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Saxena M.C., Silim S.N., Matar A.

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Agronomic management of faba bean for high yields

M.C. SAXENA
S.N. SILIM
A. MATAR
INTERNATIONAL CENTER FOR AGRONOMICAL RESEARCH IN THE DRY AREAS (ICARDA)
P.O. BOX 5466, ALEPPO, SYRIA

SUMMARY - Experiments were conducted in Syria and Lebanon in different seasons to determine optimum agronomic practices for faba bean (*Vicia faba* L.). At all the sites, the best time of sowing for high seed yield and yield stability was the first half of December and earlier or later sowing reduced yield. A range of seeding densities (16.6 to 60 seeds/m^2) were tested. The yield of indeterminate faba beans was not influenced much by change in seeding density, but determinate faba bean responded to higher seeding density. Optimum seeding densities were 20-26 seeds/m^2 for indeterminate lines and 44 seeds/m^2 for determinate line. Under rainfed conditions at Tel Hadya, the effects of row spacing (45 and 22.5 cm) and seeding density (22 and 44 seeds/m^2) on seed yield were studied. Sowing at 22.5 cm row spacing or 44 plants/m^2 increased seed yield but the best yield was from a combination of 22.5 cm row spacing and 22 seeds/m^2. Studies on P fertilization revealed that the critical level of available soil P was 5.5 ppm. Where barley was grown with 0, 50, 100, 150 and 200 kg P_2O_5/ha, only residual P in treatments that received 100 kg P_2O_5/ha and above increased significantly seed and biological yields of a succeeding crop of faba beans. Weeds reduced yield significantly. Hand weeding twice and pre-emergent application of Terbutryne or Cyanazine were as effective as repeated hand weeding in controlling weeds. Pronamide was effective in controlling grassy weeds.

RESUME - "Techniques agronomiques pour l'obtention de hauts rendements chez la fève". Des expériences ont été réalisées en Syrie et au Liban en différentes saisons afin de déterminer les techniques agronomiques optimales pour la fève (Vicia faba *L.). Partout, la meilleure date de semis pour le plus haut rendement de graine et pour la stabilité du rendement était la première quinzaine de décembre, et le semis précoce ou tardif diminuait le rendement. Une série de densités de semis (16,6 à 60 semences/m^2) ont été essayées. Le rendement des fèves de type indéterminé n'était pas très influencé par la densité de semis, mais le type déterminé répondait à une plus grande densité. Les densités optimales étaient de 20-26 semences/m^2 pour les lignées indéterminées et de 44 semences/m^2 pour la lignée déterminée. Sans irrigation, à Tel Hadya, les effets de l'écartement des rangées (45 et 22,5 cm) et la densité de semis (22 et 44 semences/m^2) sur le rendement en graine ont été étudiés. Le semis à un écartement de 22,5 cm entre rangées ou 44 plantes/m^2 augmentait le rendement, mais le meilleur rendement était obtenu avec une combinaison d'écartement de 22,5 cm entre rangées et 22 semences/m^2. Les études sur la fertilisation avec P montraient que le niveau critique de P disponible dans le sol était de 5,5 ppm. Dans les zones où l'on avait cultivé l'orge à 0, 50, 100, 150 et 200 kg P_2O_5/ha, seulement le P résiduel des traitements au-dessus de 100 kg P_2O_5/ha augmentait d'une façon significative le rendement en semences et le rendement biologique de la culture de fève qui y succédait. Les mauvaises herbes diminuaient significativement le rendement. Deux sarclages manuels et l'application de Terbutryne ou Cyanazine avant la levée résultaient aussi effectifs pour le contrôle des mauvaises herbes que le sarclage manuel à plusieurs reprises. La Pronamide était efficace pour contrôler les graminées nuisibles.*

Introduction

Faba bean (*Vicia faba*) is a crop well adapted to the Mediterranean environment. When carefully managed, it can yield more than 6 t/ha of seed (Newton and Hill, 1977; Dantuma and Thomson, 1983; Saxena *et al.*, 1986). Additionally it helps in restoring the fertility of soil in crop rotations through biological nitrogen fixation (Dyke and Prew, 1983). Despite its high yield potential, a major limitation of faba bean is the variability in its performance from season to season as well as from location to location (Hebblethwaite *et al.*, 1977). Quite a substantial part of this apparent gap between potential yield and that actually realized may be attributed to inadequate agronomic management. The present paper reports some of the research conducted by ICARDA for improving productivity and yield stability of faba bean through crop management in the Mediterranean environment.

