

Performance of grain legume crops in organic farms of central Italy

Migliorini, P.¹, Tavoletti, S.² Moschini, V.³ & Iommarini, L.²

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Abstract

In the 2005-2006 growing season, eight varieties of faba bean, pea and lupin were compared in two organic farms, located in two regions of Central Italy (Tuscany and Marche), to evaluate their adaptation to local environment and agronomic performance in terms of grain yield and competitive ability against weeds. Pea showed a higher grain production than faba bean and lupin, which were negatively affected by the environmental conditions during winter 2005 and spring 2006. Time of seeding seems to be very important for the competitive ability against weed of the different varieties. In Tuscany the lupin Italian variety Multitalia, the only one Italian variety, obtained interesting performance in terms of grain yield and weed competition, although the spring seeding.

Introduction

Grain legumes such as faba bean (*Vicia faba L. var. minor*), field pea (*Pisum sativum L.*) and lupin (*Lupinus albus L.*) play a fundamental role in organic agriculture and livestock (Siddique et al, 1999) to improve soil fertility, to close the cycle of nitrogen and as protein sources alternative to soybean which could reduce the risk of GMO contamination in the food chain. Even though field pea and faba bean are mainly diffused in Italy as grain legumes for animal feeding, recently a strong interest has been developed for white lupin (*Lupinus albus L.*) due to its interesting performance in France, Germany and Australia. In Italy only one lupin variety (Multitalia) is enrolled in the national registry; moreover lupin cultivation was reduced from 60.000 hectares in 1931-35, with an average seed production of 0,93 t/ha, to 3.000 hectares in the period 1986-1990, with an average seed production of 1,27 t/ha (Fagnano and Bozzini, 2001). At present, due to the need of identifying an alternative to soybean in the organic livestock sector, the cultivation of lupin can gain a renewed interest. The purpose of the research was to evaluate the adaptability to environments of Central Italy and to evaluate the agronomic performance (grain yield and ability to control weeds) of grain legumes such as field pea, faba bean and lupin in organic cropping system.

Materials and methods

¹ Department of Agronomy and Land Management (DISAT), University of Florence Piazzale delle Cascine 18, 50144 Florence, Italy, E-Mail paola.migliorini@unifi.it, Internet www.unifi.it/disat

² Department of Food Science, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy, email s.tavoletti@univpm.it.

³ Department of Agronomy and Land Management (DISAT), University of Florence Piazzale delle Cascine 18, 50144 Florence, Italy, E-Mail valentina.moschini@unifi.it, Internet www.unifi.it/disat

The field experiments were carried out in the growing season 2005/06 in two organic farms of the Central Italy, one (S1) located in province of Florence (Tuscany) and the other (S2) in province of Ancona (Marche region). The soil characteristics in the two locations are reported in Table 1.

Tab. 1: Soil characteristic (0-30 cm) in the two experimental fields

Experimental site	Clay content %	organic matter %	pH	N tot ‰	P2O5 avail. mg/kg	K2O exch. mg/kg	Ca exch. mg/kg
S1	65,00	1,67	6,86	1,21	150,60	351	2321
S2	41,40	1,68	8,20	1,10	19,00	228	81000

The eight varieties (2 of faba bean, 3 of field pea, 3 of white lupin) of Italian and French origin used in both field trials are listed in Table 2. Both in Tuscany and in the Marche region sowing was carried out in November. Lupin seeds were inoculated with *Bradyrhizobium lupins* (souche LL13). In the trial carried out in the Marche region also the pea varieties Speleo and Pacific were included.

Tab. 2: Characteristics of the varieties of leguminous used in the experiment

Species	Variety	Constitutor	Seed density (seeds/m ²)	Distance between rows (cm)
<i>Vicia faba L. var. minor</i>	Vesuvio	Iscl/SIS	50	18
	Chiaro di Torre Lama	Università di Napoli/Agroservice	50	18
<i>Pisum sativum L. leafless type</i>	Classic	Cebeco	100	18
	Hardy	Serasem/Florisem	100	18
	Ideal	Serasem/SIS	100	18
<i>Lupinus albus L.</i>	Multitalia	Università di Napoli/Agroservice	50	36
	Lumen		50	36
	Luxe		50	36

In both locations lupin crop has endured strong damages from winter cold and in the S1 trial a spring seeding of lupin was executed. The field trial was laid out in a randomized block design with two and three replicates in the S1 and S2 location, respectively. Plot size was 1020 m² (6x170m) in S1 and 420 m² (6x70m) in the S2 location. In the S1 site, the presence and density of weeds (number of species and number of individuals for each species) was determined in April 2006 with two samplings of 0,25 m² within each plot. In June 2006 average plant height and time of the reached maturity (expressed as number of days after sowing) were assessed. Moreover, at maturity plants were harvested by hand with 3 samplings of 1 m² within each plot. Weeds were separated from leguminous crop plants and both were oven dried at 80 °C to constant weight to assess dry matter (DM) production.

