increase was significant only at 0.125 and 0.25% of EMS and DES, respectively. The soaked control also showed an increase in seed weight over that of the unsoaked control.

Discussion

Chemical and physical mutagens are known to produce adverse effects on germination, seedling growth, and plant growth in M_1 generation. Delayed maturity, varying degrees of sterility, and reduced survival are other features recorded in M_1 generation after mutagen treatments (Blixit 1960; Sjodin 1962; Nerkar 1970; Goud 1972; Sinha and Godward 1972; Dixit and Dubey 1981). The above mentioned attributes are generally taken as an index of the efficiency of various treatments in inducing mutations. Both the chemical mutagens applied during the present study produced adverse effects on germination, seedling growth, pollen fertility, maturity and survival. Concentrations of DES applied were more effective than those of EMS in most cases.

Growth and yield parameters including plant height, branching, leaf number, pod number, seed number, and yield/plant were affected by EMS and DES in various ways. DES at all concentrations applied and EMS only at the highest concentration (0.25%) produced significant adverse effects on all these traits. On the other hand, lower concentrations of EMS, slightly promoted these traits or had no significant influence on them. Growth promoting effects of mutagens when applied at low doses have earlier been recorded in a number of crops (Sax 1963; Singh *et al.* 1978; Venkteshwarlu *et al.* 1978; Trivedi and Dubey 1982).

Thus concentrations of DES used in the present study appeared to have more pronounced effects on growth and fertility in M_1 generation than those of EMS. EMS was effective only at the highest concentration (0.25%). An interesting observation of the present study is the increase in seed weight, which may indicate a possibility of isolating bold seeds in later generations.

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تأثير Ethyl Methane Sulphonate (EMS) و Diethyl Sulphate (DES) على انبات ونمو وخصوبة وغلة الفول Vicia faba L.

ملخص

عوملت بذور من الفول Vicia faba var minor بمحلول (EMS) بجرعات 0.05 % ، 0.125 % و 0.25 % ، وبمحلول (DES) بجرعات 0.25 % ، 0.50 % ، و 0.75 % . وقد تأثر عكسيا كل من : الانبات ، ونمو البادرات ، وخصوبة حبوب اللقاح ، وفترة النضج وبقاء survival النباتات ، بكل من المادتين المطفرتين . وقد أظهرت صفات طول النبات ، والتفرع ، وعدد الاوراق والقرون والبذور ، وكذلك غلة النبات الواحد استجابات متباينة لمختلف تراكيز المطفرين . من ناحية ثانية كان لـ DES عند جميع الجرعات و EMS في أعلى جرعة فقط تأثيرات عكسية على هذه الصفات ، في حين لم يكن للجرعات الادنى من EMS أى تأثير ، أو كان لها تأثيرا محفزا طفيفا .

Agronomy and Mechanization

المعاملات الزراعية والمكننة

Effect of Nitrogen Nutrition on the Production and Quality of Two Cultivars of Vicia faba L. var major in a Mediterranean Area (Spain)

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Abstract

The yield of two cultivars of *Vicia faba* var *major* (Reina Mora and Reina Blanca) were studied for two consecutive seasons. The effects of two levels of nitrogen fertilizer applied as ammonium nitrate or ammonium sulfate and the date of fertilizer application on yield and protein content was also determined. Treatment with either source of N resulted in an increased yield of cv Reina Blanca, whereas it reduced the yield of cv Reina Mora. In contrast with yield, the protein content was decreased in R. Blanca and increased in R. Mora seeds.

Introduction

Reports concerning the effect of nitrogen application on the production and symbiotic nitrogen fixation of legumes show contradictory results depending on the experimental conditions. In general, it is accepted that combined nitrogen inhibits not only the nitrogenase activity but also the root infection and nodule development (McEwen *et al.* 1981). However, Rigaud (1981) reported a positive response to N fertilizer of several legumes (increased nodulation and N fixation) when adequate amounts of N fertilizer were supplied. Roughley *et al.* (1983) found that faba bean could tolerate high levels of mineral N.

This work aimed to determine the optimum level and time of N application to improve the production and protein content of two faba bean cvs Reina Mora and Reina Blanca. Two N applications were tested; the first at the beginning of the intense vegetative growth phase and the second during the pod filling stage. Both periods correspond to maximum N demand by the plant.

Materials and Methods

Plants of the two faba bean cultivars Reina Mora and Reina Blanca were selected for this test. The experimental field was located at Barcelona. Two trials were conducted for two consecutive seasons (1983-1984) on a mollic xerofluvents soil with a sandy loam texture and a soil pH of 7.8 (Fransi *et al.* 1986).

Seeds of each cultivar were sown on 31 Jan 1983 in 8 plots (10 x 0.8 m) in rows 5O cm apart. A randomised block design was used with two replicates. After emergence, 12 plants were kept in each plot. Four treatments with ammonium nitrate were used: (0 and 70 kg N/ha applied after 33 days from sowing, 70 kg/ha applied 97 days from sowing, and 140 kg N/ha applied in two equal split doses at 33 and 97 days after sowing). On day 33 plant height was 17 ± 2cm, corresponding to the beginning of the intense vegetative growth phase, and on day 97 the plant height was 70 ± 5 cm and pods had appeared. At the 97 day the plants of R. Blanca were more vigorous than those of R. Mora but R. Mora showed larger pods and some of them were completely formed.

During the second season (1983/84), the field was divided into 56 randomized plots 3 m^2 each (4.3x0.7 m) and seven treatments with two different sources of N (ammonium nitrate and ammonium sulfate) were used. Eight plots (four for each cultivar) were used as control with 0 N. Of the remaining 48 plots each 24 plots were supplied with 180 kg N/ha of either NH_4NO_3 or $(NH_4)_2SO_4$ in one dose at 54 or 103 days after sowing, and in two equal split doses at 54 and 103 days after sowing. On day 54 faba bean plants were at the vegetative phase (plant height was 25 ± 5 cm) and on day 103 at the pod filling stage.

Production was expressed in dry weight. For dry matter determination, plant tissues were oven dried (105°C) to constant weight. Protein was assayed by the

Kjeldahl method, which measures total-N. The factor 6.25 was used to convert N to its crude protein equivalent.

Results

Pod and seed production

The two faba bean cvs Reina Mora and Reina Blanca responded differently to N applications during the two seasons (Tables 1 and 2).

In the first experiment, Reina Mora produced the highest yield of pods when 70 kg N/ha was supplied at the beginning of the intense vegetative growth (33 days after sowing), whereas lower yields were obtained when the same level of N was applied during the grain filling stage (97 days after sowing). However, higher percentages of seeds/pod (82.6±1.2) were obtained when N fertilizer was applied late in the season (Table 1) indicating that the late applied N was mainly used for seed filling.

Of the four treatments assayed in experiment 1, the nitrogen fertilizer did not increase seed production of R. Mora plants. The highest values were recorded in the control plots, which produced 3842±33 kg/ha of dry seeds, whereas plants supplied with 140 kg of N/fertilizer had the lowest seed yield (3418±147 kg/ha). However, in Reina Blanca, pod and seed production were increased with increasing rates of N fertilizer. When 140 kg N/ha was applied the dry weights of pods and seeds were 6997±293 and 5668±352 kg/ha, respectively. This represents 10% increase in pod and seed production as compared with the control (Table 1).

The results obtained during the second year of experimentation were similar to those of the first one (Table 2). Reina Mora did not show any response to N fertilization and its yields of pods and seeds were lower than the control, whereas R. Blanca yielded 22% to 31% higher than the control.

Protein content

Table 1 shows that seeds of cv Reina Mora, obtained from fertilized plots, where higher in their protein content than those of the control. However, the highest content of crude protein (23.8±2.1%) was reached when 70 kg of N/ha was applied 33 days after sowing and the lowest (20.8) when no N was supplied, whereas, in Reina Blanca, the highest content of crude protein

Table 1. Effect of level of N fertilizer, date of application (early and late fertilization correspond to fertilizer applied 33 and 97 days after sowing, respectively), and cultivar, on yield and % crude protein of faba bean cvs Reina Mora and Reina Blanca.

Trait	Cultivar	0 kg N/ha (control)	70 kg N/ha (early)	70 kg N/ha (late)	140 kg/ha (early and late)
Pod yield (kg DW/ha)	R. Mora	4487±398[a]	4773±373	4641±181	4557±101
	R. Blanca	6236±413	6389±285	6225±800	6997±293
% Dry weight	R. Mora	84.1±6.8	88.1±1.5	82.7±3.0	86.8±2.5
	R. Blanca	89.9±1.1	83.9±2.9	86.2±2.9	85.7±4.8
Seed yield (kg DW/ha)	R. Mora	3842±330	3561±362	3836±189	3418±147
	R. Blanca	5092±237	4656±451	5057±340	5668±352
% Seed:pod	R. Mora	85.6±6.9	74.6±1.8	82.6±1.2	75.0±4.9
	R. Blanca	81.6±0.2	72.8±2.3	81.2±5.5	81.0±1.6
% Crude protein in seeds	R. Mora	20.8±0.0	23.8±2.1	22.1±0.7	22.9±0.1
	R. Blanca	23.1±0.7	22.1±2.0	21.3±0.6	21.1±1.4
Protein yield (kg DW/ha)	R. Mora	799±800	847±164	848±710	783±390
	R. Blanca	1176±310	1029±500	1077±400	1196±158

a. Each figure represents the mean of two plots (24 plants) ± SE.

Table 2. Effect of source of N (ammonium nitrate and ammonium sulphate) and date of application (early and late fertilization correspond to fertilizer applied 54 and 103 days after sowing), on pod and seed productions of faba bean cvs Reina Mora and Reina Blanca.