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Date of sowing

In low to medium altitudes of West Asia and North Africa (WANA), the two most important agroclimatic constraints to faba bean production are temperature and moisture supply. The optimum temperature for faba bean growth lies between 10 °C and 30 °C (Saxena, 1979). During the cold winter months (December, January, February), temperatures are sub-optimal for crop growth and the accompanying frost, particularly during flowering period may cause crop damage (Saxena *et al.,* 1981). The rapid rise in temperatures during the spring months to supra-optimal levels imposes a limit on yield potential by encouraging flower and young pod drop and reducing the duration for reproductive growth. The amount and duration of precipitation in winter months exerts further restriction on the period over which faba bean is grown, particularly in the rainfed areas. Seeding date would, therefore, have a profound influence on crop performance because it determines the kind of environmental conditions to which various phenological stages of the crop will be exposed. Since little information was available for WANA region, sowing date studies were started in the region in collaboration with the national scientists with a view to provide information for optimum time of sowing. The seeding time ranged from end of October to beginning of February. The results for the 1981/82 season for Tel Hadya (North Syria), Lattakia (Mediterranean coast, Syria) and Terbol (Lebanon) are given for grain yield in Fig. 1 and for total biological yield and the harvest index in Table 1.

In all the three locations sowing faba bean after mid-December reduced both seed and biological yields (Fig. 1 and Table 1). Advancing sowing date into late October/early November did not lead to additional yield advantage over early December sowing in locations where subzero temperatures occurred in early spring; the earlier planted crops which were at an advanced stage of deve-

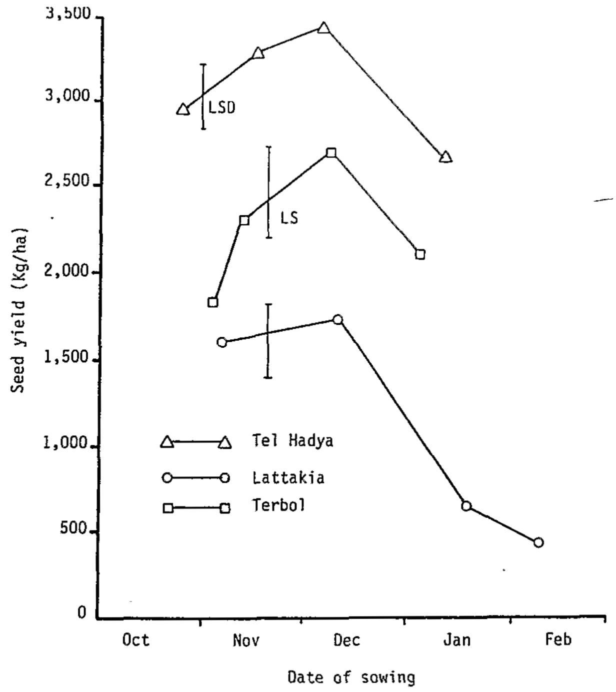

Fig. 1. Effect of date of sowing on seed yield (kg/ha) of local large faba bean at Tel Hadya, Lattakia (ILB 1814) and Terbol in Lebanon (ILB 1817), 1981/82.

Table 1. Effect of date of sowing on the total recoverable biological yield (TBY, t/ha), and harvest index (HI) of local large faba bean at Tel Hadya (ILB 1814), Lattakia (ILB 1815) and Terbol (ILB 1817), 1981 - 1982.