In both experimental sites, mechanical harvesting was performed when grain reached 13% of relative humidity.

Differences between treatments were tested using an analysis of variance (ANOVA) and mean comparisons were evaluated by the Bonferroni test.

Results and Discussion

In the location S1, faba bean and field pea reached maturity with slight differences (tab. 3) while the varieties sown in spring didn't manage to mature properly before the warmth.

Tab. 3: Reached maturity of leguminous crop in Days After Sowing (DAS) in S1

Crop	Variety	Sown period	Maturity DAS (gg)
Faba bean	Vesuvio	autumn	214
Faba bean	Chiaro T.L.	autumn	213
Pea	Classic	autumn	214
Pea	Hardy	autumn	216
Pea	Ideal	autumn	216
Pea	Hardy	spring	88
Lupin	Multitalia	spring	102
Lupin	Luxe	spring	102

At maturity faba bean plant were higher than the other species but both field pea and faba bean sown in autumn accumulated equivalent biomass (tab. 4). However, field pea varieties sown in autumn obtained greater grain yield than faba bean. The performances of lupin Multitalia is interesting as it reached equivalent height and biomass of pea and faba bean varieties sown in autumn and greater grain yield than faba bean. The weed DM biomass is inversely proportional to the biomass developed by the cultivated plant. Spring pea Hardy was the less competitive against weed and lupin Multitalia was competitive as the crops sown in autumn.

Tab. 4: Average height (cm) and dry matter of leguminous crop (gr/m²), dry matter of weed (g/m²), grain yield at 13% of humidity (t/ha) in S1

Source of variation	n weed plant	n weed species	DM weed		H Leg		DM Leg		Grain Yield	
			(g/m ²)		(cm)		(g/m ²)		(t/ha)	
Species			***		***		***		***	
Faba Vesuv.	95	8,0	45,58	c	98,00	ab	940,63	a	3,16	f
Faba Chiaro	117,5	8,0	56,16	c	107,33	a	1036,60	a	3,49	e
Pea Class.	43,5	8,5	49,66	c	92,83	b	1039,98	a	5,36	b
Pea Hardy a	94,5	10,5	43,50	c	95,16	ab	1117,66	a	6,03	a
Pea Ideal	98	8,5	34,33	c	91,00	b	1040,35	a	5,15	c
Pea Hardy s	59	8,0	140,00	b	52,16	c	263,33	b	0,00	g
Lupin Multi.	42,5	4,0	36,95	c	91,50	b	874,25	a	4,50	d
Lupin Luxe	9,5	1,5	251,00	a	26,66d	d	170,83	d	0,00	g

* significant for P<0.05; *** significant for P<0.001

Results concerning grain production obtained in the field trial carried out in the Marche region are summarized in Table 5. Field pea varieties showed significantly higher seed productions than faba bean. In particular, the varieties Speleo and Hardy showed seed yield higher than 4 t/ha, which can be considered of relevant interest for organic farms of Central Italy. Pacific was characterized by the lowest yield among the field pea varieties tested. The low grain yield of faba bean varieties (low vegetative growth, a low density of the faba bean crop in terms of number of plants/m² and a low number

of legumes per plant) could be a consequence of the environmental conditions of winter and spring in the growing season 2005-2006. This trend was observed also in most of the farms which cultivated faba bean in the area where the field trial was conducted. Lupin cultivation completely failed in the S2 location, probably due to the high pH and CaCO₃ concentration values of soil (tab. 1), soil parameter values which characterize most of the soils of the Marche region. This result, compared to the success of the lupin crop in the Tuscany trial, support the need of new lupin varieties with an increased tolerance to high soil pH values to extend this crop in wider areas of Central Italy.

Tab. 5: Average grain yield at 13% of humidity (ton/ha) obtained in the field trial carried out in the Marche region. All lupin crops failed

Source of variation	Grain (ton/ha)	
Species/Variety	*	
Pea Speleo aut.	4,34	a
Pea Hardy aut.	4,23	ab
Pea Ideal aut.	3,80	ab
Pea Classic aut.	3,51	b
Pea Pacific aut.	2,61	c
Faba bean Chiaro T.L. aut.	2,07	c
Faba bean Vesuvio aut.	1,89	c

* significant for P<0.05; *** significant for P<0.001

Conclusions

Pea was shown to have higher grain yield in both sites than faba bean and lupin. The proper choice of variety and right time of seeding are fundamental for the pea cultivation in organic agriculture. Faba bean and lupin were influenced by winter cold and adverse environmental condition. However, lupin Multitalia sown in spring managed to develop a good biomass in order to compete against weeds and to produce grain yield greater than autumnal faba bean. The study shows the need to continue in the search of suitable varieties for central Italy areas.

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