2017

PGRO PULSE AGRONOMY GUIDE

Advice on agronomy and varieties of combining peas, winter and spring field beans, and other pulse crops

including latest PGRO Recommended Lists

CONTENTS

INTRODUCTION

With an increasing number of growers bringing peas and beans into the rotation, the ability to access sound information and agronomic advice on pulses is important.

This PGRO Recommended List offers growers and advisors an independent comparison of varieties, supporting their decision making process when considering these crops. Frontier recognises the importance of the PGRO's work and the value of the Recommended List. We therefore provide our support to ensure that all those associated with the production of pulses receive the most comprehensive information possible in the form of this levy funded Recommended List.

UK pulse acreage continues to increase and this trend shows no sign of abating as growers recognise the opportunities offered by pulses. If anything, the continuing prevalence of black-grass, the need to improve soil health and the introduction of the three crop rule are likely to lead to more growers turning to pulses.

As well as the agronomic benefits offered, marketing opportunities both here and overseas remain strong. The UK market is buoyant, with feed compounders incorporating pulses into cattle and pig rations, replacing other mid-range proteins such as rapeseed meal. This demand underpins the market value for UK feed pulses. Growers can also take advantage of a growing export market for human consumption beans and peas. Frontier is the only UK merchant to trade directly with customers in Egypt and the Middle East. Quality pulses, traded by Frontier on behalf of UK growers, typically attract premiums of £10-£20.

Frontier is committed to innovation and has created 3D thinking to consider new ideas and concepts that will help address the challenges of the future for growers. As part of our support for the PGRO Recommended List, we have made our 3D thinking trials sites available to enable additional replicated variety trials work. This will further strengthen the value of the PGRO Recommended List as the essential reference point for pulse growers. ***Our best wishes for a successful growing season.***

Mark Aitchison
Managing Director
Frontier Agriculture Limited

3D thinking
DISCOVERY, DEVELOPMENT AND DEMONSTRATION

The Recommended List (RL) tables contained within this agronomy guide are independently produced by the PGRO. The PGRO is in part funded by the voluntary levy received from growers trading pulse crops in the UK. The RL trials are designed, located, coordinated, managed, analysed, monitored and reported by the PGRO team. NIAB validate the data independently. The PVC (Pulse Variety Committee) sits each autumn to evaluate the trials results and consider variety performance.

The outcome of these discussions decides the status of a variety on the RL. The PVC is made up of independent representatives from the industry, growers, advisors, traders, administrators and agronomists operating and guided by the PGRO team.

In the compilation of the RL the PGRO gratefully acknowledges the support of the following organisations providing sites and support for its trials:
Wherry and Sons Ltd, Limagrain UK Ltd, 3D thinking.

Sub-Contractors are: Limagrain UK Ltd, NIAB, SACCS, LS Plant Breeding Ltd and Pearce Seeds.

VALUE OF PULSE CROPS FOR UK GROWERS

As the prices of commodity crops have fallen, so too have the value of pulse crops – yet pulses are competitive against other arable crops. Indeed, as well as being profitable in the rotation on their own account, pulse crops have a positive effect on the whole farm rotation, providing substantial benefits to subsequent crops - particularly cereals or oilseeds.

For example, for a first wheat following beans, the value in additional wheat yield is likely to be around £100/ha to add to a saving in applied nitrogen of circa 50kg/ha. Spring cropping significantly opens the window to attack problem weed species such as black-grass and pests such as slugs with both cultivation and alternative chemistry techniques. Pulse crops also provide disease breaks for cereals and oilseeds and have the advantage of spreading the workload on farm.

There are many growers in the UK who routinely achieve significantly higher pulse crop yields than average – it is not unusual for growers to produce double the average yield of pulses in the UK from very much the same level of inputs. Hence, as part of PGRO's role to encourage progress in pulse growing, we launched the Bean Yield Challenge.

The PGRO Bean Yield Challenge looks towards growing a 10 tonne field bean crop by 2020 and is open to any UK-based grower of any commercial UK-grown grain crop. It will run annually until crop 2020, or until the first 10t/ha crop is validated, whichever is the sooner. A prize trophy will be awarded annually for the highest verified yield for each crop year starting with the 2015-2016 year. The absolute Yield Challenge winner will be the first grower to achieve a verified yield of 10t/ha or more.

For more information about the Challenge and the rules in full, visit the Bean Yield Challenge page at www.pgro.org

PGRO BEAN YIELD Challenge

CHOICE OF PULSE CROPS FOR UK GROWERS

Spring peas

Spring peas are very versatile, most current varieties are semi-leafless with high yields and improved standing ability. While heavy rainfall and wind in June and July can result in tall crops that are prone to lodging, growing peas on lighter soils reduces lodging risk. The tolerance of peas to drought stress allows good yields in low rainfall areas. Spring peas mature early enough to allow production as far north as central Scotland.

Winter beans

Winter beans are the classic pulse crop for heavier land that is difficult to work in the spring. Though the preferred method of establishment is by drilling, ploughing-in remains an option. Early crop development reduces their susceptibility to early summer drought.

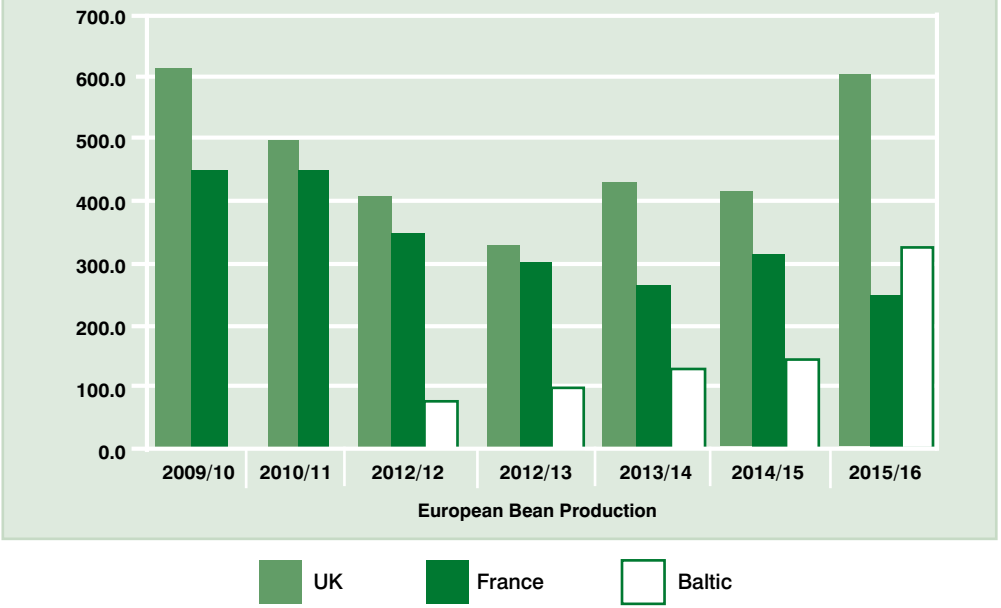
Spring beans

Spring bean yields have fluctuated with the success of the crop linked to early summer rainfall. In dry years, yields can be disappointing, but in wet years much better results can be expected. Vulnerability to drought can be reduced by growing on more moisture-retentive soils and by sowing early. Spring beans are now being successfully produced in arable areas of Northumberland and southern Scotland with good yields. In these higher rainfall areas, the late maturity of spring beans needs to be considered and early maturing types are now available for selection. Premium markets exist for pale hilum beans which can be exported to the Middle East for human consumption and for small, round-seeded samples which can be used for pigeon feed.

Other protein-rich dried pulse crops

Other protein-rich dried pulse crops can also present opportunities. For example, lupins have a high protein content, ranging from 30 to 45%, depending upon species, variety and growing conditions, and provide a useful level of oil, offering possibilities in animal feeding rations.

European bean production - 2009/10 to 2015/16 (000's tonnes)



UK bean - Supply & Demand - 2009/10 to 2016/17 (000's tonnes)

	2009/10	2015/16	2016/17
Production – Winter	292	230	250
– Spring	309	415	350
Imports	0	0	0
Supply	601	645	600
UK Feed Market	150	240	260
Seed/Farm	67	110	110
Export – Feed	200	70	70
– Human Consumption	175	230	160
Anticipated Consumption	592	650	640

BEPA - The British Edible Pulses Association - is the UK trade association that trades, processes and exports UK grown dried pulses. The principal aims of the association are to promote and develop markets for all pulses in order to maintain a strong sustainable UK based industry.

Concerns in late spring of 2016 that seedbed conditions might result in some pulses not being drilled proved largely unfounded. This was reflected in the DEFRA June 2016 Survey figures indicating that the winter/spring bean area was up to 173k ha (5.2% increase on 2015 harvest) and peas up to 49.9k ha (18.7% increase on 2015 harvest).

The continued wet and cool June appeared to affect yields, and while there were some geographical areas with pleasing results, yields appear to have been variable nationally.

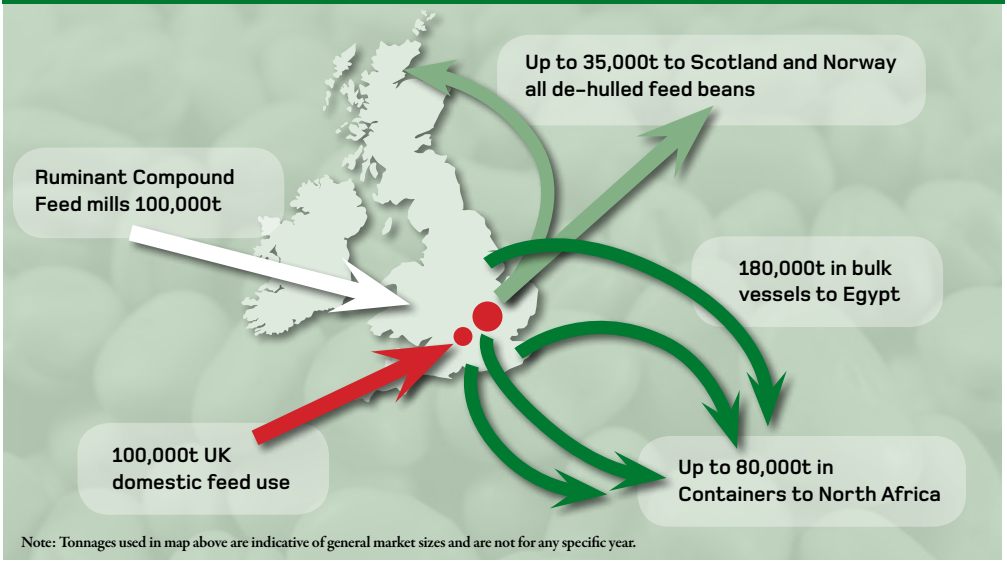
Winter beans may have yields better than spring beans, with generally lower bruchid beetle, but higher staining levels appeared to have reduced the number of samples suitable for human consumption. Spring beans produced lovely samples visually, with moistures well below the maximum 15% required, due to the ideal harvest conditions. The encouraging visual appearance has, however, masked high and very variable - dead or yet to emerge - bruchid beetle still inside the beans. French and Baltic state material has been variable in quality and therefore not offered much competition to UK beans this year.

