Performance of organic grain legumes in Tuscany

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Abstract

In 2005-2007 growing season, few varieties of field bean, high protein pea and white lupin were compared in an organic farm of Central Italy (Mugello area, Tuscany), to evaluate their agronomic performance in terms of grain yield, nutritional quality and competitive ability against weeds. The experiment was performed under rain-fed conditions. Furthermore, grain legumes features were compared between two different sowing seasons (autumnal vs late-winter) for two years, in order to get information on the best time of sowing of these species, and the stability of yields of different genotypes in those climatic and soil conditions. These legumes could be an alternative protein source to external soybean, a high-risk alimentary source of genetically modified organisms, in the organic livestock sector. The main findings indicate that higher yields in grain and crude protein were obtained with the pea species and in particular with cultivars Hardy (4.0 t/ha grain yield; 626 kg/ha crude protein yield) and Classic (3.1 t/ha grain yield; 557 kg/ha crude protein yield); followed by field bean cv. Chiaro di Torre Lama (2.9 t/ha grain yield; 624 kg/ha crude protein yield) and cv. Vesuvio (2.5 t/ha grain yield; 549 kg/ha crude protein yield). Furthermore the field bean is interesting for the stability of yield in both years despite climatic conditions rather different. The white lupin has showed the lower yield but the values of grain quality, with higher values in lupin Multitalia for dry matter, crude protein and ether extract and in lupin Luxe also for crude fibre, respect to the other legumes analysed. Among lupin varieties, lupin Multitalia showed the best yield results for the pedo-climatic conditions of Mugello area (0.9 t/ha lupin Multitalia; 0.2 t/ha lupin Luxe). The total yield of organic grain legumes, in the experimental site, is resulted higher with an autumnal seeding respect to the late-winter seeding (2.8 t/ha vs 1.9 t/ha).

Introduction

There are 1.8 million farmers in 162 countries growing organically on more than 37 million hectares of agricultural land worldwide. The global market for organic food reaches US$ 62.9 billion, which is an increase of US$ 4 billion compared to the previous year (Willer et al., 2013), mainly because of their reputation as being environmentally-friendly and healthy products. In Italy 1,167,362 hectares of farmland are organically managed, employing 49,709 operators (SINAB, 2013), with an increase trend (respectively +6% and +3% of 2012), compared with a not positive tendency of primary sector in general (Mipaaf, 2012a). However, the livestock sector shows great instability, in particular the cattle one. The problem faced by organic livestock farmers is the supply of feed certificated genetically modified organisms (GMO)-free, with affordable and stable costs (Mordenti and De Castro, 2005; Mipaaf, 2012a).

Indeed, though its ancient traditions in central and south Italy the cultivation of grain legumes has undergone significant contraction in the last forty years (Ranalli, 2001), to the benefit of crops more profitable and/or more subsidized (i.e. corn). These trends have led Italy to be largely dependent on grain imports. The amount of organic soybean imported in Italy (85% from Asia) in 2011 was 20.187 ton (SINAB, 2013) with high risk of GMO contamination (Nowack et al., 2002). Moreover, in organic animal husbandry, the low availability of certified organic grain legumes increased the cost of this input and could cause problems in economic sustainability of those farms. Furthermore, the recent amendment of Regulation (EC) No. 889/2008 (Commission Implementing Regulation (EU) No. 505/2012) requires that at least 60% of the feed (20% in case of pigs and poultry) has to come from the farm unit itself or in case this is not feasible, has to be produced in cooperation with other organic farms in the same region (European Commission, 2008, 2012).

The production of soybean in the Italian area is conditioned by the availability of water, which makes this crop not suitable for all farm situations, especially in rain-fed farming condition of central-south Italy (Bonciarelli and Bonciarelli, 2001). Grain legumes such as field bean (Vicia faba L. var minor), high protein pea (Pisum sativum L.) and white lupin (Lupinus albus L.) play a fundamental role in organic agriculture and livestock (Siddique et al., 1999) to improve soil fertility (Unkovich et al., 1997; Van Kessel and Hartley, 2006; Ranalli, 2001; Badgley et al., 2007), to close the cycle of nitrogen (Unkovich et al., 2006; Pang and Letey, 2000; Jensen

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Key words: organic farming, grain legumes, field bean, high protein pea, white lupin, Mediterranean crops.

