

IENICA

Agronomy Guide

Generic guidelines on the
agronomy of selected industrial
crops

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This document was compiled with invaluable input from the IENICA partners and Advisory Group, in particular the Institute of Natural Fibres (INF) in Poznań, Poland.

For further information see www.ienica.net and:

INF and The FAO/SCORENA European
Cooperative Research Network on Flax and Other
Bast Plants (<http://iwn.inf.poznan.pl>)

INTRODUCTION

Whilst the markets for biorenewable and sustainable products from land-based industries declined during the 20th Century, environmental and other drivers are now causing a reappraisal of their potential and a likely increase in their production.

However, it must be realised that non-food products from plants or indeed animals are not necessarily better than those from fossil-based feedstocks. Equally, the agriculture of the European Union particularly in north west Europe is highly developed and relatively high cost in comparison with some other parts of the world and in some instances EU-produced feedstocks may not be able to compete economically in the marketplace with feedstocks from other parts of the world.

Nonetheless, other things being equal there are very significant markets in the EU for a wide range of sustainable biorenewables. These were confirmed in the original IENICA project (www.ienica.net).

Clearly the production of some broad-acre crops is well known and there is little virtue therefore in reporting it again here. There are however several plant species which have been shown to have considerably underexploited market potential and it is those that are reported here. Additionally this short summary begins with some generic markets and issues in the non-food sector with a view to putting their potential impact in perspective.

Melvyn F Askew
IENICA Co-ordinator
CSL, York

Sip de Vries
COPA-COGECA

SET-ASIDE

The set-aside system was introduced by the European Commission during 1992 as a means of controlling market supplies of cereals, oilseeds (defined as oilseed rape, sunflower and soyabean) and proteins in the European Union. Whilst set-aside levels are currently set at 10% of cereals, oilseeds and protein crop acreage overall, reductions in production of cereals at harvest 2003, caused by heat and drought conditions, led to a reduction in set-aside level to 5% for the 2004 harvest year.

EC regulations permit the production of a number of crops on set-aside land, provided that the use of these crops is primarily for the non-food sector. The primary crops grown on set-aside land in EU in recent years include:

- *Potatoes for starch production*
- *Maize for starch production*
- *Flax for use in textiles*
- *Rape for industrial uses*
- *Hemp for use in textiles*

Clearly therefore, set-aside arrangements, though primarily intended as a market management tool for food crops like cereals, have also shown to provide a basis for a non-food crop industry. Whilst this is true it has to be recognised that variations in the set-aside area make long term planning of non-food crops more difficult.

Also, it is essential to recognise that traditional agricultural crops have potential to fill both food and non-food market demands (e.g. oilseed rape oil, wheat starch and sugar from sugar beet). Moreover, most of these traditional crops have the potential to supply *both* food and non-food products

simultaneously (e.g. wheat grain for food and wheat straw for cosmetics manufacture or fermentation to bioethanol).

Current regulations for non-food set-aside also permit the planting of perennial crops, for example biomass for energy production on set-aside land.

ESSENTIAL OILS

Unlike vegetable oils, which are extracted from oleaginous seeds through traditional crushing/expulsion followed by chemical extraction from residual meal, essential oils can occur almost anywhere in the plant and are extracted by techniques such as steam distillation or super-critical CO₂ processes.

Essential oils only occur at very low levels in plants, relative to the storage oils of rapeseed or sunflower. Moreover their quantity and quality is often affected critically by time of harvest and harvest condition.

Whilst the market for stored vegetable oils is large, that for essential oils is very small. Conversely the value of essential oils is considerably greater per unit weight than that of the vegetable oils.

The essential oil market tends to be widely international and can be characterised by seasons of glut or shortage. Consequently buyers/traders of essential oils will hold stocks from year to year if the opportunity to buy well arises.

Much of the market for essential oils is traditional and many of the trading arrangements in the production-utilisation chain are well established.

Key factors in adding value are quality-assurance, traceability and reliability in delivery.

The nature of international business means that currency exchange is involved; with USA as a major market then the relative value of \$US is therefore a key element affecting profitability.

Anyone considering production of essential oils *de nouveau* would be strongly advised to establish and confirm stable markets before proceeding with any field production whatsoever.

It is to be noted that whilst named cultivars of some plants producing essential oils do exist there may well be clear chemo-types within that variety and that these chemo-types will have differing performances in terms of essential oil productivity.

For further information on essential oils, see the Essential Oils Market Information on the IENICA website.