With continued weakening of the Egyptian pound, export of UK human consumption beans to Egypt has been relatively modest. In September forward sales were pegged at approximately 20k tonnes, against 80k tonnes at the same time last year. The lack of appetite for cargo purchases of 4-7k tonnes at any one time has encouraged buyers to consider the containerised route where they can buy in multiples of 20 tonnes.
A number of UK exporters therefore continue to explore markets into other North African states.

Human consumption spring beans are trading at some £25/t higher than last year along with feed beans at the time of writing (late 2016), and further demand will come from Egypt in particular once overyeared stock is consumed and forward purchases from the UK are delivered.

Where the weak £ has helped significantly is in the white and green pea markets. Good samples of these are trading at £40-60/t higher than winter last year as increased interest occurs from Europe in light of the cost of more expensive Canadian alternatives, and of poor domestic quality in France. Highly bleached samples of green peas are also trading at a £40/t premium over feed peas. While considered a relatively small market in the UK, the spot white pea demand has increased considerably in light of the £ weakness against the euro/US dollar.

Markets for UK beans



Note: Tonnages used in map above are indicative of general market sizes and are not for any specific year.

GROWING COMBINING PEAS

Combining peas *(Pisum sativum)* are a valuable break crop. The produce is mostly used for human consumption or as a high protein component of pet and livestock feeds.

The first step in planning a pea crop is to decide upon the intended market. Many types of high quality peas are suitable for a range of premium markets, but all types are suitable for animal feeds.

Current marrowfat human consumption varieties are relatively lower yielding and they are often more expensive to produce - but they can command a high premium price.

Production of combining peas for seed is another option.

COMBINING PEAS CLASSIFIED BY TYPE AND QUALITY CRITERIA

White flowered varieties

All varieties of white flowered peas are suitable for premium markets but can also be used for animal feed. These are further classified on the current PGRO Recommended List into white (yellow) types, large blues, small blues and marrowfats.

Type	Description	Quality criteria
White peas	Seed coat white/yellow, smooth and round. Primarily of use in animal feeds but small quantities of white peas are used for canning as 'pease pudding' and as split peas in ingredients for soups and prepared meals. Suitable for a wide range of soil types.	Commercially referred to as yellow peas. Samples for the human consumption markets should have smooth skin and a bright, even colour.
Large blues	Seed coat blue/green, smooth, large and round. In addition to the animal compounding market, large blue varieties can be sold for micronising and for human consumption for export or UK packet sales. The micronising process produces a high protein feed for use in certain dried animal rations and pet foods. Breeding programmes are now producing a number of high yielding large blue varieties with different agronomic characteristics suited to a range of soil types.	Sample colour is one of the more important quality criteria for micronising, with the higher premiums being offered for samples of green, large, even-sized seed.
Small blues	Seed coat blue/green, smooth, round and small. Varieties are available for use on a limited scale for canning as small processed peas, or for micronising or for the pigeon trade.	Canning samples must be free from waste and stain, and pass cooking tests. A good even, green colour is necessary for acceptance for the pigeon feed market.
Marrowfats	Seed coat blue/green, large, dimpled seeds. Varieties in this group are the most important for human consumption, being used for both dry packet sale and canning as large processed peas. They are suited to a wide range of soil types and some are relatively late maturing.	The best samples will go for export to the Far East. A good colour, free from blemishes, is also required for packet sales. Samples for canning must be free from waste and stain, and pass soaking and cooking tests.
Coloured flowered (Maple) varieties		
	A very small area of this type of pea is grown, principally for pigeon feed. Samples for this market are brown-seeded, small, round or dimpled.	
Maples	Coloured flowered. Seed coat is brown, often with flecked orange / yellow markings. Principally used in the pigeon trade.	Samples for the pigeon trade should be blemish free, brown-seeded, usually small and sometimes round and smooth.

Variety/ type: all varieties are semi-leafless	White peas					Large blue peas								Small blue	Maple peas		Marrowfat peas		
	NEW Karpate P1	Salamanca R	Kareni P2	Mascara R	Gregor R	NEW LG Stallion P1	Bluetooth R	Prophet R	NEW Vertix P1	Daytona R	Crackerjack R	Kingfisher P2	Campus R	NEW Greenwood P1	Mantara R	Rose R	Aikido P2	Sakura R	Genki R
UK Agent: see page 8 for key	Sen	LSPB	Sen	Sen	LSPB	LUK	LSPB	LUK	Sen	Agrii	Dalt	LUK	LSPB	IARA	LUK	Dalt	LSPB	Dalt	Dalt
Yield as % Control (4.81 t/ha) 5 year mean	105	101	101	99	97	102	102	101	100	99	98	97	97	95	93	90	90	88	83
Agronomic characters																			
Earliness of ripening	5	5	5	6	5	5	5	5	4	6	5	6	5	6	5	6	5	5	4
Shortness of straw	5	4	5	5	5	4	5	5	5	5	5	4	4	6	7	5	4	5	5
Standing ability at harvest	6	7	6	4	5	6	5	5	6	6	4	6	8	4	5	5	6	5	6
Resistance to Pea wilt (Race 1)	R	R	R	R	R	R	R	R	R	R	R	R	R	-	R	S	R	R	R
Downy mildew	6	6	6	7	5	6	7	7	7	7	5	6	6	5	7	7	6	5	5
Seed characters																			
Thousand seed weight (g)(@15%mc)	287	265	283	277	298	262	271	290	268	274	287	264	276	253	236	250	373	377	413
Protein content (%dry)	22.4	22.6	23.6	22.0	23.8	22.4	23.5	21.6	23.1	22.4	22.4	21.1	22.5	21.0	22.5	25.2	23.3	23.4	23.8
Year first listed	**17**	11	16	07	09	**17**	15	07	**17**	10	08	16	14	**17**	10	06	16	08	07

NOTES TO RECOMMENDED LIST

Recommendation categories: R=Recommended, P1/P2=1st/2nd year provisional recommendation.

Yield as % of control is the mean of Prophet & Mascara and is expressed in percentage terms in relation to the mean (100%) of these varieties. Yield differences of less than 7.4% (p=0.05) should be treated with caution. Provisionally Recommended varieties may only have been in trials for three years, but a statistical adjustment makes their data comparable with Fully Recommended ratings, for which yield is based on the five-year mean.

Earliness of ripening is expressed on a 1-9 scale where 1= late, 9 = early. Differences in maturity dates are greatly influenced by growing conditions and are extended in the north and west of the country. A difference of one point represents approximately two days in eastern England.

Shortness of straw is greatly influenced by growing conditions and is expressed on a 1-9 scale where 1 = tall, 9 = short. A difference of one point represents approximately 7 cm.

Standing ability at harvest now incorporates the character for ease of combining, which has been removed, and is expressed on a 1-9 scale where 1 = late, 9 = erect. Standing ability has been improved with new varieties, but crops often lodge at harvest.

Pea wilt - (*Fusarium oxysporum* f. sp. *pisi)* (Race 1) where R = Resistant, S = Susceptible. This is a disease that reduces yields and can only be controlled effectively by genetic resistance. Race 1 is the most common form, the majority of varieties are resistant to this race.

Downy mildew (*Peronospora viciae*) resistance is expressed on a 1-9 scale where 9 indicates a high level of resistance. It is a soil-borne disease, favoured by cool, moist conditions. It can kill young plants and reduce pod-fill in older plants. Varietal resistance should be taken into account when deciding whether to use a seed treatment to control the disease. It is advisable that seed treatment is used where high levels of the disease have occurred before, or where susceptible varieties are grown, as there are no foliar fungicides which give effective control. Generally, seed of any variety with a rating of 6 or below should be treated for downy mildew control. Downy mildew is a variable fungus, with many different races. Occasionally some races may become more dominant in certain growing areas and some varieties may be more susceptible to these, therefore, the ratings may change from year to year.

Thousand seed weight is very dependent on growing conditions. Data are presented in grammes and reflect the mean 1000 grain weight recorded in trials over a number of sites and seasons. Data have been established from samples at 15% MC.

COMMENTS ON 2017 RECOMMENDED LIST

***'Something that may or does change'* is a dictionary definition of variable, and it is a word that has been used more than once to describe the 2016 season and data obtained from trials. Recommended Lists are based on variable data, and while individual trials may exhibit low variability, when combined to produce a 5-year data set variability creeps in. Trials are grown in different seasons, geographic locations, soil types and weather conditions, all of which introduces variability.**

This was seen in 2015/16 when a mild and wet winter period in 2015 was followed by an unremarkable spring 2016 with temperatures and rainfall close to average. The summer months were generally cool with average amounts of rainfall, but with some localised heavy storms. The hot weekend of 18-20 July curtailed flowering in many crops and sunshine levels were lower than normal.

Overall 2016 trial yields (3.79t/ha) were well down on the 5 year (4.81t/ha) average.

Five trials went through to harvest. Yields were generally lower than in 2015, but the trial near Harwich bucked the trend and gave the highest yields at 5.16t/ha. Trials varied greatly in the degree of lodging that occurred and was greatly influenced by bursts of heavy rainfall.

White peas - Karpate a new white-seeded pea from Senova joins the RL with a P1 recommendation as the top yielding variety with a yield of 105% of controls. Kareni, top yielder in 2015 moves to 2nd year of provisional recommendation. Salamanca, Mascara and Gregor remain fully recommended.

Large blue peas The aptly named large blue Bluetooth (LS Plant Breeding) joins Prophet, Daytona, Crackerjack and Campus as fully recommended varieties in that category.
Two varieties LG Stallion (Limagrain UK) and Vertix (Senova) join the list with a 1st year provisional recommendation. LG Stallion tops the large blue yield rankings at 102% with Vertix 2% lower. Kingfisher moves to 2nd year of provisional recommendation.

Small blue peas - The small blue category makes a re-appearance on the RL with the addition of Greenwood (IAR Agri) with a P1 recommendation. Yields are 6% lower than Prophet, but while seed is smaller it is on the large side for a small blue. Standing ability rates at only 4, similar to Crackerjack.

Maple peas - Coloured flowered maple peas Mantara and Rose remain as fully recommended varieties.

Marrowfat peas - In the marrowfat category, Sakura and Genki remain fully recommended and top yielder in this category, Aikido moves to 2nd year provisional recommendation.

UK AGENTS AND BREEDERS DETAILS

AGENT CODE ON RL	UK AGENT	BREEDER
LUK	Limagrain UK Ltd	Limagrain Europe
LSPB	LS Plant Breeding	NPZ-Lembke (DE), RAGT 2n (FR)
Sen	Senova Ltd	SARL Adrien Momont et Fils (FR), Lochow-Petkus (DE)
Dalt	Dalton seeds	Toft (DK)
Agrii	Agrii	Danisco (DK)
IARA	IAR Agri	Toft (DK), Plant Research (NZ) Ltd.

ADDITIONAL PEA VARIETIES

The following varieties are not on the current RL, but are available for various reasons including value for specialist markets or in particular regions of the UK.

Jackpot - UK Agent: Dalton Seeds

A white pea that has not been through official trials and is available through the common catalogue. It is semi-leafless, tall with and gives moderate yields. It has good standing ability and ease of combining. Jackpot has good resistance to downy mildew and limited information suggests good tolerance to *Mycosphaerella*. Quality of produce is good for the white pea markets.

Kabuki - UK Agent: Limagrain UK Ltd

This semi-leafless marrowfat variety has found favour for human consumption in all marrowfat market sectors and is reported to have good colour retention. It is only available when grown under contract to Dunns of Long Sutton. It has not been through UK official trials and is available through the common catalogue. Limited data suggests yields and standing ability are similar to Princess. Little information on downy mildew resistance, but as for other marrowfat varieties a multipurpose seed treatment is advised.