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Materials and methods

The research was carried out in 2005-2007 in an organic dairy farm of Tuscany (Borgo San Lorenzo, Florence, 193 m asl). The experimental site was located in a part of the farm characterized by flat fields. The soil is classified as Typic Udifluvents (Sanesi, 1977) and it has been created from fluvial deposits of Sieve river. Texture characteristics place the soil in a clay soil. Main soil physical and chemical properties are reported in Table 1. The crop rotation is the following: maize - pea - barley - maize - alfalfa 3 years. The preceding crop to our experimental cultivation of grain legumes was maize in both years.

The experiment was performed under rain-fed conditions. The climate in experimental area is continental (Table 2). In particular winter 2005/2006 was characterized by temperature more severe and colder than the long-term mean with a long freeze-up period; while the winter 2006/2007 was characterized by low precipitation and higher temperature compared to long-term mean.

The seven varieties (2 of field bean, 3 of field pea and 2 of white lupin) of Italian and French origin used in both years are listed in Table 3.

The field trial was laid out in a randomized block design with two replicates. Plots size was 1200 m² (6x200 m). The experimental plots were ploughed (35 cm deep) on 28 September 2005 and 15 September 2006 and then they were hooned with a rotating harrow joined to the seeder at sowing time. Sowing was executed on 22 November 2005 and 13 November 2006 (autumn sowing) and 6 February 2007 (late-winter sowing), with the plant density reported in Table 3 and without fertilization. White lupin seeds were inoculated with Bradyrhizobium lupins (souche LL13). In winter 2005 white lupin crops have endured strong damages from winter cold (Table 2) and a spring seeding of white lupin has been necessary on 3 April 2006. The presence and density of weeds (number of species and number of individuals for each species) was determined on 6 April 2006 and 9 May 2007 with two samplings of 0.25 m² within each plot. Furthermore for weeds was calculated the Shannon index (Shannon and Weaver, 1963), whose value depends on the species richness and the distribution of individuals among species (Pielou, 1966).

On 26 June 2006 and 9 May 2007 the average plant height was assessed. Seeds were harvested on 26 June for all varieties, in both years, with 3 samplings of 1 m² within each plot, except for white lupin with spring sowing in 2006 that was harvest on 14 July 2006. Mechanical harvesting was performed when grain reached 13% of relative humidity.

Quality of grains were assessed with chemical analysis to determine dry matter (DM), crude protein, fat, crude fibre, ash according with AOAC methodology (AOAC, 1990) and fibrous fraction (NDF, ADF, ADL) according with Van Soest (Van Soest et al., 1991).

Differences between treatments were tested using an analysis of variance (ANOVA) and mean comparisons were evaluated by the Bonferroni test (SPSS; Stata Corp., College Station, TX, USA).

Table 1. Main characteristics of soil.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand (%)</td>
<td>7</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>28</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>65</td>
</tr>
<tr>
<td>pH</td>
<td>6.86</td>
</tr>
<tr>
<td>N total (%)</td>
<td>1.21</td>
</tr>
<tr>
<td>P2O₅ avail. (ppm)</td>
<td>150.60</td>
</tr>
<tr>
<td>K₂O exchang. (ppm)</td>
<td>351</td>
</tr>
<tr>
<td>Ca exchang. (ppm)</td>
<td>2321</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>1.67</td>
</tr>
</tbody>
</table>
Results

Competitive ability against weeds

The analysis of variance (ANOVA) for the variables number of weeds, number of weeds species and Shannon index for the factors species variety and seeding season, as showed in Table 4, do not present statistical significance differences of the variables analysed in function of legume species and seeding time.

Grain yield and nutritional quality

Significant differences emerge among the species and varieties in relation to morphological and productive parameters.

For the factor height of legume plants the ANOVA highlights a

Table 2. Monthly precipitation, average daily, minimum temperature, number of freezing days and ice days at the experimental site (Borgo San Lorenzo, Florence, Italy; Source: http://www.giottoulivi.it/Meteo.asp; http://www.ilmeteo.it/portale/archivio-meteo/Borgo+San+Lorenzo/2007/Maggio).

