

# SPRING LUPINS IN UK AGRICULTURE – EXPERIENCES AND CHALLENGES

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## ABSTRACT

**The interest in spring lupins in the UK has been re-awakened by the introduction of varieties mainly originating from Eastern Europe. However, the range includes all three lupin species and growth characteristics which present some agronomic management challenges for UK growers. Although seed protein yield is high, the grain yield is often only 2/3<sup>rd</sup> that of peas or *Vicia faba* beans and an annual series of variety trials is identifying those with the highest potential for both yield and feeding value. The wide range of maturity of the different species can cause management difficulties with establishing the following crop, which is invariably winter wheat. However, weed control is the most important factor to ensure the crop's reliability. Cultural control of weeds is not always possible and the use of mechanical weeders is restricted to a narrow window of opportunity. There is therefore a reliance on the use of herbicides but the recent review of pesticides carried out by the European Commission has resulted in the loss of many long established products. The search for suitable herbicides both for pre-emergence and post emergence use has given some encouragement for lupin crop expansion in the UK and the crop is also the subject of a major research project (LISA) sponsored by Defra. The paper describes the current position and prospects for lupins in the UK and the work with varieties and weed control.**

## KEYWORDS

UK production, varieties, herbicides, mechanical weed control

## THE UK LUPIN EXPERIENCE

Lupins are not new to the UK although only in recent years has there been any movement to improve production. The increasing cost of imported soya, the need for a GM free ration and full traceability of feed has generated a renewed interest for home produced protein crops particularly for home feeding of livestock. More recently, the increasing cost of nitrogen fertiliser is expected to result in a larger area of legume crops being grown in the UK from 2009 onwards. Whilst much of this area will be taken with beans (*Vicia faba*) and peas (*Pisum sativum*), the high protein content of lupin grain is likely to encourage a further increase in

the crop currently running at around 6,000 ha, although this area includes a significant proportion of lupins grown in mixture for forage feeding.

Interest in lupins began in 2001 and national surveys in 2002 and 2003 clearly defined areas where crop improvement was needed both in the variety type and basic agronomy (Landrock-White, 2004).

The survey indicated that winter lupins could be grown successfully with good yields to 3.7 t/ha, but they were found to be unreliable with 24% of crops failing or having a very poor yield and only 29% giving yields of 2.5 t/ha or more. Generally it was felt that winter lupins were uneconomic to grow because of low yields and poor returns. Spring lupins showed more promise than winter lupins in the survey, with yields averaging around 2.5 t/ha for yellow and narrow-leafed lupins, and 2.4 (2002) and 3.3 t/ha (2003) for the *L. albus* cv. Dieta.

Further work in the form of a Defra sponsored research project (Lupins in Sustainable Agriculture) began in 2004 as the first comprehensive evaluation of the advantages and disadvantages of the lupin crop for both organic and conventional use in the UK. Three species of lupin are in agricultural use in the UK: white lupin (*Lupinus albus*), yellow lupin (*L. luteus*) and narrow-leafed lupin (*L. angustifolius*). Previous studies have generated information on agronomy requirements and genetics of white lupins in the UK but work in the crop concentrated on autumn sown types, and trials suggested high yields and earlier harvest dates (Milford & Shield, 1996). However, autumn sowing in practice showed that newly planted seed was susceptible to damage by the larvae of bean seed fly (*Delia platura*) and disease pressure from seed borne lupin anthracnose (*Colletotrichum acutatum*; syn. *C. lupini*) was very high and largely uncontrollable in the wet UK autumn and early spring seasons. Since then there has been more interest in spring sown types. In the LISA project, therefore, efforts are concentrated on filling gaps in our knowledge of narrow-leafed and yellow lupins. Some 6500 ha of commercially sown spring lupins were established in the UK during both 2003 and 2004, with yields in the range of 2.0 to 4.0 t/ha. A major aim of this project is to optimise the use of lupins in mixed farming systems, as an arable cash grain crop and as a feed system that provides sustainable economic returns to the producers and compounders through a better

understanding of the agronomy, husbandry, nutritive value, feed utilisation and nutrient flow (Jones *et al* 2006).