Maro - UK Agent: W.A.Church (Bures) Ltd/ Boston Seeds

Suitable for the whole range of processing markets for human consumption and is favoured for the Japanese export market. Premiums are required to compensate for the very low yield. It is late maturing with very poor standing ability. It is extremely susceptible to downy mildew and a multipurpose seed treatment is required.

Minerva - Breeder: W.A. Church (Bures) Ltd

A conventional-leaved coloured flowered, forage variety. Very long strawed and poor standing ability. Seed yield is very low, but having small, brown and smooth seed it is the most preferred variety for the pigeon feed market. It is sensitive to several herbicides.

Princess - UK Agent: Limagrain UK Ltd

Used to be the preferred variety for canning as 'mushy peas' and for fish and chip shop outlets. It has moderately long straw and average standing ability. Princess is rather susceptible to downy mildew and therefore a multipurpose seed treatment is required.

Progreta - Breeder: Progreta Ltd

A tare-leaved marrowfat variety that has relatively poor standing ability and ease of combining. Samples are usually smaller and more irregular in size than Maro and a good sample is required for canning. It is very susceptible to downy mildew and a multipurpose seed treatment is required.

Zero4 - UK Agent: Limagrain UK Ltd

A semi-leafless small seeded blue variety. In National List (NL) trials it had very early maturity, maturing a week before Nitouche and suitable for northerly or late maturing areas. Straw was relatively short and standing ability very good. In NL trials yields were low, but the Agent recommends sowing at a higher plant density (110 plants/m^2) to achieve higher yields. The variety has good resistance to downy mildew.

The following varieties were promoted from NL2 to RL1 for 2017 after completion of National List trials in 2016 to be further evaluated in Recommended List Trials

VARIETY	TYPE	UK AGENT
Bluetime	LB	LS Plant Breeding
Blueman	LB	LS Plant Breeding
Mankato	LB	Momont
Karioka	LB	Senova Ltd
Manager	W	Momont
Calumet	W	Senova Ltd

In the UK Seed Certification Scheme, seed is graded as Basic (B), Certified Seed of 1st Generation (C1), and Certified Seed of 2nd Generation (C2). Basic and C1 seed is generally grown for the production of further seed crops and C2 seed is used for commercial crop production. Basic seed is the most expensive and C2 the least expensive. Certified seed is required to meet a minimum germination of 80% and to achieve a standard of purity.

Leaf and pod spot (Ascochyta) caused by *Mycosphaerella pinodes* and *Ascochyta pisi*, is a potentially serious seed-borne disease, which can affect both quality and yield. However, growers should note that there are no minimum infection standards specified by the statutory certification scheme for this disease. Seed tests are available from PGRO.

Seed Treatment

All pea seed should be treated with a fungicidal seed protectant such as thiram (Flowable Thiram, Thiraflo or Thyram Plus) to avoid seedbed losses caused by damping-off diseases. Seed-borne infection by Ascochyta may be controlled effectively by using Wakil XL (cymoxanil + fludioxonil + metalaxyl M) which will also reduce losses caused by downy mildew in susceptible varieties.

Seed Size

Seed size is very dependent on growing conditions and variety, hence the 1000 seed weight data shown in the Recommended List should be used only as a guide to the relative seed size of varieties.

Seed rate and plant population

Target populations should be set according to the type of the pea variety being sown. The optimum population depends on seed cost and return of produce per hectare. Adjustments should be made accordingly. The populations given below are an average recommended by PGRO as the most profitable levels for each type. Targets could be lower than these on fertile soils. Higher populations may be beneficial on light, drought prone soils, or where there is a risk of attack from birds.

Typical target plant populations

Type	Varieties	Population plants/m²
Some marrowfats	Maro, Princess, Kahuna, Kabuki	65-70
Others	Kareni, Salamanca, Gregor, Mascara, Prophet, Bluetooth, Campus, Crackerjack, Kingfisher, Daytona, Mantara, Rose, Aikido, Sakura, Karpate, LG Stallion, Vertix, Genki, Greenwood	70
	Zero4	110

The seed rate can be calculated from the following formula:

$$\text{Seed rate kg/ha} = \frac{\text{thousand seed weight x target population plants/m}^2}{\text{\% germination}} \times \frac{100}{(100\text{-field loss})}$$

Use of the seed rate formula, and adjustment for expected field losses, is necessary to achieve the most profitable populations. Expected field losses are given in the table below, and are lower for large-seeded peas. Losses will be higher on heavy, poorly drained soils.

Expected field losses (%)

Sowing time	Marrowfats (large seeds)	Others
Very early (February)	15	18
Early (March)	10	13
Mid-season (April)	5	7

Rotation

It is recommended that the rotation carries no more than a single crop of the following group every five years: peas, field beans, green beans, vetches, lupins and broad beans. This four-year break is the minimum recommended without increasing the risk of building up persistent, soil-borne pests and diseases.

A predictive test for the presence of soil-borne, root-infecting diseases is available from PGRO and details can be found in the PGRO Technical Update TU34.

Cultivations

Often land is ploughed in the autumn. This allows natural weathering to aid in the production of adequate tilth in the spring with minimal cultivations (stale seedbed). Peas are sensitive to compaction. On lighter soils, spring ploughing is an option where over-wintered stubbles are required. Here, drilling with a cultivator drill on spring ploughed land is popular. In some situations, peas can be successfully established by direct drilling or min-till.

Fertiliser

The requirements of peas are small and no N is required. Where P and K fertiliser is required, it should be put deep enough into the seedbed to allow full utilisation by the crop. Broadcast fertiliser should be ploughed shallow or applied over the furrows. It can then be worked in by subsequent cultivations, but the production of too fine a tilth and compaction must be avoided.

Peas may suffer from sulphur deficiency on poor, light textured soils away from industrial emissions. Where soil deficiency is suspected, apply 25-35 kg/ha SO_3 as a pre-drilling treatment. This can be in the form of magnesium sulphate, calcium sulphate, potassium sulphate or elemental sulphur.

Go to www.pgro.org for full details

The fertiliser requirements of peas (kg/ha)

Soil index# N,P or K	N	P_2O_5	K_2O*	MgO
0	0	100	100	100
1	0	70	70	50
2	0	40	40(2-) 20(2+)	0
>2	0	0	0	0

KEY

#According to soil analysis on the ADAS classification:
0 = very low, 1 = low, 2 = medium, >2 = high
*Not more than 50 kg/ha K_2O should be combine-drilled, otherwise germination may be affected. The rest should be broadcast.

The amounts of phosphate and potash are appropriate to pea yields of 4 t/ha. Where yields are likely to be greater or smaller, phosphate and potash applications should be adjusted accordingly.

Time of drilling

The benefits of early drilling can include higher yield, earlier maturity and some escape from pests. However, it is more important to drill peas when soils are drier and less prone to compaction.

Row width and plant population

Peas sown in rows wider apart than 20 cm may give lower yields. Narrower rows result in higher yields and tend to give more even crops, easier combining and better competition with weeds. An adequate plant population is essential since low populations are more difficult to harvest, later maturing and more prone to bird damage.

Drilling and rolling

Most cereal drills are suitable for peas. The drill should be accurately calibrated for each seed lot before sowing. Seeds should be sown so that they are covered by at least 3 cm of settled soil after rolling. On most soil types it is necessary to roll the field to depress stones in order to avoid damage to the combine, and for effective pre-emergence weed control. Rolling should be done soon after sowing, but prior to the application of pre-emergence herbicide application and well before emergence.

Peas are uncompetitive during their early development

Volunteer oilseed rape can be a problem in peas

High numbers of uncontrolled mayweed in peas

Choosing a spring crop does not guarantee black-grass control. Both cultural and chemical approaches have to be carefully considered together and carried out effectively.

Good weed control is essential in the pea crop, since it is not very competitive and is easily dominated by weeds. Efficient control will ease combining and facilitate rapid drying in addition to increasing yield. A number of pre- and post-emergence herbicides are available and a list of currently approved herbicides can be found in the PGRO Technical Updates TU19 *'Choice of Herbicides for Combining Peas'* and TU23 *'Checklist of Herbicides for Combining Peas'.* Pre-emergence herbicides are best applied to a rolled, clod free, moist seedbed.

Broad-leaved Weeds

General control of annual broad-leaved weeds can be achieved pre-emergence with a soil-applied residual herbicide or, when weeds and crop have both emerged, with a foliar-applied post-emergence herbicide.

Where soil type allows, it is advisable to use a pre-emergence herbicide. It removes weed competition early and gives better control of some weeds, for example, knotgrass and annual meadow-grass. However, adequate soil moisture is needed for good

efficacy of a residual herbicide. Pre-emergence Stomp Aqua, Cinder etc (pendimethalin), Nirvana (imazamox + pendimethalin) and Lingo (linuron + clomazone) are effective. Afalon (linuron) in the spring crops has a more limited spectrum but is a useful tank-mix product especially if mayweeds are a problem. Pre-emergence cleaver control is possible using Lingo or Centium 360CS (clomazone). Although active against a few other weeds, Centium is most likely to be used in tank-mix with a partner product.

Post-emergence sprays of full rate bentazone can be applied from 3 nodes of the crop to well-waxed peas (tested with crystal violet dye). It has useful activity on volunteer oilseed rape and small cleavers but less on black-bindweed and fat hen. MCPB controls thistles and docks and effectively stunts large volunteer oilseed rape. Check product labels for any varietal restrictions. Bentazone + MCPB mixes are permitted, but past work has shown increased likelihood of crop damage if both are used at permitted full doses.

Weed control images on these pages from © Blackthorn Arable Ltd.

Overdosing may not cause visual damage but may affect development.

At early crop development – so long as soil conditions are suitable – it is possible to achieve acceptable weed control in peas using a tined weeder.

Amaranthus

Bindweed

Charlock

Chickweed

Cleaver

Corn Marigold cotyledon stage

Volunteer Oilseed Rape

This can be a serious problem if it is grown in the same rotation. Pre-emergence Nirvana and Stomp are effective. However, control particularly of rape germinating from depth, may be incomplete.

To avoid harvesting difficulties, a post-emergence treatment will be required. The least expensive herbicide is MCPB which is effective on small rape - however it stunts, rather than controls, larger plants. If infestation is severe, post–emergence application of bentazone should be effective.

Wild-oats

Infestations of wild-oats can cause severe yield reduction and interfere with harvesting. They must be controlled to avoid re-seeding in the following crop. Post-emergence graminicides such as Fusilade Max (fluazifop-p-butyl), Laser (cycloxidim) + oil, Pilot Ultra (quizalofop-p-ethyl), and Falcon (propaquizafop) give control.

Couch and Perennial Broad-leaved Weeds

Couch is best controlled with products containing glyphosate pre-harvest of cereals, or in the autumn, or pre-harvest of peas (except for seed crops). Although some graminicides offer control, recommended application rates are uneconomically high.

Glyphosate applied seven days pre-harvest will eradicate perennial broad-leaved and grass weeds. It must be applied when moisture content of the peas is 30% or less, at this stage the crop is overall yellow and senescent. It must not be applied to seed crops.