<table>
<thead>
<tr>
<th></th>
<th>Long-term mean °C</th>
<th>mm/month</th>
<th>2005/06 °C</th>
<th>mm/month</th>
<th>Departure from long-term mean °C</th>
<th>mm/month</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>9.2</td>
<td>142</td>
<td>−2.41</td>
<td>16.2</td>
<td>−0.43</td>
<td>−59.19</td>
</tr>
<tr>
<td>December</td>
<td>5.1</td>
<td>110</td>
<td>−2.16</td>
<td>11</td>
<td>0.88</td>
<td>−50.55</td>
</tr>
<tr>
<td>January</td>
<td>4.3</td>
<td>96</td>
<td>−2.44</td>
<td>−8.4</td>
<td>3.86</td>
<td>−62.99</td>
</tr>
<tr>
<td>February</td>
<td>5.8</td>
<td>99</td>
<td>−1.59</td>
<td>−26.6</td>
<td>4.3</td>
<td>−13.92</td>
</tr>
<tr>
<td>March</td>
<td>8.7</td>
<td>91</td>
<td>−1.56</td>
<td>51.8</td>
<td>3.1</td>
<td>−63.05</td>
</tr>
<tr>
<td>April</td>
<td>12.3</td>
<td>88</td>
<td>0.67</td>
<td>−60.6</td>
<td>4.7</td>
<td>−80.89</td>
</tr>
<tr>
<td>May</td>
<td>16.3</td>
<td>79</td>
<td>−0.12</td>
<td>31.8</td>
<td>2.9</td>
<td>−4.59</td>
</tr>
<tr>
<td>June</td>
<td>20.3</td>
<td>58</td>
<td>−0.53</td>
<td>−23.71</td>
<td>2.4</td>
<td>−32.6</td>
</tr>
<tr>
<td>July</td>
<td>22.8</td>
<td>30</td>
<td>1.09</td>
<td>−23.9</td>
<td>2.7</td>
<td>−30</td>
</tr>
<tr>
<td>August</td>
<td>22.5</td>
<td>53</td>
<td>−2.32</td>
<td>4.4</td>
<td>1</td>
<td>63.59</td>
</tr>
<tr>
<td>September</td>
<td>19.2</td>
<td>88</td>
<td>−0.83</td>
<td>−59.1</td>
<td>0.5</td>
<td>−33.39</td>
</tr>
<tr>
<td>October</td>
<td>14.2</td>
<td>118</td>
<td>0</td>
<td>−80.15</td>
<td>1.9</td>
<td>−68.72</td>
</tr>
<tr>
<td>Mean</td>
<td>13.39</td>
<td>1052</td>
<td>−1</td>
<td>−167.3</td>
<td>27.8</td>
<td>−496.3</td>
</tr>
<tr>
<td>Minimum temperature</td>
<td>−9.7</td>
<td></td>
<td></td>
<td></td>
<td>−3</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>30 December</td>
<td></td>
<td></td>
<td></td>
<td>27 December</td>
<td></td>
</tr>
<tr>
<td>Freezing days*</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Ice days#</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Days with a minimum temperature under 0°C between November and March; #days with a maximum temperature under 0°C between November and March.

Table 3. Characteristics of the varieties of legumes crops used in the experiment.

<table>
<thead>
<tr>
<th>Species</th>
<th>Variety</th>
<th>Constitutor</th>
<th>Seed density (seeds/m²)</th>
<th>Distance between rows (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicia faba L. var. minor</td>
<td>Vesuvio</td>
<td>Iscf/SIS</td>
<td>50</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Chiaro di Torre Lama</td>
<td>Università di Napoli/Agroservice</td>
<td>50</td>
<td>18</td>
</tr>
<tr>
<td>Pisum sativum L. leafless type</td>
<td>Classic</td>
<td>Cebeco</td>
<td>100</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Hardy</td>
<td>Serasem/Florisem</td>
<td>100</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Ideal</td>
<td>Serasem/SIS</td>
<td>100</td>
<td>18</td>
</tr>
<tr>
<td>Lupinus albus L.</td>
<td>Multitalia</td>
<td>Università di Napoli/Agroservice</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Luxe</td>
<td>Inra-AgrObtentions/Jouffrey Drillaud</td>
<td>50</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 4. Effect of species variety and seeding season on number of weeds (n/m²); number of weed species (n/m²) and Shannon index.