Trait	Cultivar	0 kg N/ha (control)	180 kg N/ha (early application)		180 kg N/ha (late application)		(90 + 90) kg N/ha (early and late applications)	
			A/N	A/S	A/N	A/S	A/N	A/S
Pod yield (kg DW/ha)	R. Mora	6370±317[a]	5804±308	5875±282	5053±311	6347±378	5656±406	5939±155
	R. Blanca	5586±614	7089±490	6932±502	6929±365	6588±730	6819±401	7141±340
Seed yield (kg DW/ha)	R. Mora	5115±254	4772±227	4707±196	4051±280	5143±219	4556±323	4721±118
	R. Blanca	4476±470	5803±385	5578±428	5714±322	5476±613	5490±354	5867±292
% Seed:pod	R. Mora	80.3±1.0	82.2±0.9	80.1±0.6	80.2±1.4	81.0±1.5	80.5±0.9	79.5±0.3
	R. Blanca	80.1±0.8	81.8±1.6	80.5±1.5	82.5±0.6	83.1±0.9	80.5±1.2	82.1±0.4

a. Each figure represents the mean of four plots (24 plants) ± SE.
A/N = Ammonium nitrate.
A/S = Ammonium sulphate.

(23.1±0.7%) was found in the untreated control and increased levels of N fertilization reduced the protein content. At 140 kg N/ha the protein content was lowest (21.1±1.4%).

Our results suggest a negative correlation between seed production and seed protein content.

Discussion

From the results of the two experiments, it is evident that Reina Mora produced lower yields of pods and seeds than those of Reina Blanca. However, it is an early cultivar and therefore it produces higher economic benefits.

Reina Blanca responded positively to N fertilization especially when 180 kg N/ha was applied. Thus, it did not derive sufficient N from symbiotic fixation.

Ammonium sulphate gave the best results when 180 kg/ha was supplied in two split doses 90 kg each. However, single application (180 kg/ha) reduced root and shoot development, possibly by affecting soil pH. Similar results were obtained by Joseph *et al.* (1976) in soybean.

The protein content of R. Mora seeds was increased by all N applications. In contrast, the protein content of R. Blanca seeds was not affected by additions of N. This is probably because of the dilution effect produced by the increase in dry matter production. However, crude protein yields were always higher in cv R. Blanca than in cv R. Mora.

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تأثير التغذية الازوتية على انتاج ونوعية صنفين من الفول (Vicia faba L. var major) في منطقة بحوض المتوسط (اسبانيا)

ملخص

درست غلة صنفين من الفول Vicia faba L. var major (Reina Blanca و Reina Mora) على امتداد موسمين متعاقبين ، وحددت أيضا تأثيرات مستويين من السماد الازوتي — المضاف على شكل نيترات امونيوم او كبريتات (سلفات) امونيوم — وموعد اضافة السماد على الغلة والمحتوى البروتيني . وقد أدت المعاملة باى من السمادين الازوتيين الى زيادة في غلة الصنف R. Blanca وانخفاض في غلة الصنف R. Mora . وعلى عكس الغلة انخفض المحتوى البروتيني في بذور الصنف R. Blanca ، وازداد عند الصنف R. Mora .

Effect of Time of Harvest on Physical and Chemical Compositions, Cookability, and Yield of Faba Bean

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Abstract

Studies were carried out at Shambat and New Halfa locations in Sudan. The effect of time of harvest on seed yield and its components was highly significant. Seed yield increased as the harvesting was delayed. The seed size increased progressively till it reached the maximum at 110-120 days and started to decrease gradually till 140 days. At Shambat locality plants at 120 days gave seeds of larger size, higher hydration coefficient, good cookability, and lower percentage of non-soakers. The same results were obtained at New Halfa from plants at 110 days. The most convenient and practical method for reducing non-soakers is to soak the faba beans in hot water, or to immerse them in boiling water for 5 min, or to steam the beans for 5 min before soaking. The chemical composition did not offer an explanation for the difference in the percentage of non-soakers at the different plant ages.

Introduction

In Sudan, farmers tend to harvest the faba bean crop before full maturity to benefit from the relatively high prices at a time when supplies are short. However, this practice may adversely affect seed yield and quality.

Reports show that optimum time to harvest varies from one location to another. Ageeb (1980) and Salih (1983) found that harvesting the crop at 110-120 days after sowing gave maximum yield, and delaying harvest to 130-140 days from sowing reduced the yield by 10%. However, Salih and Ali (1986) obtained maximum yield from 100-day old plants and harvesting the crop at 110 and 120 days from sowing, reduced yield by 6.8% and 16.8%, respectively.

In Sudan, faba bean is mainly grown for human consumption, so the incidence of hard seed adversely affects cooking quality and therefore, the marketing value of the product (Salih *et al.* 1986). Ageeb (1980) reported that faba bean can be produced economically in the new areas south of Khartoum, but the quality is poor, because many of the seeds are hard.

The present work was undertaken to study the effect of time of harvest on faba bean seed yield and quality at two different locations, i.e. Shambat and New Halfa. The aim was to determine the optimum time to harvest for maximum yield and better seed quality. Different methods to overcome the problem of hard seed were evaluated, and the physico-chemical composition of seeds was determined.

Materials and Methods

Seeds of the faba bean variety BF 2/2 were planted by hand on 27 and 30 Oct 1986 at Shambat and New Halfa Research farms, respectively. Treatments of time of harvest were arranged in a randomized block design with four replicates. Harvesting was done at 90, 100, 110, 120, 130, and 140 days after sowing. Total seed yield was recorded for each plot. Pods/plant and seeds/pod were determined from 20 randomly selected plants/plot. The seed quality characteristics studied were percentage non-soakers, hydration coefficient (HC), cooking quality, and chemical composition. For each plant age, 1000 seeds were selected at random and soaked in tap water at a ratio of 1 part of seed to 4 parts of water for 16 h. The hard seeds (non-soakers) were counted and recorded as percentage.

The hydration coefficient (HC) was calculated from the equation:

$$HC\ (\%) = \frac{\text{Weight of soaked beans}}{\text{Initial weight}} \times 100$$

To test cooking quality, the samples from each plant age were cooked, using Labconco apparatus, for 30 min in 200 ml of water. The cooking quality was assessed as the increased weight after processing (IWP) and was calculated from the equation:

$$IWP\ (\%) = \frac{\text{Weight of beans after cooking}}{\text{Weight of beans before cooking}} \times 100$$

Samples of each plant age were ground and analyzed for their total ash, calcium, magnesium, and crude fiber content according to Pearson (1970). Protein content was determined by the Kjeldahl method. Tannic acid content was determined according to Ranganna (1977). Phytic acid content was carried out by Wheeler and Ferrel (1971) method as modified by Hussein (1986).

To investigate whether the hard seededness could be corrected, various seed soaking treatments were investigated. The hard seeds were either treated with hot or cold water or soaked in boiling water or steamed for various lengths of time (5, 10, and 15 min) before immersing them in cold water for 16 h, or treated with 0.2 % sodium bicarbonate solution for 16 h. After these treatments, percentage of seeds that imbibed water was calculated.

Results and Discussion

The effect of time of harvest on grain yield and its components at Shambat and New Halfa was significant. At both locations, grain yield increased significantly by delaying harvest from 90 to 120 days after sowing.

Seed quality

The plant age showed a highly significant ($P < 0.01$) effect on seed size (Table 1). In both locations, the seed size progressively increased as harvest was delayed from 90-120 days from sowing, then it started to decrease gradually and reached the minimum at 140 days. These results are in agreement with the findings of Salih and Ali (1986). In general, seed size was larger in Shambat at all plant ages than in New Halfa.

In both localities, there were no significant differences between harvesting dates for hard seed (non-soakers) percentage (Table 1). However, the highest value was recorded from seeds harvested at 90 days from sowing. Then there was a gradual decrease as harvest was delayed from 90-120 days from sowing. The percentage of non-soakers seeds was generally lower in New Halfa.

In both locations, the highest hydration coefficient, and the best cookability, were obtained from plants which were 120 days old (Table 1).

It is evident from the above that plant age has a significant effect on seed quality of faba bean.

Table 1. Mean effect of plant age on seed quality.

Plant age (days)	1000 seed weight (g)		Non-soakers (%)		Hydration coefficient (%)		IWP (%)	
	Shambat	New Halfa	Shambat	New Halfa	Shambat	New Halfa	Shambat	New Halfa
90	318.3	331.3	28.3	12.2	185.0	195.4	20.0	11.5
100	382.0	330.0	20.9	8.0	185.7	198.1	23.0	13.5
110	403.0	354.7	18.1	8.0	184.7	196.4	33.0	22.0
120	414.3	363.3	12.7	3.5	187.2	202.6	33.5	23.5
130	403.4	362.0	15.5	6.1	187.8	201.3	22.5	15.5
140	312.4	355.3	15.2	6.1	181.4	206.3	30.6	11.5
SE±	18.5	6.7	2.3	1.3	0.9	1.7	2.4	2.2
Mean	372.2	349.4	18.5	7.4	185.3	200.0	27.0	163.0

Harvest at 120 days gave seeds of larger size, lower percentage of non-soakers, higher hydration coefficient, and better cookability than harvest at other stages.

Treatment of hard seededness

Soaking of hard seeds in tap water (cold treatment) gave a lower percentage of soakable beans than all other treatments (Table 2). Soaking in hot water gave a high percentage of soakable beans. The same trend was obtained when soaking was made in 0.2% sodium bicarbonate solution. Immersion of hard seed in boiling water for 5, 10, and 15 min gave a higher percentage of soakable beans than the steaming treatment. Because the differences between 5, 10, and 15 min of immersion or steaming were not significant, we recommended the use of the 5 min treatment as a practical and economic method to overcome the problem of hard seed in cooking.

Table 2. The efficacy of different treatments in converting non-soakable beans to soakable ones.

Treatment	Soakable beans[1] (%)
Tap water	34.0
Hot water (added after boiling)	71.5
Sodium bicarbonate (0.2%)	
cold	42.5
hot	75.0
Boiling water	
5 min	85.0
10 min	89.0
15 min	89.5
Steaming	
5 min	76.0
10 min	76.0
15 min	80.5

1. Percentage of seeds that become soakable after applying different treatments on non-soakers.

Also, it is possible that storage conditions could play a role in altering non-soakable beans to soakable ones. Therefore, further investigations to determine the effect of storage conditions on the incidence of hard seeds are needed.

Chemical analysis

Table 3 shows the chemical composition of the different samples from the two localities.