Other Grass Weeds

The post-emergence graminicides can control volunteer cereals and offer some reduction of black-grass and other grass weeds, however, resistant grass weed populations will cause problems. Laser has activity on only enhanced metabolism resistant black-grass populations. Falcon achieves some suppression of annual meadow-grass. Control with the graminicides, particularly of high populations of black-grass can be disappointing. Where black-grass is anticipated to be a problem, it is recommended that populations are depleted as much as possible by ploughing and the use of stale seedbeds prior to drilling.

Weed control images on these pages from © Blackthorn Arable Ltd.

Corn Marigold

Field Pansy

Fools Parsley

Fumitory


Sitona weevil larvae eating roots


Thrip damage in peas


Pea downy mildew


Pea Enation Mosaic Virus transmitted by pea aphid


Pea aphid

Many factors can affect growth of the pea crop, and the notes below describe the main pests and diseases which reduce yield and quality. Further information can be found in PGRO Technical Update TU15 *'Checklist of Fungicides and Insecticides for Combining Peas'.*

EARLY RISK PESTS AND DISEASES

Pea and bean weevil *(Sitona lineatus)*

Weevil may cause damage if large numbers appear when plants are small and in particular in cloddy seedbeds and in conditions of slow growth. Leaves of attacked plants show characteristic 'U' shaped notches around the edges, but the main damage occurs as a result of the larvae feeding on the root nodules. Sprays may be applied at the first sign of leaf damage and repeated after 7 - 10 days. **A monitoring system is available from Agralan Ltd (The Old Brickyard, Ashton Keynes, Swindon SN6 6QR) to predict the likely severity of attack.**

Field thrips *(Thrips angusticeps)*

Field thrips feed on the leaf surface of emerging seedlings which results in a thickening and puckering of the tissue. Seedlings may appear pale in colour. Although further damage can be checked by spraying, in the majority of cases the peas will outgrow the effects of thrips, and yield improvement may not be achieved following treatment.

Downy mildew *(Peronospora viciae)*

This disease produces resting spores, which persist in the soil and initiate primary infections in young pea plants. Though secondary infections can develop, particularly in cool, damp conditions, they are rarely as damaging as primary infections, which can kill plants before flowering. Fungicide seed treatment should be combined with varietal resistance to avoid serious losses. There are no foliar fungicides which give effective control.

PRE/EARLY FLOWER PESTS AND DISEASES

Pea aphid *(Acyrthosiphon pisum)*

Aphids can cause severe yield loss when present in large numbers, and early infestations can result in crops becoming infected with pea enation mosaic virus. Aphids should be controlled as soon as colonies can be found on 20% of plants, particularly where crops have commenced flowering. Yield can be improved by controlling aphids at any stage up to the time when four trusses of pods have been set.

Pea cyst nematode *(Heterodera gottingiana)*

Pea cyst nematode is a very persistent soil-borne pest, often causing severe yield loss. Frequent cropping of peas and *Vicia faba* beans favours the build-up of infestations, and an adequate rotation is essential to minimise the risk of occurrence. Affected plants are stunted and pale, and the root systems do not develop nitrogen-fixing nodules, but become studded with white, lemon-shaped cysts. Correct diagnosis is essential as subsequent pea crops grown in infested fields are subject to complete failure.

Pea cyst nematode cysts on pea-roots

Marsh spot /Manganese deficiency

Marsh spot is a disorder of peas, which is due to deficiency or unavailability of manganese. The deficiency causes the formation of a brown spot in the centre of many of the peas produced, and the produce is spoilt for human consumption and for use as seed. It is particularly associated with organic and alkaline soils. When symptoms appear in a crop, 5 kg/ha of manganese sulphate with a wetter, or an equivalent application of a manganese spray, should be applied at once in a high volume of water. Similar treatment must also be carried out when an affected crop is at first pod stage, and repeated 10 - 14 days later, in order to prevent the formation of marsh spot. In some seasons flowering is prolonged and a third manganese application will be necessary. The amount of manganese in some formulations (e.g. chelated manganese) may be too low to be effective at the rate recommended.

Manganese deficiency

Marsh spot in peas caused by manganese deficiency

LATE FLOWER/EARLY POD PESTS AND DISEASES

Pea moth larvae *(Cydia nigricana)*

These feed upon the developing seeds within the pod. Yield loss is minimal, but the effect on quality can be dramatic. Damage to the seed reduces the value of the produce. The Oecos pheromone pea moth trapping system should be used to assess the need for treatment and to forecast the date on which insecticides should be applied. To further assist growers in the use of their own traps, information is provided on optimum spray dates. Growers achieving a threshold catch in their traps can obtain a predicted date for spraying in the area by going to the PGRO web site (www.pgro.org). **Pea moth traps are available from Oecos at 11A High Street, Kimpton, Hertfordshire SG4 8RA.**

Pea moth trap

Leaf and pod spots

Leaf and pod spots are caused by three fungi, *Ascochyta pisi, Mycosphaerella pinodes* and *Didymella pinodella*, which may be spread by seed infection, soil or plant debris. The most frequent is *M. pinodes*, which can cause losses in both yield and quality in wet conditions. The use of disease-free seed will help to reduce the incidence of disease. There are no minimum standards specified by the statutory seed certification scheme for *M. pinodes* but seed, especially farm-saved, should be tested. Seed treatments are recommended for the control of disease at certain levels of infection. Fungicides such as azoxystrobin, metconazole, boscalid + pyraclostrobin and cyproconazole + chlorothalonil give useful control of the disease in the crop and can give yield increases when applied during flowering and pod set.

Pea leaf and pod spot


Pod botrytis in peas


Sclerotinia in peas


Pea Wilt


Pea foot and root rot


Pea bacterial blight

Grey mould *(Botrytis* spp*)*

This can affect stems and pods during wet weather, and is initiated when petals adhere to plant parts after pod set. One or two applications of fungicides at pod set and at the flat pod stage may be required to prevent Botrytis infection when wet or damp weather occurs during flowering. It may be necessary to select products which combine control of Botrytis and Mycosphaerella. However, in dry conditions, sprays during flowering are unnecessary. Suitable products include cyproconazole + chlorothalonil, boscalid + pyraclostrobin, cyprodinil + fludioxonil and azoxystrobin.

LATER DISEASE RISKS

Powdery mildew *(Erysiphe pisi)*

Occasionally late maturing crops may become covered with a grey-white film of powdery mildew. The disease can delay maturity. Cyproconazole + chlorothalonil applied for leaf and pod spot control will reduce powdery mildew. Sulphur formulations with Extensions of Authorisation for Minor Use (EAMU) for peas can be used to control powdery mildew.

OTHER DISEASE RISKS

Pea wilt *(Fusarium oxysporum* f. sp. *pisi)*

A soil-borne disease which can occur in any pea growing area, but is generally confined to fields with a very long history of peas. It can cause substantial reductions in yield, but is effectively controlled by genetic resistance. Race 1 appears to be the most common form. The majority of varieties are resistant to this race and growers using land in known high risk areas should select these.

Foot, root and stem rots

Several species of fungi cause foot and root rots. The effects of these diseases are particularly common on heavy land with a history of frequent pea cropping. Good drainage and avoidance of compaction can help to minimise losses. A soil test, which predicts the likelihood of soil-borne disease causing serious yield loss in future crops, is available. There are no means of controlling foot rots satisfactorily once they become established in a field, other than extended cropping with species other than legumes. *Sclerotinia sclerotiorum* causes a stem rot rather than a foot rot, but affects peas, spring beans, oilseed rape, linseed, and sometimes potatoes and certain field vegetables. This should be remembered when planning rotations in areas where Sclerotinia has occurred. Cyprodinil + fludioxonil or azoxystrobin applied at first pod can give useful control.

Bacterial blight *(Pseudomonas syringae* pv. *pisi)*

This is a potentially serious seed-borne disease, which can occur on all types of peas. Symptoms consist of water-soaked brown lesions on the lower leaves, stems and stipules, and become noticeable following periods of heavy rain, hail or frost. The lesions may coalesce and show a fan shape on the leaf, following between the lines of the veins. Some pod spotting may occur. Severe infections have not occurred in spring-sown peas and effect on yield has been negligible.

Harvesting peas must be carefully carried out as a premium is often available for high quality produce. Quality can be affected by wet weather at harvest causing staining in a lodged crop, and if destined for the packet trade, chip shop or export value is reduced if pea seed becomes bleached.

Yield is lost if peas are left too long in the field when shelling out and pod shatter occurs, therefore timely harvesting is essential. If left too long until moisture content is 12% MC, or if they are over-dried, the crop may be unsuitable for human consumption, the percentage of 'non-soakers' increases and the seed may split and crack.

Peas for micronising for pet food must also have a good blue/green colour. Peas for animal feed should be dry (about 15%) and free from moulds. Split or stained peas do not adversely affect the crop value.

If the crop is very weedy or uneven in maturity, a desiccant will aid combining by killing the weeds and hastening the drying out of the less mature haulm. A desiccant will not advance seed maturity. Treatment must be delayed until the peas on the least mature plants have reached the 'starchy' stage and can be marked by a fingernail and do not readily split. The top pods at this stage will be pitted and wrinkled while the lower pods will be at the parchment stage, and the foliage beginning to turn yellow. Reglone (diquat) has been widely used for many years. The addition of Agral or other wetter may be needed to kill volunteer rape. It is rainfast 15 minutes after spraying. The crop will be ready for combining 7-10 days after Reglone application.

If the crop is free from weeds and is dying back evenly, it can be left until it is dry enough to direct combine. Efficient lifters are helpful with badly lodged crops and it may be necessary to combine in one direction only.

It is possible for peas to pass through most combines without damage when the seed moisture content is about 20% and early harvesting at 18% avoids bleaching, shelling out losses and splitting or the deterioration in quality of human consumption or seed crops during wet weather. For animal feed peas, harvesting later when they are about 16% MC will reduce drying costs.

Drying and storage for peas needs to ensure that quality standards are met. These are usually 14% MC and 2% impurities ex farm, or a combination of both, which should not exceed 16%.

The relatively large seed size of peas makes drying more difficult than with cereals. Whilst damaged peas are still acceptable for compounding, mouldy produce is not. Considerable care must be taken not to over-dry peas. For human consumption peas, the drying temperature should not exceed 49°C if the moisture content is below 24%, or 43°C if the moisture content is higher. At higher temperatures, a tougher texture or splitting of the grain may result. For seed peas, the temperature should not exceed 43°C if the moisture content is below 24%, or 37°C if the moisture content is higher.

When the moisture content is high, two dryings may be necessary with at least two days between to enable the moisture to spread evenly throughout the bulk.

Any type of dryer may be used for peas, but those operating at low temperatures are safer.

- Floor-ventilated bins are easy and relatively safe to operate. When the initial moisture content is high, the transfer of the peas from bin to bin and the use of warmed air together with adequate ventilation may be necessary to avoid mould developing in the upper layers.
- Radially-ventilated bins allow faster drying than floor-ventilated bins, but care must be taken not to overheat the peas.
- On-floor drying using ambient or warmed air can be used, and provided there is sufficient volume of air and adequate ventilation, peas of relatively high moisture content can be dried using this method.
- Continuous flow driers designed to work on a short period/high temperature basis need more careful operation than other systems.

For safe storage, the maximum moisture content of peas depends upon the method and the length of time they are to be stored. Peas may be safely stored for up to 4 weeks at 17% MC, but if they are to be stored until the following spring, the moisture content should not be above 15%. If the peas are in bulk with forced ventilation or frequently moved, the moisture content can be 1% higher.