<table>
<thead>
<tr>
<th>Weed plant (n/m²)</th>
<th>Weed species (n/m²)</th>
<th>Shannon index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species variety (V)</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Field bean Chiaro torre lama</td>
<td>224.7</td>
<td>8.9</td>
</tr>
<tr>
<td>Field bean Vesuvio</td>
<td>186.2</td>
<td>9.4</td>
</tr>
<tr>
<td>Lupin Luxe</td>
<td>131.7</td>
<td>7.4</td>
</tr>
<tr>
<td>Lupin Multitalia</td>
<td>127.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Pea Classic</td>
<td>158.7</td>
<td>10.1</td>
</tr>
<tr>
<td>Pea Hardy</td>
<td>213.2</td>
<td>10.6</td>
</tr>
<tr>
<td>Pea Ideal</td>
<td>204.7</td>
<td>9.9</td>
</tr>
<tr>
<td>Seeding season (S)</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Autumnal</td>
<td>176.7</td>
<td>9.0</td>
</tr>
<tr>
<td>Late-winter</td>
<td>180.2</td>
<td>9.3</td>
</tr>
<tr>
<td>Error</td>
<td>16</td>
<td>-</td>
</tr>
</tbody>
</table>

n.s., not significant.
tical significant result for the variables *species variety* and interaction *species variety (V) for seeding season (S)* (Table 5). Lupin Luxe (26.7 cm) showed the lesser value in terms of plant height compared to lupin Multitalia (75.5 cm) and to the others species.

In relation to interaction *species variety for seeding season*, only field bean Chiaro di Torre Lama showed a highest value in term of height, in blocks with autumnal seeding (122.48 cm) compared to those with late-winter seeding (88.8 cm).

The results of grain legumes yield and their nutritional quality are shown in Table 6. The data of lupin Luxe yield in 2006 it’s not available due to the late sowing that compromised the harvest that year. The analysis of variance (ANOVA) of the yields in both years highlighted a higher yield in pea Classic (3.1 t/ha) and pea Hardy (4.0 t/ha) compared to both lupin varieties (0.2 t/ha Luxe; 0.9 t/ha Multitalia). Also total grain yield resulted higher with an autumnal seeding (2.8 t/ha) respect to the late-winter seeding (1.9 t/ha).

For the nutritional properties of grain legumes analysed, it resulted that both kind of white lupin show the highest value of dry matter (96.4% lupin Luxe; 96.1% lupin Multitalia) and crude protein (27.0% lupin Luxe; 27.6% lupin Multitalia). Although, only the lupin Multitalia shows a higher value of ash content (5.9%) compared to the other grain legumes analysed. Furthermore the grain’s dry matter shows a higher value in autumnal seeding time (94.9%) that in late-winter time (94.3%).

The crude protein (%DM) shows a decreasing value from lupin’s variety, followed by field bean Vesuvio (21.1%) and then from pea Classic (17.0%) and Hardy (17.2%) that are respectively statistically different.

The value of crude protein yield is instead lower in lupin Luxe (47 kg/ha) and lupin Multitalia (205 kg/ha) that in the other species, not statistically different each other.

The ether extract (%DM) show the highest value in lupin Luxe grain (2.9%), followed by lupin Multitalia (2.1%) respect to all the other species that have a lower value.

Lupin Luxe shows instead a high value of crude fibre (16.4%) compared to pea Hardy (7.6%). Only the ADL fibrous fraction has a significance statistical value with a higher concentration in field bean Vesuvio (4.4%) that in all three varieties of pea (pea Classic 0.6%; pea Hardy 0.8%; pea Ideal 1.1%).

### Discussion and conclusions

The analysis of variance for the variables related to weed presence and their biodiversity it is not resulted statistically significant, but the

**Table 5. Average height (cm) in function of species variety and seeding season.**

<table>
<thead>
<tr>
<th>Legume height (cm)</th>
<th>Species variety (V)</th>
<th>Seeding season (S)</th>
<th>Interaction V*S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Field bean Chiaro torre lama</strong></td>
<td>105.7a</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>2. Field bean Vesuvio</strong></td>
<td>95.8ab</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>3. Lupin Luxe</strong></td>
<td>26.7d</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>4. Lupin Multitalia</strong></td>
<td>75.5c</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>5. Pea Classic</strong></td>
<td>88.6bc</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>6. Pea Hardy</strong></td>
<td>78.7c</td>
<td>80.6</td>
<td>76.2</td>
</tr>
<tr>
<td><strong>7. Pea Ideal</strong></td>
<td>78.7c</td>
<td>80.6</td>
<td>76.2</td>
</tr>
</tbody>
</table>