Location	Particulars	Date of sowing				CV (%)	LSD (5%)
Tel Hadya							
	Date	Nov 6	Nov 16	Dec 6	Jan 4		
	TBY	5670	5870	5310	3860	13.3	0550
	HI	0.52	0.55	0.65	0.69		
Lattakia							
	Date	Nov 6	Dec 11	Jan 18	Feb 9		
	TBY	5960	4810	2340	1990	36.0	1080
	HI	0.27	0.36	0.27	0.22		
Terbol							
	Date	Nov 3	Nov 11	Dec 8	Jan 1		
	TBY	4530	5200	5030	4020	20.0	0750
	HI	0.40	0.42	0.53	0.55		

lopment were adversely affected as shown by yield reduction in the first two seeding dates in Terbol (Fig. 1). Green *et al.* (1986) reported a strong correlation in faba bean between seed yield and biomass produced, and Hedley and Ambrose (1981) reported high biomass production and improved partitioning to the seeds as the major pre- requisites for high seed yield in peas. In our study high biomass production followed by improved partitioning were major determinants of high yield, when sowing was done at optimum time.

Seeding density

Recommendations are available on the optimal plant population in faba bean for several production areas outside WANA (Hodgson and Blackman, 1956; Kondra, 1975; Hebblethwaite *et al.*, 1983; Graf and Rowland, 1987). Such information for WANA region was however lacking. Studies were therefore conducted in 1979-1988. Initially the traditional faba bean cultivars with indeterminate growth habit were used, but in later years determinate lines became available and were also tested. The densities tested varied from 16.6 to 60 seeds sown/m^2. The results for faba bean with indeterminate growth habit show that seed yield responses to seeding density were similar across locations and the range of seeding density tested had no significant influence on yield (Fig. 2). There were, however, trends showing 20 to 26 seeds sown/m^2 as the optimum. The lack of significant response in the traditional cultivars of faba bean implies a high degree of plasticity, as was reported by Hodgson and Blackman (1956). Seeding density however, influenced seed yield significantly in the determinate faba bean and its optimum was higher than in the traditional indeterminate variety (Table 2). The small stature and determinate growth habit make it less plastic than the traditional indeterminate faba bean.

In environments where rainfall is low, rainfed faba bean growth is restricted and this results in inadequate ground cover and high evaporative losses. Studies were conducted at Tel Hadya under rainfed condition to determine whether reducing row spacing could reduce evaporation from bare ground and thus improve productivity and water use efficiency. The adapted Syrian landrace, ILB 1814, was sown at 45.0 and 22.5 cm row spacings and 22 and 44 seeds/m^2. The results are presented in Table 3. Substantial yield increases were obtained by either reducing row spacing or increasing seeding density. The highest yield was, however, obtained by a combination of narrow row spacing (22.5 cm) and low seeding density (22 seeds/m^2) (Table 3). Since evapotranspiration values were similar among the treatments, the high seed yield and hence high water use efficiency in the treatment combination of 22.5 cm row spacing and 22 seeds sown/m^2 most probably was due to the establishment of early ground cover which reduced evaporation from the bare ground, and improved transpiration and intercepted radiation.

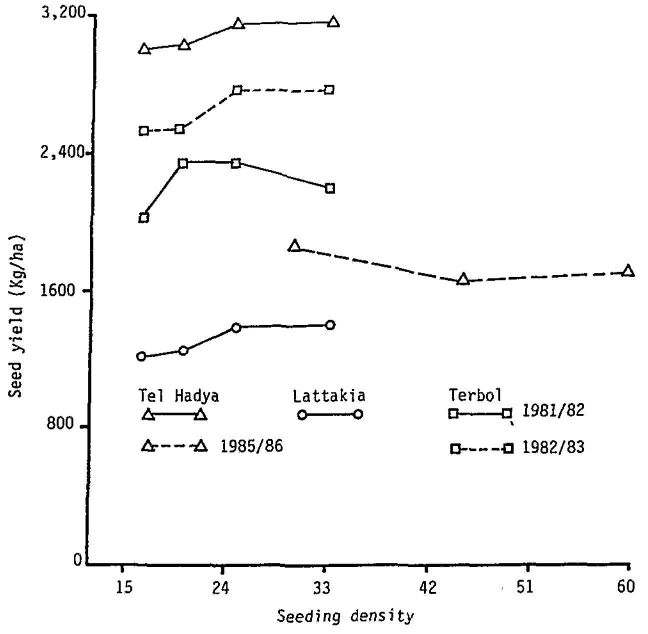

Fig. 2. The effect of seeding density on seed yield (kg/ha) of adapted local large faba bean grown at Tel Hadya (1981/82, 1985/86) and Lattakia (1981/82) in Syria, and Terbol (1981/82, 1982/83) in Lebanon.