GROWING FIELD BEANS

Field beans *(Vicia faba)* are used for inclusion in animal feed, aquaculture, export for human consumption or pigeon feed, for which suitable winter and spring varieties are available.

They provide a useful break to reduce cereal pests and diseases and an opportunity to control grass weeds in an arable rotation. In wet years and on heavy soils, beans perform better than peas. Beans also suffer less from pigeon damage, they are easier to combine, and growing costs can sometimes be lower.

Beans, however, are harvested later than peas, and time of harvest is very dependent on seasonal weather in the August/September period.

Winter beans do not have a vernalisation requirement, although they are more winter hardy than spring types. In moisture retentive and fertile fields that produce tall, lush crops, short-strawed varieties could be an asset. Ascochyta is most likely to be a problem in wet conditions and varieties with good resistance are available.

CLASSIFICATION, CHOICE OF CROP AND QUALITY CRITERIA

Type

Beans are classified as winter and spring beans and are further classified by pale or black hilum colour or tic.

Winter beans are generally large-seeded with a thousand seed weight normally above 530 grammes. Spring varieties are generally smaller seeded. Tic bean varieties have small, rounded seeds, which may be suitable for the pigeon trade.

Pale hilum spring beans for export for human consumption and small-seeded beans for the pigeon trade attract a premium. Downy mildew can cause yield loss in some seasons, but varieties with good resistance are available. Early maturing spring beans can mature before winter beans. Early maturing beans have enabled the crop to be grown in Northern Britain.

A separate table of results from Scottish variety trials is included this publication.

Quality criteria

Quality standards for export to the Middle East for human consumption are high. Varieties with a smooth and pale skin and pale hilum are suitable for this market. It is important that samples are clean, sound and have low levels of bruchid beetle damage.

Samples for the pigeon feed trade should be small, round and have consistent colour.

Beans for compounding for animal feed must be free from moulds.

PGRO RECOMMENDED LIST OF WINTER BEANS

In the mild winter and where winter beans were planted early, vigorous growth gave rise to high levels of brackling, lodging and chocolate spot. Five of the nine trials went into the 2016 matrix. 2016 yields (5.73t/ha) were 17% higher than the 5 year average (4.89t/ha), with sites at Thorney and Hereford yielding close to 6.5t/ha.

Several candidate varieties were withdrawn from RL consideration by the breeders, so there were no new additions to the RL. Clipper was also withdrawn.

In the pale hilum category, Tundra, Wizard and Honey remain as fully recommended varieties. Bumble moves from P1 to P2 recommendation and joins Tundra as the top yielding pale hilum types at 104% of controls.

In the black hilum (feed) category Arthur was moved to the becoming outclassed category.

The control for yield comparisons is the mean of Arthur and Wizard. Yield differences of less than 4.5%(p=0.05) should be treated with caution.

Variety / type	Pale hilum				Black hilum
	Tundra	Bumble	Wizard	Honey	Arthur
	R	P2	R	R	O
UK Agent see appendix	LUK	Sen	Sen	Sen	Sen
Yield as % Control (4.89/ha) 5 year mean	104	104	97	93	103
Agronomic characters					
Flower colour (C=coloured)	C	C	C	C	C
Earliness of ripening	8	8	8	9	8
Shortness of straw	8	7	8	9	7
Standing ability at harvest	7	6	7	8	6
Seed characters					
Thousand seed weight (g)(@15%mc)	646	697	678	692	657
Protein content (%dry)	26.5	25.7	26.9	26.3	25.9
Year first listed	2014	2016	2003	2012	2007

Recommendation categories: R=Recommended, P1,P2=1st & 2nd year provisional recommendation. O=Becoming outclassed.

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

The scales of characters of winter beans do not necessarily correspond with those for spring beans.

Wizard, Arthur have resistance to leaf & pod spot (*Ascochyta fabae*).

Hilum colour. The export market usually requires pale hilum types

PGRO RECOMMENDED LIST OF SPRING BEANS

All ten spring bean trials were used in the 2016 matrix. 2016 yields (5.67t/ha) were marginally up on the 5-year mean (5.44t/ha). The highest yielding site was in Kent (6.52t/ha), but several others yielded over 6t/ha.

Pale hilum types Vertigo, Fanfare, Fury, Fuego and Boxer all remain as fully recommended varieties. New to the RL with a P1 recommendation is LG Cartouche (Limagrain UK). Yields were just 1% lower than the best, but it only has a 4 (same as Fuego) rating for downy mildew resistance. Lynx moves from P1 to P2 recommendation and joins Vertigo as the top yielding varieties. As in 2015 it has maintained a 7 rating for downy mildew resistance, the best amongst the pale hilum types. Pyramid and Bablyon were removed from the RL.

Black hilum tic bean Maris Bead remains with a full recommendation.

The control for yield comparisons is the mean of Fuego and Vertigo. Yield differences of less than 6.4%(p=0.05) should be treated with caution.

Variety / type	Pale hilum							Black hilum Tic
PGRO	Lynx	Vertigo	NEW LG Cartouche	Fanfare	Fury	Fuego	Boxer	Maris Bead
	P2	R	P1	R	R	R	R	R
UK Agent see appendix	LSPB	LSPB	LUK	LSPB	LSPB	LUK	Sen	WAC
Yield as % control (5.44 t/ha) 5 year mean	103	103	102	101	99	97	97	85
Agronomic characters								
Flower colour (C=coloured)	C	C	C	C	C	C	C	C
Earliness of ripening	6	7	7	7	8	7	7	6
Shortness of straw	5	5	7	5	7	6	6	4
Standing ability at harvest	8	6	8	7	7	8	7	5
Resistance to Downy mildew	7	6	4	5	6	4	4	7
Seed characters								
Thousand seed weight (g)(@15%mc)	509	564	535	527	512	550	547	388
Protein content (%dry)	27.4	27.6	29.8	28.3	27.8	27.7	27.5	29.3
Year first listed	2016	2013	**2017**	2013	2010	2005	2012	1964

Recommendation categories: R=Recommended, P1,P2=1st & 2nd year provisional recommendation, O=Becoming Outclassed

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

The scales of characters of spring beans do not necessarily correspond with those for winter beans.

Hilum colour. The export market usually requires pale hilum types

ADDITIONAL BEAN VARIETIES

The following varieties were promoted from NL2 to RL1 for 2017 after completion of National List trials in 2016 to be further evaluated in Recommended List Trials

WINTER BEANS

VARIETY	AGENT
Bering	LS Plant Breeding
IB153	Senova Ltd

SPRING BEANS

VARIETY	AGENT
Mallory	LS Plant Breeding

PGRO / SAC SPRING BEAN VARIETY TRIAL RESULTS 2011–13

These results have not been updated due to lack of reliable new data, but have been included for information.

Variety (n) = no. of trials	Yield as % control	Maturity 1 = Late 9 = Early	Chocolate spot 1 = susceptible 9 = resistant	Plant Height 1 = short 9 = tall	Brackling 1 = poor 9 = good
Babylon	108	6.7	8.0	7	7
Boxer	103	6.8	7.5	7	7
Fuego	100	6.5	6.5	6	5
Fury	100	6.7	8.0	6	6
Maris Bead	99	6.3	6.0	8	5
Pyramid	103	7.0	7.0	7	7
Fanfare	98(2)	7.0	7.0	6	*
Vertigo	104(2)	6.9	6.5	6	*

* Insufficient data

The control for yield comparison is the mean of Fuego and Fury in 2011, 2012 and 2013. 100% = 4.78 t/ha.

Unless indicated, variety means are over 3 years

There was no lodging / brackling at the Perth site in 2012/2013. The brackling figures are based at 2011 figures.

The SAC spring bean variety trials, funded by the PGRO voluntary pulse levy have been carried out in the Perthshire area.

NOTES ON RL TABLE RATINGS

TABLE CHARACTERS

1 - 9 ratings

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

Yield

Yields are expressed in percentage terms in relation to the mean (100%) of a number of control varieties. Provisionally recommended varieties may only have been in trials for three years, but a statistical adjustment makes their data comparable with fully recommended ratings for which yield is based on a five-year mean.

Standing ability at harvest

Expressed on a 1-9 scale from lodging data recorded within trials.

Shortness of straw

A difference of one point on the 1-9 scale represents approximately 8 cm for winter beans and 10 cm for spring beans. Differences are greatly influenced by growing conditions.

Earliness of ripening

A difference of one point on the 1-9 scale represents approximately two days for winter beans and three days for spring beans. Differences are greatly influenced by growing conditions and are usually extended in the north and west compared to the south and east.

Resistance to downy mildew

Downy mildew *(Peronospora viciae)* can sometimes be severe on spring beans. Varieties differ in their resistance to the disease and this is expressed on a 1 - 9 scale, a high figure indicating a high level of resistance.

Thousand seed weight

This characteristic is very dependent on growing conditions. Data are presented in grammes and reflect the mean 1000 grain weight recorded in trials over a number of sites and seasons. These data have been established from samples at 15% MC.

BEANS – UK AGENTS AND BREEDERS DETAILS

WINTER BEANS – UK AGENTS AND BREEDERS DETAILS

Agent code on RL	UK Agent	Breeder
LUK	Limagrain UK Ltd	Limagrain UK Ltd
Sen	Senova Ltd	Wherry & Sons

SPRING BEANS - UK AGENTS AND BREEDERS DETAILS

Agent code on RL	UK Agent	Breeder
LSPB	LS Plant Breeding	NPZ-Lembke (DE)
LUK	Limagrain UK Ltd	Limagrain Europe (FR)
Sen	Senova Ltd	Lantmännen SW Seed Hadmersleben GmbH (DE)
WAC	WA Church (Bures) Ltd	PBIC (UK)

In the UK Seed Certification Scheme, seed is graded as Basic (B), Certified Seed of 1st Generation (C1), and Certified Seed of 2nd Generation (C2). Basic and C1 seed is generally grown for the production of further seed crops and C2 seed is used for commercial crop production. Basic seed is the most expensive and C2 the least expensive. Certified seed is required to meet a minimum germination of 80% and to achieve a standard of purity.

Seed-borne leaf and pod spot *(Ascochyta fabae)* and stem nematode *(Ditylenchus* spp.*)* can be very damaging to field beans. It is strongly recommended that seed is tested for Ascochyta. It is advised that Basic seed should not contain more than 0.2% infection, C1 seed should not contain more than 0.4% and C2 seed should not contain more than 1% infection where a fungicide seed treatment is not used. It is also strongly recommended that seed is tested for the presence of stem nematode and only clean seed should be used. Seed tests are available from PGRO.

Seed treatments

Seed treatments are sometimes used on winter beans although they seldom produce a significant improvement in seedling establishment. Some control of seed-borne *Ascochyta fabae* is provided by Wakil XL which has an EAMU in beans until 31/3/2017, but the level of control is not considered to be good enough to be recommended for seed with more than 3% infection. Due to changes in the registration of Wakil XL, MAPP numbers must be checked before application. Seed treatments are not often used on spring beans, although Wakil XL will help to control primary downy mildew. Thiram can be used to control damping off.

Sowing

There is growing interest in direct drilling or minimum tillage drilling of both winter and spring beans. There is an advantage in the min-till system for spring beans where over-wintered stubble is part of the farm management scheme.