**Table 6. Average grain yield (t/ha) of both growing season at 13% of humidity and value of quality parameters.**

<table>
<thead>
<tr>
<th>Species variety (V)</th>
<th>Grain yield average t/ha</th>
<th>Ash (%)</th>
<th>CP (%)</th>
<th>CP yield kg/ha</th>
<th>EE (%)</th>
<th>CF (%)</th>
<th>NDF (%)</th>
<th>ADF (%)</th>
<th>ADL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field bean Chiaro TL</td>
<td>2.9ab</td>
<td>93.8ab</td>
<td>4.0b</td>
<td>20.7bc</td>
<td>624a</td>
<td>0.4c</td>
<td>11.9ab</td>
<td>33.9</td>
<td>17.2</td>
</tr>
<tr>
<td>Field bean Vesuvio</td>
<td>2.5ab</td>
<td>93.7b</td>
<td>3.9b</td>
<td>21.1b</td>
<td>549a</td>
<td>0.4c</td>
<td>15.5ab</td>
<td>33.7</td>
<td>23.4</td>
</tr>
<tr>
<td>Lupin Luxe</td>
<td>0.2b</td>
<td>96.4a</td>
<td>4.0b</td>
<td>27.9c</td>
<td>47b</td>
<td>2.9a</td>
<td>16.4a</td>
<td>27.8</td>
<td>21.0</td>
</tr>
<tr>
<td>Lupin Multitalia</td>
<td>0.9b</td>
<td>96.1a</td>
<td>5.9b</td>
<td>27.5b</td>
<td>265b</td>
<td>2.1b</td>
<td>15.2ab</td>
<td>30.1</td>
<td>21.2</td>
</tr>
<tr>
<td>Pea Classic</td>
<td>3.1a</td>
<td>94.2b</td>
<td>3.4b</td>
<td>17.1c</td>
<td>55b</td>
<td>0.6a</td>
<td>8.4ab</td>
<td>31.6</td>
<td>13.4</td>
</tr>
<tr>
<td>Pea Hardy</td>
<td>4.0a</td>
<td>93.7b</td>
<td>3.5b</td>
<td>17.2c</td>
<td>626c</td>
<td>0.5a</td>
<td>7.6b</td>
<td>32.9</td>
<td>15.3</td>
</tr>
<tr>
<td>Pea Ideal</td>
<td>2.7ab</td>
<td>94.4b</td>
<td>3.5b</td>
<td>18.7bc</td>
<td>542bc</td>
<td>0.5a</td>
<td>8.6ab</td>
<td>31.3</td>
<td>13.4</td>
</tr>
</tbody>
</table>

**Discussion and conclusions**

The analysis of variance for the variables related to weed presence and their biodiversity it is not resulted statistically significant, but the
average number of weed plants for each crops variety (Table 4) it is in line with other experiments on field bean in Tuscany (Barberi et al., 2004) and pea (Lundkvist, 2009) in organic farming systems and white lupin (Carruthers et al., 2008) in conventional one.

The number of weeds seems not to affect the yield of the field pea and field bean, which are in line with the yields expected. In fact, these crops are quite competitive against weeds and, in particular, the field bean has a minimum critical period of weed control (Frenda et al., 2013) and both field bean and pea have a great capacity of soil cover (Tavoletti et al., 2004). This aspect makes these crops particularly interesting for organic cultivation.

In relation to growth of plants, it is possible to note a lower height of lupin Multitalia respect to the standard cultivar characteristic (Agroservice, 2012) in conventional agriculture. A result even lower respect to the standards of cultivar (Arvalis, 2010) was obtained for lupin Luxe. These results make suppose a difficult adaptation of lupin Luxe to soil and climatic condition of Mugello area, irrespective of sowing times, as shown in Table 4. Field bean shown a higher value of plant’s height in autumnal sowing, respect to late winter sowing, in agreement with results obtained by other authors (Husain et al., 1988; Duzdemir and Ece, 2011). In the case of pea and lupin species, there is no effect on plant’s height in relation to sowing season. This is in agreement with other results obtained in Central Italy for protein pea (Dal Re et al., 2005) but not for white lupin, that usually in autumnal sowing produces taller plants (Postiglione, 1986).