Fertilizer application

Earlier studies at ICARDA have shown that in the presence of effective rhizobial flora faba bean meets its nitrogen requirement mainly through biological nitrogen fixation (Murinda and Saxena, 1985). The studies in addition showed that the crop responds positively to P application (Saxena, 1979). Little, however, was known about the relationship between available P in the soil and the response of faba bean to phosphate fertilization. Hence this aspect was studied. Variability in soil P was created by applying 0, 50, 100, 150 and 200 kg P_2O_5/ha and cropping the area with barley. The following season, soils were sampled and analyzed for available P (Matar *et al.*, 1988), then 0, 50 and 100 kg P_2O_5/ha were superimposed on each of the treatments and faba bean sown. The faba bean results showed that treatments that received 0 or 50 kg P_2O_5/ha during the barley phase produced less seed yield and total dry matter than those that received 100, 150 or 200 kg P_2O_5/ha, indicating that a barley crop given 50 kg P_2O_5/ha leaves little available P to the succeeding crop of faba bean and if a strategy of applying fertilizer only during the cereal phase is to be practiced, then at least 100 kg P_2O_5/ha is required (Table 4). The effect of direct application of P on biolog-

Table 2. Seed yield and biological yield of determinate, FLIP 84-239F, and indeterminate, ILB 1814, faba bean lines sown at two populations at Tel Hadya.

Season	Lines (L)	Seed yield (kg/ha) Seeding density/m² (D)			Biological yield (kg/ha) Seeding density/m² (D)		
		22	44	Mean	22	44	Mean
1986/87							
	FLIP 84-239F	3428	3892	3660	5931	6878	6404
	ILB 1814	4419	4332	4375	8032	8026	8029
	Mean	3924	4112	6982	7452		
		L	D	LxD	L	D	LxD
	LSD (5%)	429	NS	576	750	NS	964
	SE	134.1	84.9	180.0	234.3	134.1	301.4
	CV (%)	11.0	9.8		10.5	8.5	
1987/88							
	FLIP 84-239F	2380	2787	2583	4968	6061	5514
	ILB 1814	3372	3249	3310	6967	7403	7185
	Mean	2876	3018	2947	5968	6732	
	LSD (5%)	264.0	167	373	498	315	704
	SE	90.9	57.5	128.5	171.6	108.5	242.6
	CV (%)	9.8			8.8		

Table 3. Seed yield, evapotranspiration (ET) and water use efficiency of ILB 1814 faba bean sown at 22 and 44 plants/m², and at 22.5 and 45.0 cm row spacing. Tel Hadya 1985/86.

Treatment		Seed yield (kg/ha)	ET (mm)	Water use efficiency (seed yield kg/ha/mmET)
Seeding density/m² (D)	Row spacing (cm) (R)			
22	45.0	762	243.6	3.13
22	22.5	1817	239.4	7.59
44	45.0	1451	242.1	5.99
44	22.5	1566	253.8	6.17

LSD 5% for seed yield: R = 106, D = 106, RxD = 150
CV (%) for seed yield 19.7

Table 4. The means of the effects from residual and applied phosphorus on total biological yield (TBY) and seed yield (SY) of faba bean. Tel Hadya, 1986/87.

	Phosphorus (P_2O_5 kg/ha)					LSD(5%)	CV(%)
	0	50	100	150	200		
Residual:							
TBY (kg/ha)	3513	3851	3954	4004	4255	NS	11.2
SY (kg/ha)	1727	1916	2180	1998	2087	147	6.9
Applied:							
TBY (kg/ha)	3678	3924	4144			NS	13.6
SY (kg/ha)	1812	2029	2087			179	11.4

ical and seed yields of faba bean is given in Table 4. The optimum level of direct application on faba bean was about 50 kg P_2O_5/ha.

Available phosphorus status of the soil was determined for each of the treatment combinations before sowing faba bean crop. Using that data and applying the Cate-Nelson procedure, the critical level of available P in the soil was determined. As shown in Fig. 3, this was 5.5 ppm. Application of P fertilizer on a soil with >5.5 ppm Olsen's available P would result in little increase in yield.