The variation in phytic acid content among the different harvesting dates was not significant in each locality. But it was significant ($P < 0.01$) between the two localities. Shambat locality showed the highest phytic acid content at 100 and 110 days (0.08%) and the lowest (0.02%) at 120 days (Table 3). In contrast, in New Halfa the highest value (0.06%) was obtained at 120 days. The results of our study show that there is no definite relationship between phytic acid content and percentage of non-soakers. This is in agreement with Herderson and Ankrah (1984) who reported that there is no relationship between the cookability index and either phytase or phytic acid content.

Significant differences in tannic acid content due to time of harvest were observed in Shambat but not in New Halfa (Table 3).

At the plant age of 110 and 120 days, the percentage of non-soakers in both localities was minimum (Table 2). This may indicate that there may be

Table 3. Approximate chemical analysis of whole seeds of *Vicia faba*. Mean value expressed on dry weight basis and the standard error of mean.

Time of harvest from sowing	Protein (%)		Phytic acid (%)		Tannic acid (%)		Ash (%)		Crude fiber (%)	
	Shambat	New Halfa	Shambat	New Halfa	Shambat	New Halfa	Shambat	New Halfa	Shambat	New Halfa
90 days	31.2±0.3	32.3±0.1	0.03±0.03	0.01±0.0	0.04±0.0	0.05±0.01	3.3±0.03	3.2	8.3±0.2	7.8±0.02
100 days	31.6±1.7	32.1±2.0	0.08±0.03	0.04±0.02	0.09±0.03	0.05±0.0	0.0±0.01	3.2	7.0±0.2	7.2±0.01
110 days	32.8±3.6	33.0±0.1	0.08±0.03	0.02±0.0	0.05±0.0	0.03±0.0	2.8±0.02	3.3	6.7±0.3	7.3±0.01
120 days	33.5±4.1	29.5±2.8	0.02±0.0	0.06±0.03	0.03±0.01	0.05±0.0	2.8±0.05	3.4	7.2±0.2	7.2±0.01
130 days	32.1±0.1	27.2±3.7	0.07±0.02	0.04±0.02	0.02±0.0	0.05±0.0	3.0±0.04	4.1±0.2	7.6±0.1	8.0±0.07
140 days	28.5±0.8	28.2±0.1	0.05±0.0	0.02±0.0	0.90±0.01	0.04±0.01	2.9±0.04	3.1±0.01	6.7±0.1	7.7±1.2

some relationship between non-soakability and tannic acid content which requires further confirmation.

The difference in ash and phytic acid content in the two localities was highly significant ($P < 0.01$), but these differences did not relate to differences in the percentage of non-soakers in seeds harvested at the different plant ages.

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تأثير موعد الحصاد على المكونات الفيزيائية والكيمائية وعلى طبخ وغلة الفول ٠

ملخص

اجريت الدراسات في شمباط وحلفا الجديدة في السودان وكان تأثير موعد الحصاد على الغلة البذرية ومكوناتها معنويا جدا ؛ فقد ازدادت الغلة مع تأخير الحصاد ٠ اما حجم الحبة فقد ازداد بشكل مضطرد حتى وصل الى حد اعظمي بعد 110 - 120 يوما ، ثم بدأ بالتناقص تدريجيا بالوصول الى 140 يوما ٠ وفي موقع شمباط أعطت النباتات بعمر 120 يوما بذورا بحجم أكبر ، ومُعامِل إماهة (تميُّه) اعلى ، وقابلية طبخ جيدة ، ونسبة مئوية دنيا من الحبات الطافية (غير المتشربة) ٠ وتم الحصول على نتائج مماثلة في حلفا الجديدة من نباتات بعمر 110 أيام ٠ ان اكثر الطرق الملائمة والعملية لتقليل كمية الحبات الطافية تتمثل بنقع بذور الفول في مياه حارة ، او غمرها في ماء مغلي لمدة خمس دقائق ، او تعريضها للبخار لمدة خمس دقائق قبل نقعها ٠ ولم يظهر التركيب الكيميائي اى تفسير للفرق في النسبة المئوية للحبات الطافية عند أعمار مختلفة للنباتات ٠

Pest and Disease

الآفات والأمراض

Effect of Growth Regulator 6-Benzylamino Purine and Dithane M-45 on Chocolate Spot Disease and Growth of Faba Bean Plants

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Abstract

The effects of the growth regulator 6-benzylamino purine (6-BAP) and Dithane M-45 on the development of chocolate spot disease (*Botrytis fabae* Sard.) and also on the growth parameters of faba bean were studied. Four treatments were employed, of which one was kept as control and the other three were sprayed four times, at 10-day intervals, with 6-BAP (20 mg/l), Dithane M-45 (2.5 g/l), and mixed application of 6-BAP and Dithane M-45, respectively. A significant reduction was observed in the severity of *B. fabae*, judged by lower lesion grade, slower lesion spread and fewer spore formations, compared with the control. Of the plant traits studied, shoot weight/plant was most affected by 6-BAP application. Among all treatments the differences for nodes/plant, shoot length, root length and weight were not significant.

Introduction

Several methods have been used to control or reduce the severity of chocolate spot disease of faba bean (*Botrytis fabae* Sard.); including breeding for resistance or tolerance (Abo-blan 1983), application of fungicides (Mohamed 1982), and biological control, which showed, under specific conditions, a limited success (Gullino and Bazzano 1982).

Application of growth regulators has been reported to decrease severity of some pathogens (Moore and Leach 1968; Tani *et al.* 1971). The inhibitory action was either direct on the pathogen or through changing the host's metabolism process. However, growth regulators failed to inhibit development of some other pathogens (Bailiss *et al.* 1977).

Several factors may affect the efficacy of growth regulators; applying dosage (Selman 1964), time of application (Aldwinckle 1975), plant age (Fletcher *et al.* 1968), and environmental conditions (Keller and Bellucci 1983).

In general, the aim of applying growth regulators to faba bean plants is to improve the quantity and quality of grain yield. Keller and Bellucci (1983) claimed that seed germination, root growth, shoot growth, yield components (pod set/node, number of nodes, and seeds/pod), photosynthetic activity, and protein content might be affected by growth regulator application. Recently, Standish (personal communication) claimed that applications of the growth regulator 6-BAP had improved the yield performance of faba bean. However, reports concerning the role of exogenously supplied growth regulators on faba bean plants have been contradictory (McEwen 1970; Diethlem *et al.* 1986).

The present work was undertaken to study the effect of the growth regulator 6-benzylamino purine (6-BAP) alone, or in combination with the fungicide Dithane M-45 on the development of chocolate spot disease and also on the growth parameters of faba bean plants.

Materials and Methods

In the 1986/87 season, seeds of the faba bean cv Giza 2 were sown in 30-cm pots containing clay soil at Bahtim Agricultural Research Station, Egypt. At the beginning of flowering stage, four similar 60-day old plants were selected and kept in each pot for further studies. Each treatment was replicated five times, and plants were sprayed four times, at 10-day intervals as follows:
1) untreated (control), 2) sprayed with 6-benzylamino purine (20 mg/l) mixed with 2 ml/l of tween-20, 3) sprayed with Dithane M-45 (2.5 g/l), and 4) mixed application of 6-BAP and Dithane M-45 using the same doses.

Ten days after the last application, intact leaves from each treatment were excised, and immediately transferred to the laboratory for the detached leaves test. The cut ends of the leaves were wrapped in wet absorbent cotton, and placed inside sterilized petridishes (15 cm in diameter) with close-fitting lids. The petridishes were previously lined with wetted tissue paper and covered with plastic mesh, to provide suitable environment for fungal development, and also to prevent direct contact between the leaves and moistened tissue paper.

Droplets (10 μ l) of *B. fabae* conidial suspension were placed on the abaxial surface of the leaves using an "Agla" micrometer syringe. Four drops were applied to each leaflet, 2 on each side. Inoculated leaves were incubated at $20 \pm 3^{\circ}C$, and development of *B. fabae* was assessed according to the key of Mansfield and Deverall (1974):

Infection grade

Represents the percentage of browning or blackening of the abaxial leaf surface beneath the inoculum droplets one and three days after inoculation.

Lesion spread

Represents the spreading beyond the inoculum droplets towards the uninoculated tissue recorded from the infection site seven days after inoculation.

Sporulation

Graded according to density of sporulation 0, +, ++, and +++ representing nil, few, moderate, and dense sporulation, respectively.

Plant growth parameters

The following plant growth parameters were measured 20 days after the last application of 6 BAP and/or Dithane M-45: number of nodes, shoot length (from stem base to the top of the youngest leaf), shoot fresh weight, shoot dry weight (after drying at 70°C), length of the root (from root tip to the stem base), and root fresh and dry weights.

Results

Faba bean leaves pretreated with 6-benzylamino purine and/or Dithane M-45 showed less susceptibility to *B. fabae* than untreated leaves (Table 1 and Fig.1). Differences in infection grades were noticed one day after inoculation, but after three days they became more evident. Treatments with 6-BAP and/or Dithane M-45 prevented sporulation of the fungus, and also limited the spread of lesions (Table 1).

Table 2 shows the effect of 6-benzylamino purine and/or Dithane M-45 on faba bean growth parameters. It is clear that shoot length, root length, and root fresh and dry weights did not differ from the check. However, the fresh shoot weight of plants treated with the growth regulator (6-BAP) was increased and their leaves were thicker and slightly rougher than plants which had received other treatments.

Discussion

Pretreating with the growth regulator 6-benzylamino purine and/or Dithane M-45 had significantly reduced the severity of chocolate spot disease. However, the mechanism by which the growth regulator 6-BAP affects the development of chocolate spot disease is complicated. Nevertheless, some researchers have attributed the inhibitory effect of 6-BAP to different mechanisms--physiological changes (Moore and Leach 1968; Omar *et al.* 1986), increased phytoalixin concentration (Mukhopadhyay and Purkayastha 1981; Mansfield 1982), decreased levels of sugars and amino acids (Omar 1984), and increased Ca^{++} ion in the leaf tissue (Deverall and Wood 1981). From our results, the leaf thickness observed in 6-BAP-treated plants may have partially retarded the spores of *B. fabae* from penetrating and growing within leaf tissue.