ENVIRONMENT

There are a number of factors of agricultural policy which relate to the environment at present:

- CAP reform, cross compliance and a general move to Pillar 2 (i.e. environmental focus)
- Biodiversity
- Concerns over the global environment, greenhouse gases, global warming, pollution

Together these issues offer considerable potential for the sustainable use of biorenewable products provided that diligence is used in their selection and introduction or extension of production. It is essential to note that in future land-based industry

will be 'growing for' environmental benefit, amenity, cultural benefits plus traditional, saleable economic products – 'cross-compliance'. Also plants per se are not always equal in their contributions in these directions. For example, cotton produces a desirable fibre especially for apparel but currently has heavy demands upon agrochemicals and supplementary water supplies. However, albeit on a small scale of production, Stinging Nettle produces excellent fibre with low production inputs and considerable benefits to wildlife, both vertebrate and invertebrate.

STARCH

The production of starch is an international business usually based upon a least cost feedstock. Feedstocks include maize, tapioca, wheat and potato, this latter with EC aid which will continue at least in part in future. Production techniques are well documented already. Markets for starch are large and expanding. Data from the original IENICA project showed an estimated potential market for starch in EU-15 during 2000 of 3.7 million tonnes (used in paper-making, plastics, detergents and fermentation). Starches exist in two structural formats, broadly straight molecules (amylose) or branched molecules (amylopectin). Undoubtedly industry would prefer these in a pure state rather than in mixtures as occurs in plants at present.

Whilst the above data highlights past markets for starch use, considerable new markets are developing with starch-based polymers like PLA (poly-lactic acid). Such polymers are an extension of basic starch fermentation and are particularly attractive in the marketplace because of their widespread applicability to many uses. The key issues in

approaching production for this market are that of feedstock value (i.e. price) and tonnage availability. As markets extend it seems likely that feedstocks will be traded at commodity prices.

Brassica carinata (Ethiopian Mustard)

The plant has a wide growing range from the UK to North Africa; it is hardy and well adapted to the temperate climatic zones of Europe. The crop is still at an experimental stage. Current work on the crop suggests it may be most suited to semi-arid climates with mild or hot temperatures. Canadian trials suggest it can out-yield the best *Brassica napus* cultivars in these kinds of environments. The consensus is that the crop could be developed for use in drier areas where *Brassica napus* is less well adapted; this may include the Mediterranean basin. Developing the crop for use in these areas would allow oilseed production over a greater climatic range.

Sowing

Brassica carinata is both heat and drought tolerant but not very resistant to frost; as such best results are achieved by sowing in autumn in Mediterranean areas, whereas in cooler areas (Northern Europe) it is best sown from spring onwards. Sowing date has been found to have a much larger effect on yield than seed rates and, where environments allow, an early autumn sowing is likely to achieve best results.

The crop is much more vigorous and branched than rapeseed; therefore required plant densities are lower. Seeding rate does not seem to have a

dramatic effect on seed yields. Trials in Italy and Spain have found that seed rates between 100-200 seeds/m² have had little effect on seed yield. For biomass production a rate of 200 seeds/m² is preferred.

Nutrition

Fertiliser requirements are similar to those of *Brassica napus*.

Pests and Diseases

Brassica carinata has high levels of resistance to *Leptosphaeria maculans* (blackleg/phoma), *Alternaria* spp., *Sclerotinia* and *Phyllotreta cruciferae* (flea beetles).

Harvesting

Brassica carinata has good pod shatter resistance and can be harvested in the same way as *Brassica napus*, by combine harvesting after swathing.

End Uses

Average yields have ranged from 2t/ha up to 3t/ha in Canada. At present oil from *Brassica carinata* is regarded as low quality; seed breeding programmes must select cultivars to improve oil content, lower erucic acid and lower glucosinolate content. This would provide an edible quality oilseed crop for dryland conditions. High erucic acid *Brassica carinata* types may be suitable for biodiesel and for the production of plastics additives.

Useful References

- BioMatNet (1997) *Brassica carinata*: the outset of a new crop for biomass and industrial non-food oil production (online). Available from: www.nf-2000.org/secure/Fair/S490.htm
- Rakow, G. and Getinet, A. *Brassica carinata*: an oilseed crop for Canada: Proceedings from the International Symposium on Brassicas 97

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Cannabis sativa

(Hemp)

Cannabis sativa is an annual herbaceous plant ideally suited to mild temperate climates with min 670mm annual rainfall. The plant prefers fertile, slightly alkaline, silt or clay soils. The plant can attain heights of up to 4m. Established markets exist for hemp fibre and in excess of 10,000ha are now grown throughout Europe. In Europe hemp is mostly grown for fibre production although the crop can be grown as a seed crop for its oil content. 'Dual-hemp' cultivars which are shorter than conventional cultivars and are grown for both fibre and seed production are being developed.