Weed control

An essential component of successful faba bean production is good weed control because like other legumes, the crop is very sensitive to competition from both broad-leaved and grassy weeds (Glasgow *et al.*, 1976; Lawson and Wiseman, 1978). In WANA region, weed control is mostly by hand weeding and to a lesser extent by cultivation. In recent years, however, labour has become expensive and scarce and there was therefore need to find alternative weed control methods. With this in mind, experiments were conducted at Tel Hadya (North Syria) and by the national programs in WANA to determine yield losses due to the presence of weeds and assess the relative effectiveness of some of the promising pre-emergent herbicides identified at ICARDA as compared to hand weeding (Table 5). The trials at Hama were irri-

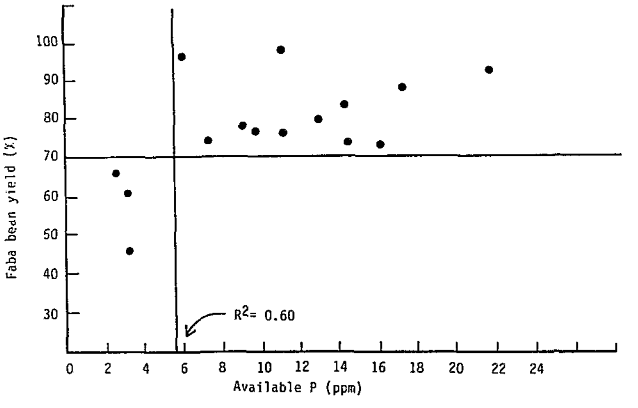

Fig. 3. Scatter diagram of the relative yield of faba bean seeds/ha in relation to available P in soils, Tel Hadya, 1986/87.

Table 5. Effect of weed control treatments on seed yield (Y=kg/ha) of faba bean in the International Faba Bean Weed Control Trial at Hama and Tel Hadya (Syria) and Terbol (Lebanon).

Treatments	Hama		Tel Hadya	Terbol		Mean Y
	1982/83 Y	1983/84 Y	1982/83 Y	1982/83 Y	1983/84 Y	
Weedy check	4844	4049	882	989	1266	2406
Weed free	6144	4383	1304	2417	1969	3243
Weeded twice	6141	4471	1298	1843	2102	3171
Chlorbromuron (Maloran) at 1.5 kg a.i./ha	5914	4148	913	2007	1362	2869
Methabenzthiazuron (Tribunil) at 3 kg a.i./ha	6105	4152	1135	2628	1622	3128
Terbutryne (Igran) at 2.5 kg a.i./ha	6358	4572	1136	3742	1747	2511
Cyanazine (Bladex) at 0.5 kg a.i./ha	5952	5072	1278	1942	1557	3160
Cynanzine (Bladex) at 1 kg a.i./ha	5883	4068	1201	2200	1471	2965
Chlorbromuron + Pronamide (Kerb) at 0.5 kg a.i./ha	6105	4678	1217	1999	1638	3127
Methabenzthiazuron+Pronamide	6210	4420	1136	2513	1493	3154
Terbutryne + Pronamide	5699	5356	1061	2583	1711	3282
Cyanazine at 0.5 kg a.i./ha + Pronamide	6502	5115	1200	2102	1337	3251
CV (%)	7.8	18.5	15.7	27.2	27.2	
LSD (5%)	667	NS	254	724	NS	

gated and those at Tel Hadya and Terbol were rainfed. Seed yield losses due to weeds varied depending on the level of infestation. In 1982/83 these losses were 21% for Hama, 33% for Tel Hadya and 52% for Terbol. Two hand weedings were as effective as repeated hand weeding. Of the various herbicides tested, pre-emergence application of 2.5 kg a.i./ha of Terbutryne was most effective in controlling weeds as shown by high seed yield, followed by Cyanazine at 0.5 kg a.i./ha. In locations where grassy weeds or cereal volunteers were present, a combination of 0.5 kg a.i./ha of Pronamide (Kerb) along with either Terbutryne or Cyanazine at 0.5 kg a.i./ha gave very good weed control.

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