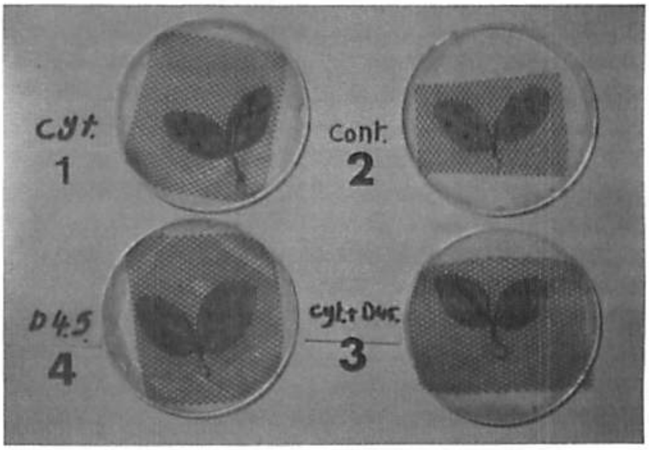

Fig. 1. Effect of 6–benzylamino purine and/or Dithane M–45: 1) 6–BAP, 2) control, 3) 6–BAP+Dithane M–45, and 4) Dithane M–45 on *Botrytis fabae* development.

Table 1. The effect of 6-benzylamino purine (6-BAP) and Dithane M-45, alone or in combination, on the development of chocolate spot (*B. fabae* Sard.) disease on faba bean cv Giza 2.

Treatment[1]	Lesions grades[2]		Lesions spread (mm)	Sporulation[3]
	1 day after inoculation	3 days after inoculation	7 days after inoculation	10 days after inoculation
6-BAP (20 mg/l)	2.5	13.2	0.1	0
Dithane M-45 (2.5 g/l)	0.5	5.6	0.0	0
6-BAP (20 g/l) + Dithane M-45 (2.5 g/l	1.8	8.7	0.1	0
Untreated control	8.5	71.5	3.1	+++
LSD (5%)	1.3	7.2	0.03	

1. Each treatment was applied four times, at 10-day intervals.
2. Values are mean of 40 inoculum sites.
3. 0, +, ++, +++, = nil, few, moderate, and dense sporulation, respectively.

Table 2. The effect of 6-benzylamino purine (6-BAP) and/or Dithane M-45 on the different growth parameters of faba bean cv Giza 2 plants.

Treatment[1]	Number[2] of nodes/ plant	Shoot length (cm)	Shoot fresh weight/plant (g)	Shoot dry weight/plant (g)	Root length (cm)	Root fresh weight/plant (g)	Root dry weight/plant (g)
6-BAP (20 mg/l)	17.9	54.9	10.8	3.3	17.1	4.5	1.0
Dithane M-45 (2.5 g/l)	17.3	48.2	8.2	2.7	17.2	4.5	1.1
6-BAP (20 mg/l) + Dithane M-45 (2.5 g/l)	17.2	51.5	8.4	3.0	17.4	4.4	1.0
Untreated control	18.3	49.1	7.1	2.1	17.0	4.0	0.8
LSD (5%)	NS	NS	1.5	NS	NS	NS	NS

1. Each treatment was applied four times, at 10-day intervals.
2. Values are mean of 20 replicates.

Further experiments should be planned to study the inhibitory effect of the growth regulator 6-BAP against pathogens other than *B. fabae*, and also to study its effect on yield performance of faba bean crop.

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تأثير منظم النمو 6-Benzylamino Purine (6-BAP) والدايثين M-45 على مرض التبقع الشوكولاتي ، وعلى نمو نبات الفول

ملخص

تمت دراسة تأثيرات منظم النمو 6-Benzylamino Purine (6-BAP) والدايثين M-45 على تطور مرض التبقع الشوكولاتي (Botrytis fabae Sard.) ، وايضا على معايير النمو عند نباتات الفول . وقد درست اربع معاملات ؛ واحدة منها كشاهد غير معامَل ، وثلاث معاملات بالرش اربع مرات بفاصل زمني قدره عشرة ايام باستخدام 6-BAP (20 مغ/ل) ودايثين M-45 (2.5 غ/ل) ، وبالاثنين معا على التوالي . وقد لوحظ حدوث انخفاض معنوى في شدة الاصابة ب B. fabae متجليا بانخفاض حجم الضرر ، وبطء انتشار البقع المرضية ، وقلة تشكل الابواغ مقارنة بالشاهد . ومن بين الصفات النباتية المدروسة كان وزن الفروع/النبات أكثرها تأثرا باضافة 6-BAP . كما ان الفروق بين جميع المعاملات لعدد العقد/النبات ، وطول الفروع ، وطول الجذور ووزنها كانت غير معنوية .

Evaluation for Tolerance to Broomrape in a Germplasm Collection of Vicia faba L.

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Abstract

Populations of faba bean (*Vicia faba* L.) of different origin were tested for their tolerance to broomrape (*Orobanche crenata* Forsk.). Evaluation was carried out at Valenzano (Bari) for two years in naturally infested field plots. During growth, traits concerning host plant and parasite were recorded. Tolerant accessions and highly tolerant plants within accessions were identified.

Introduction

In Southern Italy, especially in Sicily, broomrape (*Orobanche crenata* Forsk.) frequently limits yields of faba bean and sometimes completely destroys the crop (Polignano 1979). Seed yield reduction caused by competition with broomrape at different densities has been reported by Mesa Garcia and Garcia Torres (1982).

As control measures, Cubero and Moreno (1979) recommended growing faba bean on new fields not previously planted to this crop, using trap crops and germination-stimulating substances, and sowing tolerant and early cultivars. Similarly Ciccarone and Piglionica (1979) call for the use of tolerant cultivars pointing out that so far faba bean has not been sufficiently studied by pathologists and breeders. Fumigants (Ciccarone *et al.* 1962; Piglionica 1973, 1975) have been shown to be highly effective against broomrape, however they are costly, and the government has restricted the use of some of their active ingredients. Much the same can be said of some herbicides (glyphosate, pronamide) that can control *Orobanche* in faba bean (Zahran *et al.* 1981; Abdalla *et al.* 1983; Nassib *et al.* 1985; Miccolis and Bianco 1984, 1986).

In the last few years, plant breeders have been trying to identify and breed plants resistant or tolerant to broomrape. To reach the objective they must screen large collections (Cubero and Moreno 1979). Hernandez *et al.* (1984), analysing populations from inbred lines, and segregating generations, found that there is no dominance for the genetic control of resistance and that *Orobanche* reduces seeds yield of faba bean/plant, through pods/plant rather than through seeds/pod.

Recently Kukula and Masri (1985) developed a greenhouse technique for screening a large number of faba bean genotypes. As an alternative, we recommend screening on fields where *Orobanche* seeds are dense. Our experience suggests it is an inexpensive and practical method for identifying tolerance in large collections. The objective of this paper is to present and discuss the results of field screening of several accessions selected from a world collection of *V. faba* L.

Materials and Methods

At Valenzano (Bari) during 1984/85, plants of 24 accessions of *Vicia faba* L. (19 of different origin, 1 cultivar, and 4 local varieties) were grown in a field naturally infested with broomrape. The next season (1985/86), a different set of 23 accessions was grown in the same field. The local variety Locale di Castellana was included in both years as a check. Each year 100 kg P_2O_5/ha was applied at sowing in November.

The experimental design was a randomized block with three replicates. Thirty plants were grown per plot (50 cm between rows and 40 cm between plants within row). In both years a field free of broomrape was planted with the same experimental material for an indication of potential yield. The criterion for tolerance to broomrape was arbitrarily chosen -- number of faba bean seeds per infested plot. When fewer than 10 seeds/infested plot were harvested, the accession was considered to be highly susceptible (S); when 10 - 100, susceptible but with probable tolerance (t); and when more than 100, tolerant (T).

During growth, data were recorded on agronomic traits of faba bean plants (host) and some features of broomrape, including: 100 - seed weight (g) before seeding (SW); number of host plants at emergence (NHPE); number of host plants at flowering time (NHPF); days to flowering of host plants (FTHP); height (cm) of host plants at flowering (HHPF); number of spikes of broomrape at flowering of host plants (NSBF); number of spikes of broomrape at harvesting time of host plants (NSBH); height (cm) of spikes of broomrape at harvesting time of host plants (HSBH); number of host plants at harvesting time/infested plot (NHIP); number of pods at harvesting time/infested plot (NPIP); number of faba bean seeds/infested plot (NSIP); number of faba bean seeds/uninfested plot (NSSP).

The data related to agronomic traits recorded during growth were statistically analyzed.

Results and Discussion

Among the 24 accessions studied in 1984/85 seed weight ranged from 60 to 238 g (Table 1), host plants at emergence ranged from 28 to 30 plants/plot and at flowering from 27 to 30 plants/plot. Flowering time was 125 - 135 days, and height of host plants at flowering was 31 - 57 cm. There were no spikes of broomrape at flowering time but, at harvest, the number of spikes varied from 26 to 164 and spike height from 13 to 29 cm. The number of host plants, pods, and seeds per infested plot ranged from 0 to 13, 0 to 47, and 0 to 147, respectively (Table 1).

Among the 23 accessions tested in 1985/86 seed weight ranged from 37 to 201 g (Table 1) and, as with the first set of accessions, host plants at emergence and at flowering varied little, ranging from 24 to 29 plants/plot. Flowering time was at 104 - 107 days and was much shorter than for the group of the previous year (125 - 135 days). The height of host plants ranged from 17 to 31 cm. As in the previous year there were no spikes of broomrape at flowering time but by harvest time, their numbers ranged from 7 to 51 and their heights from 6 to 21 cm. The number of host plants, pods, and seeds per infested plot ranged from 0 to 24, 0 to 156, and 0 to 453, respectively (Table 1).

During the second year, climatic conditions must have accelerated the life cycle of all the genotypes

Table 1. Effect of broomrape (*Orobanche crenata* Forsk.) on different traits of faba bean accessions during two years of experimentation.