Sowing

Fibre crops of *Cannabis sativa* require a higher plant density than for seed production. Currently hemp crops are usually sown at seed rates to achieve plant populations of 150-200 plants m². Recent work suggests that varying sowing density does not have a significant effect on yield. This is due to thicker crops self-thinning, and thinner crops compensating by producing heavier plants. Sowing density does have an effect on quality, however. Low plant densities resulted in thicker stemmed plants of lower fibre quality. It is suggested that optimal plant density is approximately 115-130 plants/m² and could consistently be achieved by sowing at 180 seeds m². This is considerably lower than current suggested rates of 300-500 seeds m².

Hemp for fibre production should be drilled as early as possible, after risk of hard frosts has past in order to maximise yield. Flowering is day length dependent and later flowering cultivars generally yield best. EC regulations dictate that harvesting must only take place after full seed set, so field conditions at harvest/retting must be taken into account when choosing these later cultivars.

Hemp crops for seed production should have much reduced sowing rates; seed rates as low as 100 seeds m² may be used.

Cultivars

The growing of this crop is subject to EU regulation due to the narcotic potential of *Cannabis sativa*. Local authorities must be contacted regarding the detailed rules and procedures before growing the crop.

Currently, only cultivars with less than 0.2% d-9 tetrahydrocannabinol (THC), the narcotic component of cannabis, may be grown in the EU. Cultivars selected for fibre production are long stalked and branch little. See http://www.gnis.fr/english/frame3_0.htm for European cultivars of hemp.

Nutrition

Hemp for fibre production is very responsive to fertiliser inputs; recommendations are 80-160kg/ha of nitrogen, 80-120kg/ha of phosphate and 160-200kg/ha of potash according to soil nutrient status. Dual hemp cultivars for seed production are less responsive to fertiliser inputs. 60-100kg/ha of nitrogen may be adequate; maintenance dressings of potassium and phosphorous may be adequate for dual hemp cultivars in all but deficient soils.

Pests and Diseases

Herbicides are not required for hemp fibre crops as the plant outgrows any competition. The two main diseases of hemp are *Botrytis cinerea* and *Sclerotinia sclerotiorum*, though treatment is neither practical nor economical. Hemp flea beetles (*Phyllotreta nemorum*) may also be present but control is not usually required due to the fast growing nature of the crop.

Harvesting

Fibre hemp must be swathed and left for retting for 2-6 weeks depending on weather conditions. Retting is the natural degradation of the crop to enable extraction of fibres later. Warmer conditions shorten this time period due to increased activity of the bacteria in this process. The crop is then usually baled. Seed production from short (seed) and dual hemp cultivars can be harvested with conventional combined harvesters, with the straw having a much shorter retting period of around 10 days.

End Uses

Hemp fibre production is moving into industrial textiles for the automotive industry and demand is strong. The fibre is also used in clothing, insulation and for specialist paper. The core of the plant is used in horse or poultry bedding. Hemp oil can be used for numerous personal care products and specialist nutrition, as it contains ideal ratios of omega-6 and omega-3 fatty acids. The hurds (short core fibres) can be used as plastic composites.

Useful References

- Bosca, I. and Karus, M. (1998) The cultivation of hemp
- IENICA crops database (2002) Hemp: <http://www.ienica.net/cropsdatabase.htm>

- IENICA Newsletter on Hemp, Issue 18, December 2002. Available from www.ienica.net
- Plants for a Future Database (2000) *Cannabis sativa*: <http://www.scs.leeds.ac.uk/pfaf/>
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- Van der Werf, H.M.G (1991) Agronomy and crop physiology of fibre hemp. A literature review. Centre for Agro biological Research
- Smith, N.O. et al, (1997) Crops for industry and energy in Europe, University of Reading, European commission, Luxembourg
- FAIR-CT95-0396 Project: Hemp for Europe – manufacturing and production systems. Co-ordinator M Bullard
- CNAP Hemp agronomy guide. Available from: http://www.york.ac.uk/org/cnap/oilcrop/crop_sind/hemp_agro.htm

Calendula officinalis

(Pot Marigold)

Calendula officinalis is hardy and well adapted to temperate climatic zones of Europe. It is a biennial but usually cultivated as an annual. It grows to between 50 and 70cm tall at maturity depending on cultivar. The crop is still at a development stage but moving towards commercialisation.

Sowing

Calendula seed is small and irregularly shaped; this can cause considerable problems with drilling. A

fine, firm seedbed with adequate moisture is required to achieve an even establishment. Plant populations should be between 40 and 60 plants/m² for oilseed production. Field emergence is usually 40-60% with germination 60-80% from good seedlots. Seed rates of 7-12kg/ha are usually used.