Yield variability was cited as a major limiting factor in grain lupin production. A number of factors have been identified associated with this, the major factors being poor weed control followed by unsuitability of soil type, geographical area, indeterminacy of maturity and diseases.

Since 2000, PGRO in collaboration with NIAB have been conducting spring sown variety trials to evaluate the agronomic characteristics of the three species. Most of the varieties currently available originate from Eastern Europe. Data from these trials conducted at two or three sites in the UK each year are used to produce a Descriptive List of Lupin Varieties (PGRO2008). Along with agronomic characteristics some measure of relative levels of seed protein and oil are presented to aid choice for feed value. Growth habit is an important issue as there are significant differences between the determinate and indeterminate types, usually the determinate

varieties are earlier maturing and are an advantage for production in more northerly and westerly areas of the UK where rainfall is higher and date of sowing can be later.

Yield remains a limiting factor to increased production. Current yields of peas are around 4.8-5.0 t/ha and beans 4.0-0-4.2 t/ha (PGRO 2008). Lupin varieties have ranged from 2.0-4.0 t/ha but the variability of ripening restricts the production of the potentially higher yielding *L. albus* varieties. Sowing date is dictated by spring weather and soil conditions but aiming for late March is optimal. As can be seen in Table 1, the *L. angustifolius* varieties range from 130 to 144 days to harvest but the *L. albus* varieties can be up to month later. This greatly restricts the advantage of an early entry of winter wheat after harvesting the *L. albus* lupins to gain advantage of the legume break crop. *L. luteus* varieties generally have a significant high level of seed protein but they are alkaline intolerant and generally lower yielding. However, data from the list helps to guide growers as to the suitability of the varieties for their particular growing area.

**Table 1.** Descriptive list of spring lupin varieties (PGRO 2008).

**Spring lupin trials 2003-2007 – 5 year summary**

The control for yield comparisons is the mean of Bora, Prima, Dieta and Wodjil.

Type	Narrow-leafed (Blue)								White		Yellow	
	R544/99	Baron	Sonet	Apr-82	Viol	Sanabor	Bora	Prima	Dieta	Amiga	Wodjil	Bornal
Yield as % control (2.37 t/ha)	122	118	113	112	110	108	104	101	115	112	81	65
<b>Characters</b>												
Habit	det	s-det	det	Indet	det	s-det	Indet	det	s-det	s-det	s-det	indet
Days to ripening	144	138	130	140	133	142	143	132	165	171	145	150
Straw length (cm)	58	62	62	67	66	74	73	56	76	79	64	75
Standing (1-9)*	8.5	8.1	8.5	8.2	8.8	6.7	7.9	8.4	5.2	8.4	8.5	8.3
<b>Seed characters</b>												
TSW	160	146	158	158	128	136	127	149	255	268	112	111
Protein % (dry)	35.7	34.6	34.3	33.8	32.8	35.5	34.4	34.0	39.5	38.1	42.9	42.2
Oil % (dry)	7.3	7.3	6.6	7.9	7.9	7.1	7.1	7.0	12.3	12.8	6.9	6.7

\* A high figure indicates that the variety shows the character to a high degree.

Type: Blue = *L. angustifolius*; White = *L. albus*; Yellow = *L. luteus*

Habit: det = determinate; indet = indeterminate; s-det = semi-determinate.

Suitability of soil type is also a restricting factor in production. Many of the UK soils in Eastern England are calcareous or have had a history of heavy repeated liming for sugar beet production. Whilst *L. albus* types appear to be more tolerant of a high pH, the complexity of the calcium status in soils can mean that a simple pH measurement is not a necessarily a reliable indicator of

the soil suitability. As part of the LISA project, the tolerance of *L. angustifolius* varieties is being trialed and whilst there are some varieties currently available which appear to perform satisfactorily on alkaline soils, the basis for genetic tolerance is being examined in more detail.