Winter beans can be broadcast or drilled onto the soil surface and then covered by shallow ploughing. However, both seed distribution and seedling emergence can be very uneven. More than half the area of winter beans is now drilled. Winter beans should not be sown too early - not before the second week of October. Crops which are too forward are more prone to disease and to the effects of severe winter weather. Sowing from mid-October to early November is usually the optimum time, but acceptable crops have been produced from early December drilling. Winter beans can be sown in the early spring. They should be treated as a spring bean, increasing the plant population to 36-40 plants/m^2.

Spring beans are best drilled as early as possible from late February onwards provided soil conditions are satisfactory. Later sowing delays harvest and may subject beans to summer drought stress at flowering. Ploughing-in is less successful for spring beans, and better yields are achieved where they are drilled conventionally. Sowing depth is important and the seed should be covered by a minimum of 3cm of settled soil where pre-emergence herbicides are used.

Seed rate and plant population

For spring beans, recent data from the Optibean project shows that maximum yields are obtained from 60-65 plants/m^2. But when taking into account seed cost and produce value, the economic target population is 50-55 plants/m^2. This is for soils/areas that produce typical bean growth. For fertile soils or areas that produce very vigorous growth, target populations should remain at 35-45 plants/m^2. Field loss for winter beans is expected to be 15% and for spring beans 5%. PGRO has produced a seed rate calculator as part of the Optibean tool (Excel based spreadsheet) and is available from the PGRO website.

Typical final target plant populations

Type	Varieties	Population plants/m^2
Winter Beans	General	18-20
	Clipper	22
	Wizard, Arthur	23-26
	Honey, Sultan	28
Spring beans (typical growth)	All	50-55
Spring beans (vigorous growth)	All	35-45

The seed rate can be calculated from the following formula:

$$\text{Seed rate kg/ha} = \frac{\text{thousand seed weight x target population plants/m}^2}{\text{\% germination}} \times \frac{100}{100-(\text{field loss})}$$

Rotation

To reduce the risk of a build-up of persistent soil-borne diseases such as foot rots caused by *Fusarium solani, Fusarium culmorum* and *Didymella pinodella,* field beans, broad beans, pea, green beans, vetches and lupins should be considered as forming a single crop group and, from the point of view of rotation, no more than one of these crops should be grown on any field every five years.

Cultivation

Beans do not require a fine seedbed and will tolerate cloddy conditions (although weed control may be poor) and over-cultivation should be avoided. Beans are sensitive to soil compaction, but are more tolerant of consolidation and waterlogging than peas.

Fertiliser

The requirements of beans are small and no N is required. Where P and K fertiliser is required, it is essential that it is put deep enough into the seedbed to allow full utilisation by the crop. Broadcast fertiliser should be ploughed shallow or applied over the furrows. It can then be worked in by subsequent cultivations, but the production of too fine a tilth and compaction must be avoided.

The fertiliser requirements of beans (kg/ha)

Soil index# N,P or K	N	$P_2 0_5$	$K_2 0$*	MgO
0	0	100	100	100
1	0	70	70	50
2	0	40	40(2-) 20(2+)	0
>2	0	0	0	0

KEY

\# According to soil analysis on the ADAS classification: 0 = very low, 1 = low, 2 = medium, >2 = high

* Not more than 50 kg/ha $K_2 0$ should be combine-drilled, otherwise germination may be affected. The rest should be broadcast

The amounts of phosphate and potash are appropriate to bean yields of 3.5 t/ha. Where yields are likely to be greater or smaller, phosphate and potash applications should be adjusted accordingly.

With only one post emergence product in spring beans it is important to get an effective pre-emergence herbicide applied.

Pre-emergence herbicide used.

Otherwise we could have problems later

Although bentazone works better at higher temperatures, it is recommended that applications are not made if temperatures shortly after application are likely to exceed 21°C. Higher temperatures give better efficacy but increase the risk of crop damage.

Weed infestations will reduce yield, and climbing species such as black-bindweed and cleavers can cause lodging. Effective weed control will ease combining. A checklist of the approved herbicides and timings for various weed problems is given for winter and spring beans in PGRO Technical Update TU24 *'Checklist of Herbicides for Beans',* and further information on choice of herbicide is given in PGRO Technical Update TU20 *'Choice of Herbicides for Field Beans'.*

Broad-leaved Weeds

It is essential that pre-emergence residual herbicides are used, since there is only one approved post-emergence herbicide which controls some emerged broad-leaved weeds. There are no herbicides to control thistles and docks - products containing MCPB, MCPA or clopyralid are damaging to beans. Most pre-emergence products have a minimum planting depth requirement and dose rate may be influenced by soil type.

If cleavers are expected to be a particular problem in winter or spring beans Lingo (linuron + clomazone) alone or Centium 360 CS (clomazone) in a suitable tank-mix

will be effective pre-emergence. Nirvana (imazamox + pendimethalin) is approved in both spring and winter beans and various pendimethalin formulations have EAMUs (Extension of Authorisation for Minor Use). Defy (prosulfocarb) has EAMUs for pre-emergence use in both winter and spring beans. Afalon (linuron) has approval for use in the spring crop.

In winter beans, residual herbicides Kerb (propyzamaide) and Crawler (carbetamide) offer limited control of broad-leaved weeds. They are chiefly used when black-grass, volunteer cereals, wild-oats and other annual grasses are expected to be a problem. There are no reports of black-grass resistance to either of these products and both are important tools in its control. Bentazone is the only active ingredient approved for post-emergence weed control. However, it has a limited weed spectrum and will not control annual meadow-grass, large fat-hen or black-bindweed. It is useful for control of small cleavers and oilseed rape volunteers which may not be controlled by pre-emergence materials. To avoid crop damage, it should be applied before 7 leaf pairs (winter beans) and before 6 leaf pairs (spring beans).

Products containing clomazone can cause a bleaching effect after emergence particularly if there have been wet conditions following application.

The early bleaching disappears over time but can reappear if wet conditions return later in the crop's development. This does not affect yield.

Heavy rainfall after application of pre-emergence products containing pendimethalin can cause cupping and distortion of leaves in both peas and beans. Unless very severe, this usually recovered from.

Late exposure to a sulfonylurea causing superfluous excessive tiller formation.

Weed control images on these pages from © Blackthorn Arable Ltd.

At early crop development and as long as soil conditions are suitable it is possible to achieve acceptable weed control in beans using a tined weeder.

Hemp-nettle

Knotgrass

Scentless Mayweed

Grass weeds, wild-oats and black-grass

Kerb and Crawler are for use only in winter beans and will control volunteer cereals, various grass weeds and are useful where black-grass is a problem especially if there are resistance issues. Fusilade Max (fluazifop-p-butyl), Laser (cycloxidim) + oil, Pilot Ultra (quizalofop-p-ethyl, Falcon (propaquizafop) post-emergence, all have some activity on wild-oats, black-grass, and volunteer cereals. Falcon gives some control of annual meadow-grass.

Couch and perennial broad-leaved weeds

As far as possible perennial weed problems should be tackled in the previous crop pre-harvest using glyphosate products. In the crop the rates required to achieve couch control with graminicides is uneconomic. Glyphosate applied pre-harvest on beans provides an excellent opportunity for eradication of couch and problem perennial broad-leaved species, but must not be used in crops for seed. It should be applied when all the pods are dry and black, and the seed is hard, with moisture content 30% or less, although the stems may still be green.

Weed control images on these pages from © Blackthorn Arable Ltd.


Annual Mercury


Annual Nettle


Wild Radish


Poppy

Bean weevil leaf damage

Stem nematode damage to bean plant

Primary infection of downy mildew in beans

Many factors can affect growth of winter and spring beans, and the notes below describe the main pests and diseases which reduce yield and quality. Further information can be found in PGRO Technical Update TU16 *'Checklist of Fungicides and Insecticides for Field Beans'.*

EARLY RISK PESTS AND DISEASES

Pea and bean weevil *(Sitona lineatus)*

The pest can cause damage to spring beans if large numbers appear when plants are small. Leaves of attacked plants show characteristic 'U' shaped notches around the edges, but the main damage occurs as a result of the larvae feeding on the root nodules. Sprays may be applied at the first sign of leaf damage and repeated after 7 - 10 days. A monitoring system for pea and bean weevil is available from Agralan Ltd., The Old Brickyard, Ashton Keynes, Swindon, Wilts, SN6 6QR. Winter beans, although still prone to attack are usually too advanced in growth for the weevil or the larvae to have any appreciable affect on yield, and spray treatment is justified only when pest pressure is very high and winter beans show retarded growth.

Stem nematode *(Ditylenchus* spp*)*

The nematode has become a major pest in field beans and can cause severe problems in wet seasons, particularly where farm-saved seed from an infested stock has been multiplied for several generations. The pest is seed-borne and can also infest soils, thereby becoming a problem for future crops of beans.
Seed should be tested for nematode, and only clean stocks should be sown.
For further information see PGRO Technical Update TU09 'Stem and bulb nematode in field beans.

Downy mildew *(Peronospora viciae)*

Mildew is prevalent on spring beans, where it causes greyish-brown, felty growth on the under-surface of the leaves. Some varieties have resistance to the disease and 1 - 9 ratings are given in the Recommended List of Varieties. However, metalaxyl M (SL567A EAMU 0917/13) mixed with another foliar fungicide may be may be necessary on the more susceptible types if infection begins at early flowering. There is an EAMU for Wakil XL until 31/3/2017 as a seed treatment for field beans which can give some useful early control of mildew on newly emerged seedlings and this should be combined with varietal resistance to avoid serious losses. Due to changes in the registration of Wakil XL, MAPP numbers must be checked before application to beans.

Leaf and pod spot *(Ascochyta fabae)*

This produces brown lesions containing distinctive black fruiting bodies (pycnidia). Winter beans are more prone to serious attacks which can develop in wet conditions but, since the disease is almost entirely seed-borne, it is advised that farm-saved seed should be tested by PGRO. Some winter varieties which are very susceptible to the disease may develop severe symptoms in wet years, particularly if growing near to previous years' bean fields where infection can be transmitted from bean volunteers. Resistant varieties are available and information is given in the main variety table. Some fungicides will give partial control of the disease.

Ascochyta fabae in beans

PRE/EARLY FLOWER PESTS AND DISEASES

Black bean aphid *(Aphis fabae)* and Pea aphid *(Acyrthosiphon pisum)*

Black bean aphid can be very damaging to field beans if colonies develop just prior to flowering. Spring-sown crops are usually more likely to suffer damaging attacks than winter beans. As well as forming dense, smothering colonies on the upper part of the stem, these and the less obvious pea aphid are able to transmit several viruses which add to the yield loss. Aphids can be controlled using pirimicarb as soon as 5% of the plants have been colonised. Care must be taken if using other insecticides, especially when flowers are present on the crop, as there is a serious risk to bees.

Black bean aphid

Chocolate spot *(Botrytis fabae)*

Symptoms appear as reddish-brown spots, which eventually enlarge to give a more damaging aggressive phase in cool, wet or damp weather. Winter beans are more likely to suffer yield losses, especially where the plant population is high and the crop becomes tall. Early fungicide treatment is essential if the crop shows symptoms at first bud or early flower. A second spray may be required 3 to 4 weeks later if damp conditions persist. Additional sprays are unlikely to be economic unless prolonged rain is experienced, and losses due to damage caused by the sprayer may be significant. Tebuconazole, azoxystrobin, metconazole, chlorothalonil + cyproconazole, boscalid + pyraclostrobin are effective.