Accession No.	Origin	SW	NHPE	NHPF	FTHP	HHPF	NSBF	NSBH	NSBH	NHIP	NPIP	NSIP	NSSP	Host reaction* to broomrape
							1984/85							
MG 106963	Greece	165	30+	28	135+	37	0	26-	13-	0-	0-	0-	1120	S
MG 106861	"	150	30	29	135	37	0	70	21	1	1	1	1047	S
MG 106815	"	114	30	29	126	37	0	95	17	1	2	4	1201	S
MG 106808	"	148	29	29	135	39	0	110	26	2	10	30	824	t
MG 106827	"	176	30	29	125-	45	0	74	18	0	0	0	824	S
MG 109746	Egypt	68	29	29	125	34	0	76	23	2	12	26	1157	t
MG 109758	"	75	29	28	125	31-	0	67	22	1	7	15	1333	t
MG 109751	"	141	30	29	128	43	0	98	17	2	6	14	789-	t
MG 107142	Spain	150	29	29	130	41	0	115	25	2	5	11	1339	t
MG 107168	"	114	29	27-	125	35	0	46	14	1	1	4	1067	S
MG 107116	"	60-	29	28	132	31	0	72	21	1	0	0	1694	S
MG 107141	"	70	29	28	134	36	0	75	19	0	0	0	1236	S
MG 107140	"	72	30	29	134	37	0	107	29+	0	0	0	1714	S
MG 107172	"	62	30	29	131	38	0	124	19	1	7	18	1432	t
MG 106865	Italy	210	30	30+	133	46	0	51	16	1	2	5	2133	S
MG 106650	"	104	30	29	125	38	0	116	20	3	15	34	2097	t
MG 106951	"	180	30	29	130	41	0	108	20	0	0	0	1830	S
MG 106609	"	148	30	28	125	45	0	139	26	1	2	5	2058	S
MG 106549	"	116	28-	28	125	42	0	131	27	3	16	38	2604+	t
Loc. Putignano	"	162	30	29	131	47	0	132	25	0	0	0	969	S
Aguadulce	"	167	29	29	130	40	0	54	13	0	0	0	800	S
Loc. di Bari	"	158	29	28	128	42	0	141	23	1	2	10	1010	t
" " Castellana	"	238+	30	29	135	57+	0	164+	22	13+	47+	147+	792	T
" " Gaudiano	"	142	29	28	133	33	0	75	18	1	2	7	903	S
							1985/86							
MG 103475	Ethiopia	47	29+	28	105	21	0	25	13	5	27	49	773-	t
MG 103476	"	38	25	25	107+	19	0	7-	6-	1	5	9	780	S
MG 103477	"	43	27	27	107	22	0	7	8	1	4	7	907	S
MG 103480	"	48	27	26	104-	24	0	18	10	4	27	56	879	t
MG 103514	"	37-	24-	24-	105	17-	0	8	9	6	39	68	1020	t
MG 106364	Algeria	88	27	27	107	27	0	20	12	3	8	21	1742	t
MG 106367	"	103	28	27	105	24	0	38	14	7	32	55	1426	t
MG 106377	"	126	27	26	106	27	0	41	11	2	16	33	1680	t
MG 106378	"	124	28	28	107	30	0	42	13	4	11	20	1862	t
MG 106383	"	129	27	27	106	28	0	44	18	2	6	13	2484+	t
MG 106669	Tunisia	134	29	28	105	26	0	30	11	2	7	17	1352	t
MG 106678	"	144	27	27	104	28	0	10	12	0-	0-	0-	1280	S
MG 106680	"	91	28	28	106	28	0	30	14	4	14	24	1730	t
MG 106681	"	106	29	29+	104	26	0	21	10	0	0	0	1325	S
MG 106686	"	141	28	28	105	27	0	21	13	1	5	11	1460	t
MG 106817	Greece	123	27	27	105	25	0	13	12	5	22	67	1553	t
MG 106829	"	115	25	25	107	25	0	51+	12	4	21	34	1489	t
MG 106844	"	107	27	27	105	23	0	37	15	5	20	41	1667	t
MG 106848	"	130	26	26	105	26	0	28	15	5	16	24	1110	t
MG 106858	"	104	28	28	106	23	0	43	13	5	20	45	1760	t
MG 106863	Italy	171	26	26	105	26	0	28	10	6	34	56	1100	t
MG 106864	"	144	26	26	106	25	0	17	14	1	2	5	988	S
MG 106865	"	133	25	25	105	28	0	16	12	2	6	10	775	t
Loc. di Castellana		201+	27	27	104	31+	0	48	21+	24+	156+	453+	824	T

* S = highly susceptible; t = moderately susceptible; T = tolerant
- = minimum value; + = maximum value.

and, as a consequence, flowering time came 25 days earlier, host plants were 15 cm shorter, spikes of broomrape were fewer and shorter, and all components for yield were higher than the first year.

In both years, the maximal values for the most variable traits were observed in Locale di Castellana. Despite being the most heavily infested with broomrape (164 spikes in 1984/85; 48 in 1985/86), this variety was the highest yielder in infested plots (147 seeds in 1984/85; 453 in 1985/86). In uninfested plots, however, its yield was much less than that recorded for others. Hence this variety was rated as the most tolerant among all accessions tested. In 1984/85 an accession (MG 106549) from Italy had the highest yield (2604 seeds) in uninfested soil, while, in 1985/86, another accession (MG 106383) from Algeria was the highest yielder (2484 seeds). However, in infested plots, competition with broomrape, devastated both these crops, with a yield of 38 seeds for the former and 13 for the later (Table 1).

In 1984/85 the most significant correlations (Table 2) were those for seed yield per infested plot (NSIP) with height of host plants at flowering (HHPP; r = 0.57), number of spikes of broomrape at harvesting (NSBH; r = 0.53), number of host plants (NHIP; r = 0.98), and number of pods per infested plot (NPIP; r = 0.99). From these correlations it seems that the only trait that may forecast tolerance to broomrape is height of host plants at flowering: the taller the host plants at flowering the higher the tolerance to

Table 2. Correlation coefficients among traits observed in accessions of faba bean screened for tolerance to broomrape (*Orobanche crenata* Forsk.) during the 1984/85 season.

Trait	SW	NHPE	NHPF	FTHP	HHPF	NSBF	NSBH	HSBH	NHIP	NPIP
SW										
NHPE	0.32									
NHPF	0.34	0.51*								
FTHP	0.24	0.20	0.24							
HHPF	0.77**	0.38*	0.42*	0.11						
NSBF	0.00	0.00	0.00	0.00	0.00					
NSBH	0.14	0.08	0.16	-0.08	0.57**	0.00				
HSBH	-0.19	-0.18	0.06	-0.01	0.14	0.00	0.68***			
NHIP	0.37	0.04	0.12	0.13	0.58**	0.00	0.50	0.17		
NPIP	0.27	-0.01	0.15	0.05	0.53**	0.00	0.52**	0.23	0.97***	
NSIP	0.34	0.01	0.13	0.12	0.57**	0.00	0.53**	0.20	0.98***	0.99***

* = P < 0.05 ** = P < 0.01 *** = P < 0.009

Table 3. Correlation coefficients among traits observed in accessions of faba bean screened for tolerance to broomrape (*Orobanche crenata* Forsk.) during the 1985/86 season.

Traits	SW	NHPE	NHPF	FTHP	HHPF	NSBF	NSBH	HSBH	NHIP	NPIP
SW										
NHPE	0.09									
NHPF	0.17	0.95***								
FTHP	-0.29	-0.20	-0.14							
HHPF	0.78***	0.31	0.38*	-0.12						
NSBF	0.00	0.00	0.00	0.00	0.00					
NSBH	0.46	0.25	0.23	0.11	0.45*	0.00				
HSBH	0.61	0.22	0.28	-0.24	0.59**	0.00	0.64***			
NHIP	0.37	-0.03	-0.03	-0.30	0.22	0.00	0.44*	0.60**		
NPIP	0.35	-0.06	-0.07	-0.35	0.19	0.00	0.37*	0.53**	0.98***	
NSIP	0.39	-0.02	-0.01	-0.34	0.26	0.00	0.35*	0.56**	0.96***	0.99***

* = P < 0.05 ** = P < 0.01 *** = P < 0.001

broomrape. The positive correlation ($r = 0.53$; $P < 0.01$) between seed yield per infested plot (NSIP) and number of spikes of broomrape (NSBH) suggests tolerance rather than resistance, among the host plants.

In 1985-86 the most significant correlations were those for seed yield per infested plot (NSIP) with height of spikes of broomrape at harvesting (HSBH; $r = 0.56$), number of host plants (NHIP; $r = 0.96$), and number of pods/plot (NPIP; $r = 0.99$) (Table 3).

Seed weight of the accessions sown in the first year was higher (132 g) than those used in the second one (109 g), but, as already reported, this trait correlated only with height of host plants at flowering (Table 3).

Conclusions

Among the 42 accessions analyzed during the 2 years, not one accession was found to be as tolerant as Locale di Castellana. On the other hand a large variability was observed within accessions. Single tolerant plants were identified and will be used for further tests.

Climatic conditions may increase or decrease tolerance to broomrape by reducing or prolonging the life cycle of the crop. A simple delay in sowing time may help in escaping or inducing tolerance. Despite this limitation, screening of germplasm for tolerance to broomrape in naturally infested fields can be non-destructive, practical, and not so expensive technique.

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تقييم مجموعة من الاصول الوراثية للفول (Vicia faba L.) لمدى تحملها للهالوك

ملخص

اختبرت عشائر من الفول (Vicia faba L.) تنتمي الى اصول وراثية مختلفة لتحديد مدى قدرتها على تحمل الهالوك المفرّض (Orobanche creneta Frosk.) . وقد اجرى التقييم في فالينزانو (بارى) على مدى سنتين في حقول مصابة بشكل طبيعي . وجرى خلال فترة النمو تسجيل الصفات المتعلقة بالنبات العائل والعشب الطفيلي ، وتم تحديد المدخلات المتحملة ، والنباتات العالية التحمل من ضمن تلك المدخلات .