The best performance in yield is harvest by pea Hardy and pea Classic, that show a better adaptability to the climatic and soil conditions of Mugello, with yield results that are in line with other Italian studies (Anniccichiarico et al., 2003; Monotti et al., 2004).

The total yield of organic grain legumes analysed resulted higher with autumnal seeding, respect to late-winter seeding; this is in agreement with results obtained by other authors for field bean (Foti, 1989; Stringi, 1994; Battini et al., 2001), white lupin (Postiglione, 1986) and pea varieties low temperature resistant (Ranalli and Parisi, 2001). Similarly, the dry matter content was higher in grain with autumnal seeding, due to a longer biological cycle (Foti et al., 2001). This result implies an advantage for the farmer due to a higher energy content of the feeding grains and possibly a longer shelf life due to less water content.

In relation to the variability of climatic condition, the field bean yield was less influenced by lower winter temperature (2005/2006) and lower precipitation (2006/2007) than the others species analysed, keeping a stable yield in both years. This result highlights that the rainfall averages and dates of sowing are suitable with field bean requirements. Otherwise as Stock (1977) noted, a water stress, at all phenological levels, would produce yield decrease, as well as low temperatures after the plant’s phenological level of 4-5 leaves (Bonciarelli and Bonciarelli, 2001). Furthermore, the protein pea cultivars analysed looks more influenced by yield low precipitation and high temperature averages in 2006/2007 (2.2 t/ha) instead that by lower winter temperatures in Mugello area in 2005/2006 (4.7 t/ha), that were lethal for lupin. This result is in line with features of the pea species as reported by Bonciarelli and Bonciarelli (2001).

The legumes crop lupin, shows the best value of the analysis of grain quality respect to the other species studied. Lupin has the highest value in dry matter, ash, crude protein, ether extract and crude fibre, in agreement with other authors (Degussa, 2006; Jezierski et al., 2007; Jezierski et al., 2010). In particular the two cultivars of lupin stand out each other for a higher value of ash in lupin Multitalia, and a higher value of ether extract in lupin Luxe.

Unfortunately, the high quality performance of lupin it’s not support by a high average yield, in this area, so the value of crude protein yield is about the half of the other species. Anyway, the crude protein yield in field bean and field pea doesn’t diverge between them, since the higher crude protein percentage in field bean grain, balance the lower field bean yield. These results are in good agreement with results obtained in Marche region in experiments carried out in 2002-2003, under organic farming approach (Tavoletti et al., 2004).

The performance of these grain legumes may be helpful in solving the problem of GMO contamination because the yields of these crops are promising if compared to soya cultivated in marginal areas, or in farms without agronomic condition suitable for soya cultivation, or in farms where no irrigation could be provided.

In confirmation of this, in 2005/06 in order to have comparison data of organic soya bean, cultivated in two adjacent fields of the same farms but irrigated, as necessary for this crop at the climatic conditions of the zone, the yields of two soya bean varieties (Riger and PR92B63) were assessed. They were sowed in May and harvested in September. Yield data were collected with three samplings of 1 m² each. The values of soya bean yields under irrigated area, in that year in 2005/06 for the varieties Riger and PR92B63 (3.8 and 4.8 t/ha respectively) were not dissimilar from yields of the field bean and field pea cultivated under rain-fed condition in the same pedo-climatic area and year (data not shown).

In conclusion, the analysis of the performance of organic grain legumes in Mugello area, highlights as field pea cultivars Hardy and Classic are crops of great interest to the production of grain supplies for feeding livestock in organic farming systems in rain-fed conditions, with a higher value of crude protein yield than the other crops; followed by field bean cv. Chiaro di Torre Lama and cv. Vesuvio. Furthermore the field bean is interesting for the stability of yield in both years despite climatic conditions rather different. The lupin has showed the lower yield but the best values of grain quality. Among lupin varieties, lupin Multitalia showed the best yield results for the pedo-climatic conditions of Mugello area.

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