## CHEMICAL WEED CONTROL

Identified as a major problem in commercial cropping, weed control of annual species remains the most difficult (Landrock-White & Biddle 2007). In the UK, a number of herbicides are used in pea and bean crops which provide a wide spectrum of control both applied as pre-emergence or post emergence applications. However, several of these have been shown to be unsafe to lupins particularly those used post emergence. Since 2005, a European Union review of pesticides known as 91/414EEC states that active substances cannot be used in plant protection products unless they are included in a positive EU list (EEC 1991). This has resulted in the withdrawal of many herbicide active ingredients which have been in use in pea and bean for many years. Changes in the EU legislation have also meant that products must be 'approved' for use in the intended crop. This factor has created a barrier for manufacturers to develop specific recommendations for lupins as the cost of registration is too high to justify for what is a very small minor crop. However, Since 1 January 1990 an arrangement exists whereby, products recommended for a major and botanically similar crop can be used on a minor crop provided that the use is within the recommendations and that chemical residue levels in the minor crop are within the tolerated levels in the major crop. This is the Specific Off-Label Approval route (SOLA) but use in these cases is undertaken at the user's choosing, and the commercial risk is entirely theirs.

PGRO have been screening possible suitable herbicides for several years. The main emphasis has been on materials used pre-emergence. Since the EU review, the range of suitable active ingredients has reduced. However, pendimethalin, isoxaben, and clomazone are all fully approved for use in both peas and beans and trials have shown their safety in lupins. Commercially, the mixture of isoxaben and terbuthylazine (Skirmish SC) either alone or with the addition of pendimethalin has been shown to provide control of a wide spectrum of weed species including troublesome polygonums. Clomazone is especially useful for control of cleavers (*Galium aparine*) and can be added at a reduced rate to the mixture to further improve weed control. These products have been shown to be crop safe to both *L. angustifolius* and *L. albus* lupins. However, as with all residual pre-emergence herbicides, they work best with a moist seed bed and need to be applied soon after drilling. There are no post emergence broad leaf weed control products available in the UK. Work with diflufenican with and without vegetable based oil adjuvant, has been done but crop damage has been noted particularly in the *L. angustifolius* types. The crop does eventually grow away from these effects but at the rates suggested by the manufacturer, these effects are unacceptable. In the UK, however, diflufenican is only approved for use on cereal crops and therefore will not gain approval for lupins

until a full study on metabolism of the active ingredient has been evaluated by the registration authority. Grass weeds can be controlled post emergence by fluazifop-P-butylcycloxydim or propaquizafop and where fop-resistant blackgrass (*Alopecurus myosuroides*) occurs, tetraloxydim is an option.

## MECHANICAL WEED CONTROL

In an organic situation, weed competition can be very damaging to yield and harvestability. The use of mechanical weeding techniques is being carried out within the LISA project. Results so far have indicated that there were differences in weed suppression between morphological types, with *L. luteus* or *angustifolius* semi determinate types providing a denser canopy than the determinant varieties therefore improving suppression.

Early experiments indicated that one or two passes with a tined weeder, improved yield compared to inter row weeding and therefore unless an inter-row weeding system which results in lower crop damage can be identified, the tined weeding system (Einbock) used once or twice and planting at a 12.5 cm distance between rows is the most suitable weeding treatment (LISA 2007). However, the work is not yet complete and further evaluation of other types of weeding operation is still required before firm recommendations can be made.

## CONCLUSIONS

Although the spring sown crop is in its infancy in the UK, the introduction and evaluation of new varieties of all three species and growth habits is providing a valuable source of information for growers wishing to produce a higher proportion of home grown protein crops in their farming systems. Advances in the agronomy including improved seed health and plant protection are also helping to reduce the variability of performance of grain lupins. Whilst weed control remains a problem in some instances, there is a choice of chemical herbicides available as pre emergence applications to cover a wide range of troublesome weeds. There is also useful data emerging from the on-going research project covering mechanical weed control, which will be essential for organic lupin production. Continuing improvements in these and other areas, should encourage a wider development of UK grain lupins.

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