Chocolate spot in beans


Bruchid damage


Bean rust


Sclerotinia

LATE FLOWER/EARLY POD PESTS AND DISEASES

Bean seed beetle *(Bruchus rufimanus)*

Bean seed beetle, also known as bruchid beetle, can affect both winter and spring varieties. Adults emerge from the seed leaving a circular hole. The beetles do not breed in grain stores, but damaged produce may not be accepted for quality markets. Adults fly to beans during flowering and lay eggs on developing pods. The larvae bore through the pod and into the seed, where they feed until mature. A pyrethroid insecticide approved for use during flowering should be applied using angled nozzles at early pod set following 2 consecutive days when the maximum daily temperature has reached 20°C and repeated 7-10 days later. For further details see PGRO Technical Update TU10 'Bean seed beetle *(Bruchus rufimanus)*'.

LATER DISEASE RISKS

Bean rust *(Uromyces fabae)*

The disease is characterised by numerous reddish-brown pustules on the leaves. It is more serious on spring beans and all varieties are susceptible. Most damage occurs if infection begins during flowering and pod set. Fungicides such as tebuconazole, cyproconazole, azoxystrobin, metconazole and boscalid + pyraclostrobin may improve yield in either winter or spring beans, but treatment is unlikely to be worthwhile if infection begins when pod fill is complete and the crop is beginning to senesce.

OTHER DISEASE RISKS

Sclerotinia *(Sclerotinia trifoliorum)*

This disease occasionally infects winter beans in damp autumn weather, and infections may be associated with preceding crops containing red clover. Plants develop a watery stem rot, which can spread from plant to plant in dense stands. The related fungus, *Sclerotinia sclerotiorum* infects spring beans and also peas, rape, linseed, lupins and a range of field vegetables. Infection in spring beans is, however, very rare, but the risk should be borne in mind when planning rotations with other host crops.

Foot, stem and root rots

These can occur on seedlings and on more mature plants, causing browning of the stem base and wilting of the leaves. Foot and root rots in beans appear to be more sporadic than those which occur in peas, and the bean crop in general appears less sensitive to root rots than peas. Nevertheless, growers should avoid over-cropping land with beans.

Text and image on this page from Dr Jake Bishop, University of Reading

Buff tailed bumblebee, ***Bombus terrestris***

Bean pollination

Field beans benefit from the activity of pollinating insects, setting seed by a combination of a) cross-pollination by bees, b) self-pollination facilitated by bees, c) spontaneous self-pollination without bees. The proportion of seed produced by each mode of pollination can vary with variety, level of cross-pollination in the previous generation, and with stress or disease.

Pollination by bumblebees increases yield of Wizard beans by around 15% under normal conditions compared to plants receiving no pollination. Quantified yield benefits in other varieties range from 17 to 30%, and can rise to over 50% when crops are affected by heat stress. Yields of bee pollinated plants can also be 20% less variable, and plants can have greater harvest index, shorter straw, and earlier ripening. It is unclear whether insect pollination changes seed size, and there is no evidence that it affects protein content.

Bean pollinators

The most common pollinator of beans is the Buff-tailed bumblebee *Bombus terrestris.* This pollinator is less effective than specialised long-tongued bumblebees, but more effective than honeybees. Many bees rob nectar from the back of bean flowers - this still improves pod set relative to no visitation.

Management for pollinators

Care must be taken regarding application of insecticides immediately before or during crop flowering.

Crop pollination by wild bees can be increased using floral and grass field margins. Floral margins can attract more pollinators of different types, and provide food and nesting resources through the season to maintain populations when crops are not in flower. Six years of experimentation in Buckinghamshire showed that converting 3 % (e.g. ELS) or 8% of land at field edges to natural habitat, mainly long grass for bee nesting, increased overall bean yield by 25% and 35% respectively compared to business as usual.

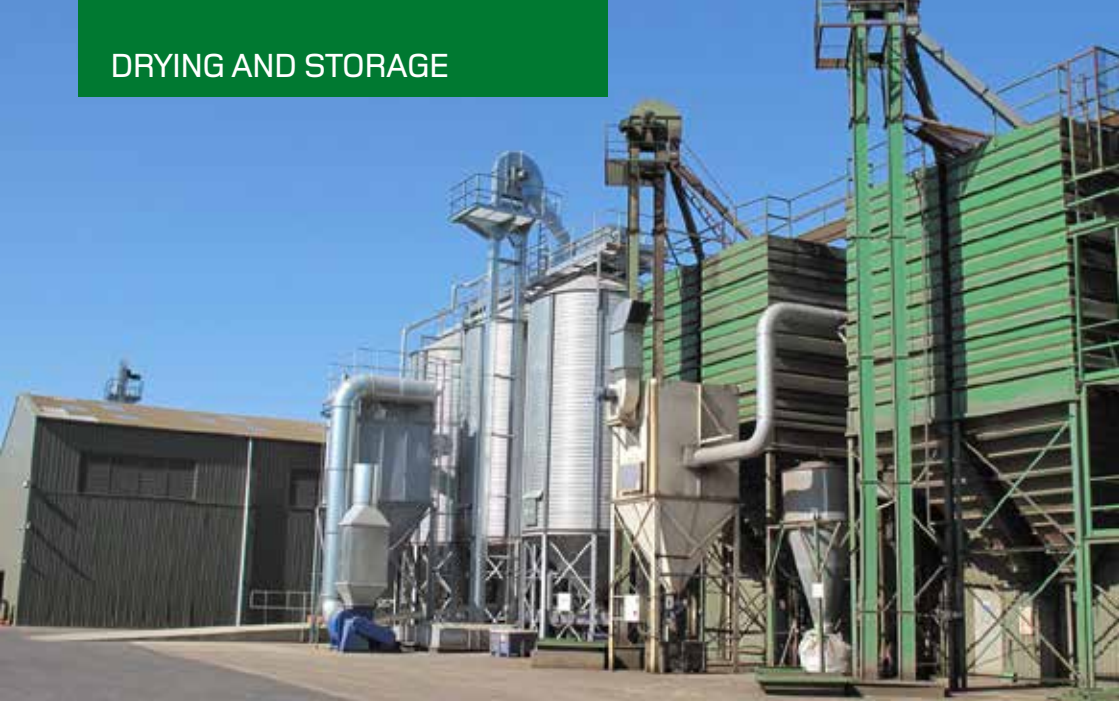
Bean harvesting dates will depend upon weather, variety and crop location, but spring sown crops are often earlier to mature than winter ones. Harvesting usually follows winter wheat. The bean crop is less affected by wet weather at harvest than peas.

Bean leaves usually fall during ripening and a desiccant has little effect on stems, so weed-free crops are not normally desiccated. If the crop is very weedy or has a few small late-set pods which are still green, a desiccant can aid harvesting. It should be applied when at least 90% of pods are dry and black and most seed is dry.

Bean pods blacken and seed becomes dry and hard first, but stems usually remain green for longer.

The pods will be easily threshed and the seed fit for combining at 18% MC but, to avoid combine blockages, it is best to wait until only a small percentage of green stem remains. If the seed is very dry, however, it may be damaged and seed crop quality may be reduced. If the crop is likely to shell out, losses can be reduced if the beans are combined when slightly damp in the early morning or evening.

DRYING AND STORAGE



The quality standard, ex-farm is usually 14% MC and 2% impurities or a combination of the two should not exceed 16%. Merchants may accept beans at 16% MC. Beans must be dried down to 14% MC for long term storage in bulk. This is important since beans are often stored for some time before they are sold.

The large seed size of beans makes drying difficult as beans have a low resistance to air flow. It takes time to move moisture from the inside to the outside and slow, gentle drying with ambient air is best. Mouldy produce is unacceptable for animal feed or other markets.

Where high quality is important, high temperatures in continuous flow driers should be avoided since they may cause cracking.

Floor ventilated bins are also suitable. When the initial moisture content is high, transfer of beans from bin to bin and the use of warmed air together with adequate ventilation may be necessary to avoid mould developing in the upper layers.

Radial ventilated bins allow faster drying than floor ventilated bins but care must be taken not to overheat the beans.

On-floor drying using ambient or warmed air is also successful, but care must be taken not to load beans too deep if moisture content is high and if lateral ducts are spaced wider than 1m.

Storage in dark areas is recommended for beans destined for the human consumption market in order to delay the development of tannins which cause beans to discolour.

WORLD CONTEXT

Combining peas and field beans make up the majority of pulses grown in the UK. However, there is a wide range of pulse crops not currently grown on a commercial scale in the UK that could be grown in the future as varieties and cultivation techniques develop – and our climate changes.

The current UK pulse crop of around 750,000 tonnes should be seen in the context of what is a major world crop of some 65 million tonnes, grown by over 170 countries throughout the world. World production is led by India, Canada, China, Myanmar and Brazil – and the top two countries will serve as examples of the wide range of pulse crops grown – ones both familiar and unfamiliar to UK growers.

India's pulse production of 15-17 million tonnes includes chickpeas, pigeon peas, urdbean, mungbean, lentils, field peas, horsegram and lathryrus, and these are grown across the country. India is the world's largest importer, producer, processor and consumer of pulses. Dal, a dried pulse that has been split and cooked, is a staple food for much of the population and has an exceptional nutritional profile. It provides an excellent source of protein, particularly for those adopting vegetarian diets or diets which do not contain much meat.

Canada grows peas, lentils, beans and chickpeas. Canadian pulse production is normally in the range of 4.5 to 5 million tonnes per year with Quebec and Ontario producing bean crops (a wide array of coloured beans as well as the white navy bean) while Manitoba produces white and coloured beans, peas and lentils. Saskatchewan is the largest producer of peas, lentils and chickpeas, and Alberta produces beans under irrigation as well as peas, lentils and chickpeas. Canada has become the world's largest exporter of peas and lentils and a leader in exports of chickpeas and beans – it exports approximately 75% of its production: pea exports mainly go into India, Spain, and China; lentils are distributed to several countries; a large percentage of beans go to the US and UK; and chickpeas are exported to Pakistan, India, Jordan and other countries.

GROWING OTHER PULSE CROPS IN THE UK

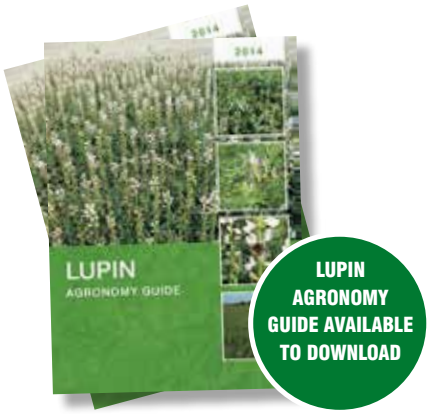
The main reasons that the other pulses are not grown in the UK are a mixture of our climate, land type, rotations, varieties available and the profitability against other competing crops such as wheat and oilseed rape. Indeed, the UK's pulse area has been static or declining for some time – however, recent EU reforms (discussed on page 5 of this guide) mean that the area of pulses is certainly likely to rise.

Whilst much of this increased area will be combining peas and field beans, it is worth taking a closer look at other pulse crops that could be grown more widely – perhaps eventually extensively - in the UK.

The project 'An Integrated Program for the Development of Lupins as a Sustainable Protein Source for UK Agriculture and Aquaculture' (LUKAA) was a joint initiative co-funded by the Sustainable Agri-Food Innovation Platform with industrial support from a consortium of food producers and research organisations. The project aimed to improve the agronomy of lupins in the UK, and provide a high quality component for livestock feed to reduce dependence on imported ingredients such as soya.