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Articles should have an abstract (maximum 250 words) and whenever possible the following sections:introduction, materials and methods, and results and discussion. Authors should refer to recent issues of FABIS for guidance on format. Articles will be edited to maintain uniform style but substantial editing will be referred to the author for his/her approval; occasionally, papers may be returned for revision.

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Manuscript
Articles should be typed double-spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute, postal address, and telex number if available. Figures should be drawn in India ink: send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table. Good quality black and white photographs are acceptable for publication. Photographs and figures should preferably be 8.5 cm or 17.4 cm wide.

Units of measurement are to be in the metric system; e.g. t/ha, kg, g, m, km, ml (=milliliter), m^2.

The numbers one to nine should be written as words except in combination with units of measure; all other numbers should be written as numerals; e.g., nine plants, 10 leaves, 9 g, ninth, 10th, 0700 hr.

Examples of common expressions and abbreviations
3 g; 18 mm; 300 m^2; 4 Mar 1983; 27%; 50 five-day old plants; 1.6 million; 23 ug; 5°C; 1980/81 season; 1980-82 seasons; Fig.; No.; FAO;USA. Fertilizers: 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec.
Versus = vs, least significant difference = LSD, standard error = SE ±, coefficient(s) of variation = CV(s). Probability: Use asterisks to denote probability * = P<0.05; ** = P<0.01; *** = P<0.001.

Botanical: Include the authority name at the first mention of scientific names. Cultivar(s) = cv(s), variety = var(s), species = sp./spp., subspecies = subsp., subgenus = subg., forma = f., forma specialis = f. sp.

References
Journal articles: Khalil, S. A. and Harrison, J.G. 1981. Methods of evaluating faba bean materials for chocolate spot. FABIS No. 3: 51-52.

Books: Witcombe, J. R. and Erskine, W. (eds.). 1984. Genetic resources and their exploitation-chickpea, faba beans, and lentils. Advances in Agricultural Biotechnology. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague, The Netherlands, 256 pp..s 1;*Articles from books*: Hawtin, G. C. and Hebblethwaite, P. D. 1983. Background and history of faba bean production. Pages 3-22 *in* The Faba Bean (*Vicia faba* L.) (Hebblethwaite, P.D., ed.). Butterworths, London, England.

Papers in Proceedings: Hawtin, G. C. 1982. The genetic improvement of faba bean. Pages 15-32 *in* Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G. and Webb, C., eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt.

Submission of articles
Contributions should be sent to FABIS, ICARDA, P.O. Box 5466, Aleppo, Syria.

NEWS أخبار

Announcements إعلانات

German National List of Faba Bean Cultivars as at April 1988

Variety	Breeder and address	On the list since
Faba bean for animal consumption		
1. Alfred	Cebeco-Handelsraad, Postfach 182 AD Rotterdam, The Netherlands	1983
2. Avanti	Kurt Behm GmbH, Kl. Johannisstrasse 20 2000 Hamburg 11, FRG	1986
3. Bolero	Same as 2	1985
4. Boss	Norddeutsche Pflanzenzucht, Hans-Georg Lembke KG, Hohenlieth, 2331 Holtsee, FRG	1987
5. Cargo	Dansk Planteforaedling A/S, Boelshoej, Hoejerupvej 31, DK-4660 Store Heddinge	1986
6. Diana	Otto Breustedt GmbH, Postfach 26 3342 Schladen, FRG	1969
7. Hedin	Dr. Peter Franck, Pflanzenzucht Oberlimpurg, 7170 Schwaebisch Hall, FRG	1986
8. Herra	Same as 7	1973
9. Herz Freya	Michael Herz, Babenhauserstrasse 18, 8941 Niederrieden, FRG	before 1953
*10. Hiverna**	Harald Littmann, Tannenhof, 2427 Timmdorf, FRG	1986
11. Kristall	F. von Lochow-Petkus GmbH, Postfach 1311, 3103 Bergen 1, FRG	1973
12. Picollo	Same as 4	1987
13. Topas	Same as 11	1986
14. Kleine Thueringer	F. Gersdorf, Dunsen, 3211 Eime 4, FRG	
For export only		
15. Francks Ackerperle	Same as 7	before 1953
16. Nabor	Same as 14	1984
Faba bean for human consumption (vegetable beans)		
17. Hedosa	Rijk Zwaan Samenzucht und Samenhandlung, Postfach 34, 4777 Welver, FRG	
18. Osnabruecker Markt	Osnabruecker Zentralstelle, L. Stahn & Finke GmbH, Postfach 3820, 4500 Osnabrueck, FRG	
19. Osnaweiss	Same as 17	

* Winter bean

Contributed by Dr. E. Ebmeyer
F. von Lochow-Petkus GmbH
Federal Republic of Germany

Progress in EEC Joint Faba Bean Trials

The following is an interim report on the EEC faba bean trial series 1985-87. Results for 1985 were reported by Dr. E. Ebmeyer in Vortraege fuer Pflanzenzuechtung 11: 151-157. In 1986 yields were generally lighter but 100 seed weights heavier than in 1985.

Nearly all the characters recorded showed a significant effect of years, locations, varieties and interactions between them. Heaviest mean yields were obtained from Alfred, Minica, F_1 hybrids, and synthetic varieties. Lightest yields were from inbred lines except that M5.1 yielded as much as Minica, the variety from which it was derived. There was a strong positive correlation between harvest index (HI) and yield, heavy yielding varieties having high HIs. Exception was Troy having high HI but low yields (93% of the controls) because of lodging. Determinate varieties had low HIs and yielded 76-80% of controls. There were remarkable differences among locations in protein content, Nottingham (23%) contrasting with Wageningen (31.3%). Alfred and Troy were significantly lower in protein than control varieties.

Contributed by Drs. E. Ebmeyer (Goettingen) and D.A. Bond (Cambridge).

If you have any

* faba bean news
* announcements of meetings
* book reviews
* new research interests
* suggestions

Please send them to:

FABIS
ICARDA, Box 5466
Aleppo, SYRIA

MAJOR FABA BEAN PRODUCING COUNTRIES

Area, yield, and production of faba bean (*Vicia faba* L.) in the major faba bean producing countries ranked on 1986 production.

Country	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1975-77	1979-81	1982-84	1985	1986	1975-77	1979-81	1982-84	1985	1986	1975-77	1979-81	1982-84	1985	1986
China	3913	2267	1855	1700	1700	1125	1162	1315	1353	1353	4400	2633	2438	2300	2300
Ethiopia	270	328	354	350	350	1200	1453	1328	1429	1429	324	476	472	500	500
Egypt	100	103	126	140	140	2301	2135	2291	2193	2214	230	219	288	307	310
Morocco	200	165	150	212	159	887	589	813	916	1264	179	97	122	194	201
Italy	190	161	148	136	134	1211	1277	1268	1327	1331	230	205	125	180	179
France	21	23	58	40	41	2003	3070	3034	3283	2976	42	70	176	130	122
Germany FR	13	5	7	14	28	2862	3224	3390	3872	3838	36	15	23	55	106
Turkey	30	30	41	42	44	1599	1751	1816	1738	1818	47	53	73	73	80
Spain	106	79	52	52	50	978	992	984	1158	1040	104	78	118	61	52
Brazil	191	146	122	142	142	462	278	307	317	317	88	41	38	45	45
Mexico	50	35	32	30	30	809	1771	1348	1333	1333	41	62	42	40	40
Sudan	16	15	16	18	20	1226	2521	2236	1944	2000	19	38	34	35	40
Algeria	35	46	48	70	78	874	594	470	357	449	31	27	23	25	35
The Netherlands				2	6				4749	5175				12	30
Tunisia	63	69	64	83	48	884	682	786	512	604	56	47	50	43	29
Peru	10	23	24	32	27	892	911	934	936	943	9	21	22	30	25
Czechoslovakia	29	39	19	14	14	1718	1641	1833	2080	1453	51	64	33	28	21
Canada			17	19	25			792	789	800			14	15	20
Dominican Republic	6	8	12	13	13	943	931	950	969	950	6	8	11	12	18
Portugal	43	36	31	23	26	659	586	614	709	635	28	21	20	17	17

Source: FAO Production Yearbooks.

Area, yield, and production of faba bean in different geographical regions.

Region	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1975-77	1979-81	1982-84	1985	1986	1975-77	1979-81	1982-84	1985	1986	1975-77	1979-81	1982-84	1985	1986
Africa	737	733	765	882	804	1181	1245	1303	1262	1398	869	913	996	1113	1124
North Central America	74	63	81	84	90	666	1244	940	987	977	50	79	76	83	88
South America	249	200	176	201	198	571	459	539	540	549	142	92	94	109	109
Asia	3982	2319	1912	1758	1763	1127	1172	1328	1362	1366	4490	2717	2538	2394	2408
Europe	459	354	332	294	310	1361	1751	1574	1727	1778	622	477	474	507	551
World total	5501	3680	3282	3235	3182	1122	1164	1292	1303	1349	6174	4283	4237	4216	4291

Source: FAO Production Yearbooks.

Forthcoming Events

أحداث مرتقبة

The First International Symposium on Integrated Pest Management in Tropical and Subtropical Cropping Systems

This Symposium, organized by the German Agricultural Society (DLG) in cooperation with the German Council for Tropical and Subtropical Agricultural Research (ATSAF), the Federal Biological Research Center (BBA), the Technical Center for Agricultural and Rural Co-operation (CTA), the German Foundation for International Development (DSE), the German Agency for Technical Cooperation (GTZ), and the German Agrochemicals Association (IPS), will be held in Bad Duerkheim, Federal Republic of Germany, 8-15 Feb 1989. The prime objective of the symposium will be the exchange of experience: between plant protection experts from North and South; between experts from tropical and subtropical countries; and between research, extension and practice. Topics of special interest are: chemical pest control, applied integrated and biological pest control programs (case studies), applied research in the tropics and subtropics (case studies), training and extension (case studies), and specialized application equipment (papers). There will be a 2-day field trip to present institutes and state plant protection offices, research facilities and experimental units of the industry, as well as production works of agricultural machinery manufacturers.

For more information write to:

International DLG Symposium
Deutsche Landwirtschafts-Gesellschaft e.V.,
Zimmerweg 16,
D-6000 Frankfurt a.M.1,
Federal Republic of Germany

XIIth EUCARPIA Congress on Science for Plant Breeding

The congress, organized by the European Association for Research on Plant Breeding, will be held in Goettingen, Federal Republic of Germany, 27 Feb-4 March 1989. The topics of the congress will cover the whole field of plant breeding. Emphasis will be given to the progress in breeding methods by applications of biotechnology and genetic manipulations, and their implications for varietal improvement will be evaluated. There will be symposia on: breeding methods, genome structure, mutagenesis, breeding for disease resistance, plant legislation and breeders' rights, low-input varieties, genetic mechanisms for hybrid breeding, and applications of biotechnology. Also, there will be workshops and group meetings on specific topics as well as business sessions of EUCARPIA Sections. Posters on scientific or technical aspects of plant breeding and related fields will be exhibited and introduced in groups during Poster Sessions.

For further information write to:

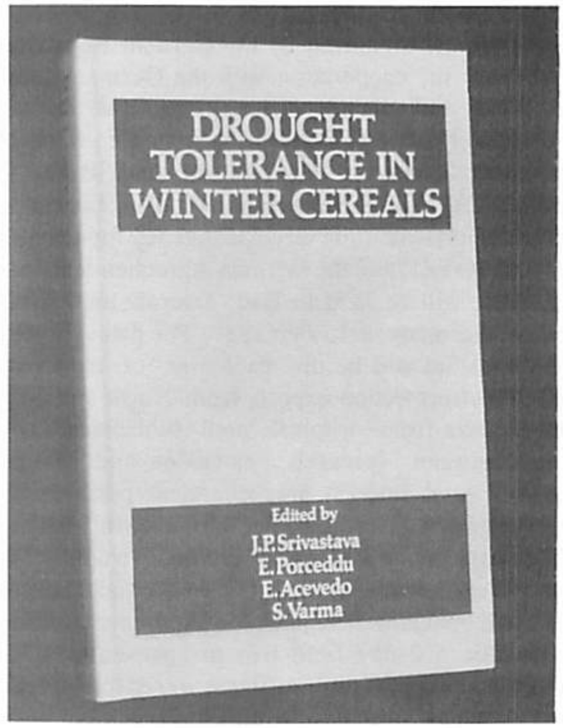
Secretariat
XIIth EUCARPIA Congress,
Institut fuer Pflanzenbau and Pflanzenzuechtung,
Georg-August-Universitaet,
Von-Siebold-Str. 8,
D-3400 Goettingen,
Federal Republic of Germany.

Book Reviews

مطالعات في الكتب

Drought Tolerance in Winter Cereals

Edited by J.P. Srivastava, E. Porceddu, E. Acevedo, and S. Varma
Published by John Wiley and Sons, Chichester, UK
ISBN 0 471 91650 1
387pp.

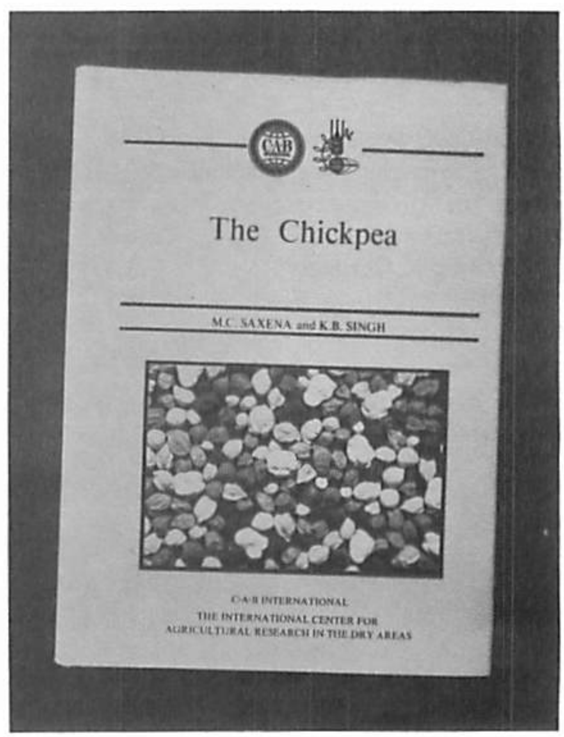


This book is the proceedings of an Interntional Symposium on Improving Winter Cereals in Moisture-limiting Areas, held in Capri, Italy. The aim of the symposium was to create a common focus, among scientists belonging to different disciplines, on how the disciplines in which they work could contribute to improving food production in those crop growing environments where availability of water, or rather the shortage of it, is the major constraint.

The book is divided into four sections. Section I deals with the role of agroclimatology and of agroecological models in developing a meaningful approach for crop improvement. Section II reviews and compares the efficiency of current breeding methods and presents some new approaches. Section III deals with research for drought avoidance and tolerance and its implication in breeding programs and section IV with plant characteristics required for improved performance in dry environments. Recommendations for action in the short and medium terms are also given.

The Chickpea

Edited by M.C. Saxena and K.B. Singh
Published by CAB International, Wallingford, Oxon, UK
ISBN 0 85198 571 8
Hardcover price £38.50
409pp.



Chickpea is the second most important pulse crop in the world and is a major food legume in the Indo-Pakistan subcontinent, East Africa, the Mediterranean, and the Americas.

Despite the importance of the crop, there was no standard work on the chickpea. This book was compiled to provide an authoritative reference for all those interested in chickpea production.

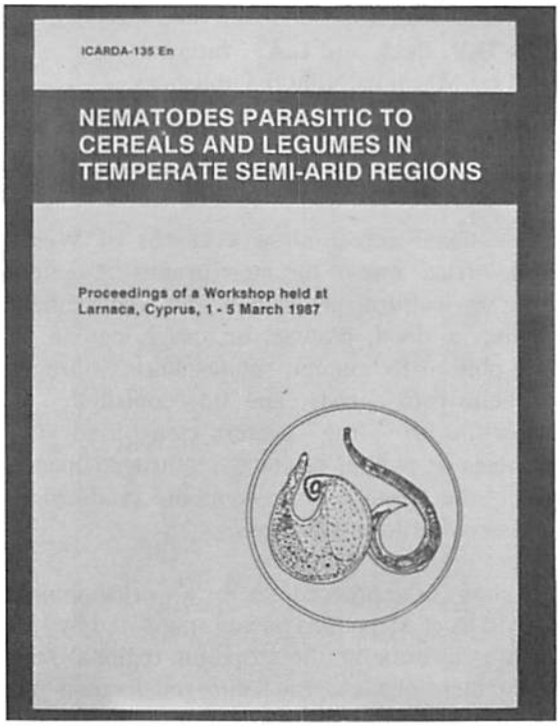
Nematodes Parasitic to Cereals and Legumes in Temperate Semi-Arid Regions

Edited by M.C. Saxena, R.A. Sikora and J.P. Srivastava
Published by ICARDA, Aleppo, Syria
217pp.

Plant parasitic nematodes are a severe constraint to agricultural production in tropical and semi-tropical developing countries. Their effects are aggravated when coupled with other abiotic stresses such as drought, heat, poor crop management, and low nutrient availability-common features of the ICARDA region.

The book is the proceedings of a workshop organized by ICARDA (Aleppo, Syria) and held 1-5 Mar 1987 in Larnaca, Cyprus. The workshop aimed to review and highlight the nematodes problems on wheat, barley, chickpea, faba bean, and forage legumes in the temperate region of West Asia and North Africa. The meeting also examined the current knowledge and control methods being employed in other countries in the light of its usage in the region. And, also identified were priority research activities and areas of cooperation among ICARDA, national programs, and other centers of excellence to develop and deploy the most effective control methods against plant parasitic nematodes.

The proceedings reflect the contributions of 25 scientists from both developed and developing countries.



Copies of the proceedings are available from STIP, ICARDA.

DOCUMENT COLLECTION

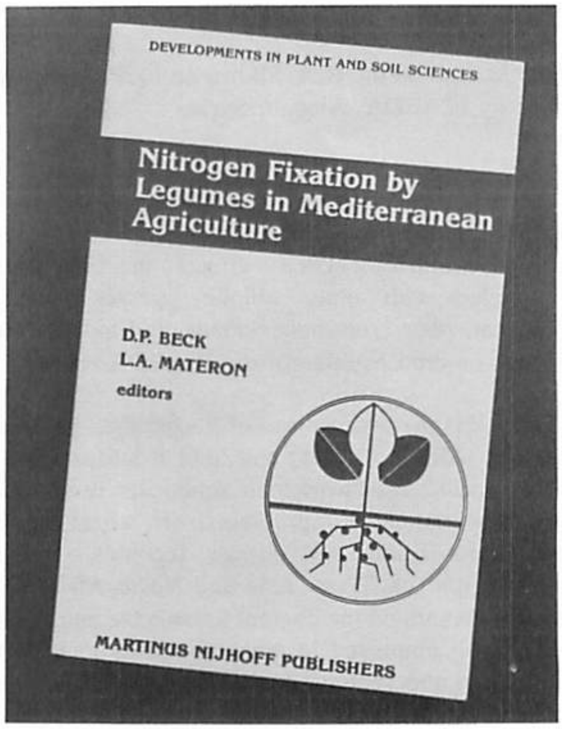
With the financial support of the International Development Research Centre (IDRC), ICARDA is building up its document collection on faba bean. The collection will be used to supply needed documents to scientists in developing countries.

We would be grateful if readers who have any relevant documents would send them to:

FABIS
ICARDA
Box 5466
Aleppo, Syria

Nitrogen Fixation by Legumes in Mediterranean Agriculture

Edited by D.P. Beck and L.A. Materon
Published by Martinus Nijhoff Publishers,
The Netherlands
ISBN 90 247 3624 2
379 pp.



In the traditional cereal/fallow rotations of West Asia and North Africa, one of the most promising options for increasing agricultural production is replacement of fallow with a food, pasture, or forage legume. Such crops are able to fix enough atmospheric nitrogen to supply their own needs and to contribute to soil fertility, while providing protein-rich food in the form of seeds or animal products. Nitrogen fixation by bacteria of the genus *Rhizobium* in symbiosis with legumes is central to this process.