Lupins offer growers a pulse crop with significantly higher protein content than peas or beans - but certain varieties can be later maturing, or sensitive to alkaline soils.

A 'Lupin Agronomy Guide' giving the latest information on varieties and on crop husbandry is available for download from the PGRO web site (www.pgro.org). Reference should be made to the Guide – and to qualified advisers – if you are considering growing lupins.



NAVY BEANS

Navy (or haricot) beans are the raw material used for baked beans and are mostly imported. They belong to the same species as green beans *(Phaseolus vulgaris)* and have many aspects of husbandry in common. These include either the use of nitrogen fertiliser or Rhizobium inoculant. *Rhizobium phaseoli* which nodulate and fix nitrogen for Phaseolus beans are largely absent from most UK soils.

Navy beans are susceptible to frost and it is important that average soil temperature exceeds 10°C. This is usually from the beginning of May. Sowings made after 25th May can suffer from delayed harvest and reduced yields. Warm temperatures are required for optimum growth and harvesting is often not until late September/October.

Suitable areas for production are most likely to be in parts of England where the mean minimum temperature in June is above 10°C and the average rainfall in September is below 75 mm. *PGRO Technical Update TU30 'Notes on Growing Navy Beans' provides more details.*

SOYA

The UK area has until now been measured in hundreds rather than thousands of hectares. There is huge market demand for the produce in the UK, and with new varieties bred with the emphasis on yield, standing ability and earliness, contracts for growers in the southern half of the UK are available. CAP reforms have approved soya as an option under the greening regulations.

Soya agronomy is well established and straightforward. Much depends on selecting the correct variety in the first place. The following advice applies: Sow in late April/early May, apply an appropriate pre-emergence herbicide. Spray broadleaved weeds with post-emergence herbicide, usually around 5 weeks from sowing in late May. Apply a graminicide two weeks later if grass weeds are a problem and desiccate prior to harvest.

Contact PGRO for more details.

APPENDIX 1.

Key pea growth stages taken from BBCH monograph: Growth stages of mono - and dicotyledonous plants 2. Edition, 2001 (Weber and Bleiholder, 1990; Feller et al., 1995b)

	CODE	DESCRIPTION
Principal growth stage 0: Germination and emergence	00	Dry seed
	07	Shoot breaking through seed coat
	08	Shoot growing towards soil surface; hypocotyl arch visible
	09	Emergence: shoot breaks through soil surface
Principal growth stage 1: Leaf development	11	First true leaf (with stipules) unfolded or first tendril developed
	12	2 leaves (with stipules) unfolded or 2 tendrils developed
	1..	Stages continuous until
	19	9 or more leaves (with stipules) unfolded or 9 or more tendrils developed
Principal growth stage 5: Inflorescence emergence	51	First flower buds visible outside leaves (enclosed bud)
	55	First separated flower buds visible outside leaves but still closed
Principal growth stage 6: Flowering	61	Beginning of flowering: 10% of flowers open
	62	20% of flowers open
	64	40% of flowers open
	65	50% of flowers open (first pod)
	67	Flowering declining
	68	End of flowering
Principal growth stage 7: Development of fruit	75	50% of pods have reached typical length;
	79	Pods have reached typical size (green ripe): peas fully formed
Principal growth stage 8: Ripening of fruit and seed	81	10% of pods ripe, seed final colour, dry and hard
	88	80% of pods ripe, seed final colour, dry and hard (desiccation stage)
	8..	Stages continuous until
	89	Fully ripe: all pods dry and brown. Seeds dry and hard (dry ripe)
Principal growth stage 9: Senescence	97	Plants dead and dry
	99	Harvested product

Source: Extract from the internationally recognised BBCH crop growth stage key (BBCH - Biologische Bundesanstalt, Bundessortenamt and CHemical industry).

APPENDIX 2.

Key faba bean growth stages taken from BBCH monograph: Growth stages of mono- and dicotyledonous plants 2. Edition, 2001 (Weber and Bleiholder, 1990; Feller et al., 1995b)

	CODE	DESCRIPTION
Principal growth stage 0: Germination	00	Dry seed
	07	Shoot emerged from seed (plumule apparent)
	08	Shoot growing towards soil surface
	09	Emergence: shoot breaks through soil surface
Principal growth stage 1: Leaf development	10	Pair of scale leaves visible
	11	First pair of leaves unfolded
	12	2 pairs of leaves unfolded
	1..	Stages continuous until…
	19	9 or more pairs of leaves unfolded
Principal growth stage 5: Inflorescence emergence	50	Flower buds present, still enclosed by leaves
	51	First flower buds visible outside leaves
	55	First individual flower buds visible outside leaves but still closed
	59	First petals visible, many individual flower buds, still closed
Principal growth stage 6: Flowering and pod set	60	First flowers open
	63	Flowers open on 3 nodes per plant
	65	Flowers open on 5 nodes per plant
	66	Full flowering, Flowers open on 6 or more nodes per plant
	67	First pod set, flowering declining
	69	End of flowering
Principal growth stage 7: Development of fruit	70	First pods have reached final length
	75	50% of pods have reached final length
	79	Nearly all pods have reached final length
Principal growth stage 8: Ripening	80	Beginning of ripening: seed green, filling pod cavity
	85	50% of pods ripe, seeds dry and hard
	89	Fully ripe: nearly all pods dark, seeds dry and hard (Dessication stage)
Principal growth stage 9: Senescence	93	Stems begin to darken
	95	50% of stems brown or black
	97	Plant dead and dry
	99	Harvested product

Source: Extract from the internationally recognised BBCH crop growth stage key (BBCH - Biologische Bundesanstalt, Bundessortenamt and CHemical industry).

APPENDIX 3. PGRO PULSE TECHNICAL UPDATES

TU01	Manganese Deficiency & Marsh Sport
TU02	Pea Midge
TU03	Pea Moth
TU04	Silver Y Moth
TU05	Pea Aphid
TU06	Black Bean Aphid
TU07	Field Thrips in Peas & Beans
TU08	Pea & Bean Weevil
TU09	Stem & Bulb Nematode In Field Beans
TU10	Bean Seed Beetle
TU11	Bean Broomrape
TU12	Fungicides For Peas
TU13	Fungicides for Broad & Field Beans
TU14	Checklist Of Fungicides & Insecticides For Vining Peas
TU15	Checklist Of Fungicides & Insecticides For Combining Peas
TU16	Checklist Of Fungicides & Insecticides For Field Beans
TU17	Checklist Of Fungicides & Insecticides For Broad, Green & Runner Beans
TU18	Choice Of Herbicides For Vining Peas
TU19	Choice Of Herbicides For Combining Peas
TU20	Choice Of Herbicides For Field Beans
TU21	Choice Of Herbicides For Broad Beans
TU22	Checklist Of Herbicides For Vining Pea Crop
TU23	Checklist Of Herbicides For Combining Peas
TU24	Checklist Of Herbicides For Field Beans
TU25	Checklist Of Herbicides For Broad & Dwarf Green Beans
TU26	Volunteer Potato Control In Vining Peas
TU27	Harvesting Combining Peas
TU28	Notes On Growing Broad Beans
TU29	Notes On Growing Green Beans
TU30	Notes On Growing Navy Beans
TU31	Notes On Growing Organic Pulses
TU32	Pea & Bean Seed Quality
TU33	Seed Treatment For Peas & Beans
TU34	Soil-Borne Disease Test For Pea Fields
TU35	Electrical Conductivity Test For Vining Pea Seed
TU36	Pea Leaf Wax Assessment
TU37	Tenderometer Standardisation & Maintenance
TU38	Optional Extra Services
TU39	Maize in the Rotation
TU40	Peas - Top Tips for Yield
TU41	Cover Crops & Legume Based Rotations
TU42	Soil Sampling Guidelines
TU43	Bean Seed Fly

Conferences, Meetings and Training Seminars

The PGRO Conference Centre is an ideal setting for conferences, meetings and training seminars. It is available for hire throughout the year and offers flexible seating arrangements for up to 100 delegates. There is ample parking at the site and space for an outside marquee. There is also wheelchair access. Full catering is available from buffet sandwiches to hot meals, salads and BBQs.

Conference Centre

- Theatre style for up to 100 delegates
- Classroom style for up to 40 delegates
- Seats up to 20 people boardroom style
- Fixed Screen with overhead projector and audio equipment
- Free wi-fi connection
- Electronic voting system for up to 70 delegates

Meeting Room

- Seats up to 12 people boardroom style
- Screen and projector available on request

Seed Testing and Plant Clinic

The PGRO laboratory runs a seed testing facility offering a range of seed testing services for quality, vigour and seed health. Seed analysts carry out a range of tests for crop research and private seed testing contracts.

In particular, growers considering the option of farm-saved seed should seriously consider a full seed health check to ensure the seed they intend to use is suitable and the best choice for new crop.

- Germination and vigour testing
- Seed-borne diseases
- Fungal, bacterial and viral diseases
- Pests
- Stem and bulb nematodes
- Seed count and moisture content
- Thousand seed weight evaluation
- Waste and stain evaluation

TRAINING COURSES

Bespoke Courses

Pulse agronomy and other related courses can be arranged to specific requirements.

Call us to discuss your requirements

Contract Trials and Services

PGRO is accredited to **GEP** and **GLP** standards and carries out a large number of field trials annually. Our contract trials services and reports can be applied to all areas of crop evaluation:

- Variety trials
- Evaluation of new crop protection products and their development, in association with manufacturers
- Fertiliser & nutrients trials
- General agronomy
- New species evaluation
- The study of seed vigour, health and protection
- Crop husbandry requirements
- The control and commercial significance of pests, diseases and disorders
- Machinery evaluation
- Crop management and timing

Please contact us to discuss ways in which PGRO's contract services can meet your research requirements.

Go to www.pgro.org for full details

PGRO is a non-statutory levy body which is the UK's centre of excellence for peas and beans. It has a long history and a well-earned reputation for stability and consistency - along with a track record of providing authoritative, up to date information and project work based on solid, reliable research.

In recent years, there has been considerable change in the way the PGRO operates, and the PGRO of today is considerably different to that of even ten years ago.

The re-launch of the PGRO web site saw the focus turn towards refreshing the external image of the organisation. This web site is now more vibrant, modern and user friendly. To build further on that step, a new logo was accompanied by a refresh and standardisation of our presentation.

Our refreshed external image is also reflected in the redesign of this Pulse Agronomy Guide and the Vining Pea Guide as well as the continuing development of the Pulse Magazine, the official journal of the PGRO. It is produced in Summer, Winter and Spring and is widely circulated around the farming community and agricultural trade, reporting on the PGRO's R&D work on pulse varieties, pests, diseases and crop protection - as well as general agronomy issues - and on pulse markets in the UK and around the world.

The PGRO aims to maintain its valued stability and consistency and, for the future, to project a modern organisation of continuing relevance for research partners, collaborators and commercial clients, as well as maintaining the confidence of staff and levy payers alike.

For the latest PGRO crop updates, technical updates and other information visit our web site at www.pgro.org

Grateful acknowledgement is made for use of pictures to :
Frontier Agriculture Ltd, Limagrain UK Ltd, LS Plant Breeding Ltd and Syngenta UK Ltd.

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www.pgro.org

BEAN YIELD Challenge

Go to www.pgro.org for full details