This book is the proceedings for a workshop organized by ICARDA at Aleppo, Syria and sponsored by UNDP. The aim was to examine the scope for regional research and development of biological nitrogen fixation (BNF) in food, forage, and pasture legumes in semi-arid Mediterranean agriculture.

This book, which contains 36 papers by authorities in the field and regional scientists, is divided into the following sections: biological nitrogen fixation in the Mediterranean region, genetic and physiological aspects of legumes and rhizobia, ecology of Rhizobium and inoculation, and nitrogen fixation limitation and potential.

The text emphasizes the relevance of BNF research and development for the region. It also includes a section with panel recommendations on improvement of economic yields and optimization of nitrogen inputs into the agricultural systems of the ICARDA region.

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Box 5466
Aleppo, Syria

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Request your list of all currently available publications from the Scientific and Technical Information Program (STIP).

ICARDA Information Brochure
ICARDA's historical background and research objectives are outlined in English and Arabic. For your copy, contact STIP.

LENS (Lentil Newsletter)
This newsletter is produced twice a year at ICARDA. Short research articles are published and comprehensive reviews are invited regularly on specific areas of lentil research. The newsletter also includes book reviews, key abstracts on lentils, and recent lentil references. For further information write LENS.

RACHIS (Barley, and Wheat Newsletter)
This ICARDA service is aimed at cereals researchers in the Near East and North Africa region and Mediterranean-type environments. It publishes up-to-the-minute short scientific papers on the latest research results and news items. RACHIS seeks to contribute to improved barley and durum wheat production in the region; to report results, achievements, and new ideas; and to discuss research problems. For further information, write RACHIS.

Field Guide to Major Insect Pests of Faba Bean in the Nile Valley (English and Arabic)
This pocket field guide for research and extension workers explains how to identify and control the main insect pests of faba bean in Egypt and Sudan. The distribution, description, and biological characteristics are given for each insect, along with the type of injury, assessment of damage, and recommended control measures. A key to injuries is included. Insects and the damage they cause on faba beans are illustrated with 41 color photos. For your copy, write FLIP.

Field Manual of Common Faba Bean Diseases in the Nile Valley (English and Arabic)
This pocket field manual is a tool for field workers to diagnose and control diseases of faba beans in Egypt and Sudan. Symptoms, development, and control of various diseases are discussed, and symptoms are illustrated with 38 color photos. Also included are rating scales for disease resistance in faba bean lines and a glossary of basic phyto-pathological terms. For your copy, write FLIP.

Field Guide to Major Insect Pests of Wheat and Barley (Arabic)
This field guide in Arabic covers fungal, bacterial, viral, and physiological diseases, as well as insects and nematodes, that attack wheat and barley crops in the Middle East and North Africa. Forty-four insects and diseases are discussed and illustrated with 72 color photos. For your copy, write Cereals Improvement Program.

Introduction to Food Legume Physiology
This comprehensive 105-page technical manual is designed for food legume scientists and their support staff. It covers several areas of food legume physiology in a practical way, with examples whenever possible. The book contains four chapters covering the following: plant structure and physiological functions; mineral nutrition; photoperiodism, vernalization, crop canopy and radiation, and growth analysis; and physiology and crop improvement.

ICARDA's Food Legume Improvement Program
In English and Arabic, the 24-page illustrated information brochure briefly describes research projects on lentil, faba bean, and chickpea treated either as single crops or as a group. For your copy, write FLIP.

Screening Chickpeas for Resistance to Ascochyta Blight A Slide-tape Audio-tutorial Module
This slide-tape audio-tutorial module is the first in the food legume training series. It is designed for the use of legume trainees during the training courses at ICARDA as well as for scientists and their support staff in the various national programs. This module is also useful educational material for universities and

training departments in national research systems. For your copy of this publication or package, write Training Department.

Checklist of Journal Articles from ICARDA 1978 - 1987
This checklist, compiled to bring information to the attention of the scientific community, consists of references of articles by ICARDA research scientists submitted to refereed scientific journals as of 1978. Each reference includes within year of publication: author, primary title, volume number, issue number, pagination, language code of the article and/or summary when necessary, and AGRIS reference number. For your copy write: STIP.

Opportunities for Field Research at ICARDA
This brochure is intended primarily to assist Master of Science candidates, who are enrolled at national universities within ICARDA region and selected for the Graduate Research Training Program. It explains to them the opportunity they have to conduct their thesis research work at ICARDA research sites under the supervision of distinguished international scientists. For your copy, write GRI Program, Training Coordination Unit.

Opportunities for Training and Post-Graduate Research at ICARDA
ICARDA has active training courses on the development and improvement of food legumes, cereals, and forages with ICARDA's research scientists, trained instructors, and proven programs. For a complete brochure of the training opportunities at ICARDA, write Training Department.

TO OBTAIN PUBLICATIONS:
Address requests for publications to the specific department or service cited above, at: ICARDA, P.O. Box 5466, Aleppo, Syria.

اعلان الى العلماء والباحثين العرب الكرام

يسر المركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا) ، اعلامكم بان مركز بحوث التنمية الدولية (IDRC) في أوتاوا بكندا ، قد وافق على تقديم دعم مالي لمشروع فابس FABIS مدته ثلاث سنوات اعتبارا من بداية عام 1987 ولغاية 1989 ، علما بان ادراج اللغة العربية ضمن النشرة الاخبارية للفول يشكل أحد أهم أهداف هذا المشروع .

وبمزيد من السرور تعلن اسرة تحرير " FABIS " للباحثين العرب العاملين في مجال تحسين محصول الفول أنها تصدر نشرتها العلمية باللغتين العربية والانكليزية . لذا فيرجى من الاخوة العلماء الراغبين في نشر بحوثهم باللغة العربية التفضل بارسالها الى العنوان التالي : نشرة " فابس " ، ايكاردا ـ برنامج المعلومات العلمية والفنية ، ص.ب. 5466 حلب ـ سورية .

ملاحظة :

تتم كتابة البحث بلغة عربية واضحة ، وفق الترتيب التالي :
1) الملخص ويكتب باللغتين العربية والانكليزية .
2) المقدمة .
3) المواد والطرق .
4) النتائج .
5) المناقشة ويمكن دمجها مع النتائج وتصبح (نتائج البحث والمناقشة) .
6) المراجع .

المعاملات الزراعية والمكننة

الفيزيولوجيا والأحياء الدقيقة

التربية والوراثة

فابِس

مشروع المعلومات المتخصصة عن الفول

فابس ، نشرة علمية 20 ، نيسان/ابريل 1988

المحتويات

صفحة
Ar

أخبار

بحوث مختصرة

الآفات والأمراض

ايكاردا والمجموعة الاستشارية للبحوث الزراعية الدولية

يتمثل الهدف العام للمركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا) في زيادة الانتاجية الزراعية والموارد الغذائية المتاحة في المناطق الريفية والحضرية بهدف تحسين الوضع الاجتماعي والاقتصادي لشعوب البلدان النامية وخاصة في شمال افريقيا وغرب آسيا . وتركز ايكاردا اهتماماتها بصورة رئيسية على المناطق التي تعتمد في زراعتها على الامطار الشتوية التي تتراوح من 200-600 مم سنويا ، وعندما تستدعي الضرورة ستمتد دائرة بحوثها لتغطي مناطق بيئية مروية او ذات أمطار موسمية .

ويضطلع المركز بمسؤولية عالمية في تحسين الشعير والعدس والفول ، وبمسؤولية اقليمية في تحسين القمح والحمص والنظم الزراعية والثروة الحيوانية والمراعي والمحاصيل العلفية . كما ويعتبر تدريب وتأهيل الباحثين الزراعيين في البلدان النامية ، وتبادل نتائج البحوث معهم أحد أهم الانشطة التي تقوم بها ايكاردا .

وقد ساهمت المجموعة الاستشارية للبحوث الزراعية الدولية (CGIAR) بتأسيس ايكاردا في سوريه عام 1977 كمركز للبحوث لا يتوخى الربح . أما المجموعة الاستشارية للبحوث الزراعية الدولية فهي هيئة غير رسمية من المتبرعين تضم حكومات ومنظمات ومؤسسات خاصة ، وتدعم البحوث الزراعية في جميع انحاء العالم بهدف تحسين الانتاج الغذائي في البلدان النامية . وذلك من خلال شبكة مؤلفة من ثلاثة عشر مركزا دوليا للبحوث من بينها ايكاردا . وتغطي أعمال الشبكة بحوثا على أنظمة المحاصيل والثروة الحيوانية التي تسهم في تأمين ثلاثة ارباع الغذاء في البلدان النامية .

فابس

تصدر ايكاردا نشرة " فابس FABIS " العلمية ثلاث مرات في السنة بدعم مالي من مركز بحوث التنمية الدولية (IDRC) في اوتاوا بكندا ، وهي نشرة علمية متخصصة بالفول ، وتعتبر وسيلة اتصال لتبادل نتائج البحوث حول هذا النبات . وتضم النشرة بحوثا مختصرة تهدف الى ايصال المعلومات بسرعة ، اضافة الى بعض المقالات العامة التي تدعو اليها أسرة التحرير بشكل منتظم وتتناول مجالات معينة من بحوث الفول . كما تضم النشرة بعض الاعلانات . وهذه النشرة تقدم المعلومات حول بحوث الفول دون مقابل من خلال قسائم الاستجواب والتصوير النسخي (الفوتوكوبي) وجمع الوثائق العلمية المتعلقة بالفول .

الاشتراكات

توزع نشرة " فابس " العلمية دون مقابل للباحثين المعنيين بنبات الفول . وللاشتراك فيها يرجى الكتابة الى :

FABIS/Documentation Unit/ICARDA, P.O.Box 5466
Aleppo, Syria

هيئة التنسيق

صورة الغلاف : مدخل وراثي من الفول في ايكاردا يتمتع بصفة الأزهار المغلقة .

فابِسْ

نشرة علمية متخصصة بالفول

العدد 20 نيسان/ابريل 1988

المركز الدولي للبحوث الزراعية في المناطق الجافة
ايكاردا
ص. ب. 5466 ، حلب ، سورية