Sowing takes place in spring; *Calendula officinalis* is less sensitive to frost than sugar beet or linseed but light, easily warmed soils are preferred.

Nutrition

A light dressing of nitrogenous fertiliser (50kg/ha) has been found to increase biomass but not necessarily directly affect seed yield. Excessive nitrogen may increase lodging and disease problems.

Pests and Diseases

Weed suppression is important for good establishment and to prevent harvesting problems. Sowing into a stale seedbed is advisable. Pre-emergence herbicides may be an option but post emergence options are limited.

In UK trials the most significant pest encountered was the caterpillar of the moth *Heliothis peltigera* though this can be controlled by insecticides.

Diseases infecting the crop include *Botrytis cinerea*, and *Sphaerotheca fuliginea* (Powdery Mildew). A positive response may be seen from a fungicide application during flowering, and just after flowers begin to fall. *Sclerotinia* has also been reported and cropping closely in rotations with other susceptible crops such as oilseed rape and sunflowers should be avoided. Trials in the USA have reported Aster Yellows as a problem; crops are protected by controlling the leaf hopper (*Macrostelus fascifrons*) that transmits the disease.

Harvesting

Harvesting method is by direct combining; the crop may need to be desiccated due to non-uniformity of ripening. Swathing is not recommended as seed shedding is a problem. Yields are generally between 2.0 and 2.5t/ha.

End Uses

The crop is still at a development stage but moving towards commercialisation. The seed oil from *Calendula* contains about 60% calendic acid. This could be used in paint manufacture, varnishes, cosmetics and some industrial nylon products; it may also have wound healing properties.

Useful References

- Froment, M, Masterbroek, D. and van Gorp, K (undated) A growers manual for *Calendula*
- Cromack, H.T.H. Smith, J.M. *Calendula officinalis* production potential and crop agronomy in southern England. In Industrial Crops and Products Vol: 7, Issue: 2-3, January, 1998
- Project AIR2-CT93-1817 Vegetable Oils with Specific Fatty Acids (VOSFA) Agricultural and Industrial Development of Novel Oilseed Crops. Available from: <http://www.nf-2000.org/secure/Air/F212.htm>
- IENICA crops database (2002) *Calendula*: <http://www.ienica.net/cropsdatabase.htm>
- BioMatNet Item: Crops - Pot marigold (*Calendula officinalis*): <http://www.nf-2000.org>

Camelina sativa

(Gold of Pleasure)

Camelina sativa is an annual or winter annual that attains heights up to 90cm tall and it is best adapted to cooler climates where higher temperatures are not experienced during flowering. The crop was grown widely in Europe before 1950. Small areas have been grown in recent years and the crop has been the subject of projects to assess its future potential. Its climatic range extends from southern limit: 36°N (Gibraltar) to 70° N (Norway). There are several winter annual biotypes available. *Camelina* can be sown as a winter crop in areas where winters are mild, but sowings must be delayed to avoid plants becoming reproductive in early spring with subsequent frost damage. Spring sown crops may be more appropriate in some areas and can give good yields (up to 2.5t/ha). *Camelina* has a short growing season (85-100 days) so it could be used in double cropping situations in some areas.

Sowing

The seed of *Camelina* is small; seedlings emerge within 5-7 days and grow rapidly. Acceptable yields can be attained on poorer soil types as the crop is relatively drought tolerant. *Camelina* should be drilled shallowly but broadcasting is an option. Plant populations of 200-250/m² can be achieved from 5-7kg/ha seed.

Nutrition

Nutritional inputs for *Camelina* are relatively low. Trials suggest for both the spring and winter crop nitrogen requirements of 70-100kg/ha. The crop is not responsive to phosphorous and potassium, providing soil levels are not deficient.

Pests and Diseases

The crop is fast growing and competes well against weeds but pre-emergence herbicides where available may be the best option if perennial grass weeds and thistles are likely to be problematic.

Diseases affecting the crop are dependent upon location and climate. Trials of the winter crop in England and Ireland have found that *Sclerotinia* and/or *Botrytis* seriously limit yield potential, with the winter crop showing no resistance to these diseases. The spring crop seems to be more tolerant of these diseases. Downy mildew (*Peronospora camelinae*) is reported in the USA as being the main problem found in later-sown crops with this also noted in the UK. Flea beetle (*Phyllotreta cruciferae*) may also be observed on *Camelina* although due to its strong growth vigour, control is not usually required.

The crop is resistant to blackleg (*Leptosphaeria maculans*) which may be a problem with oilseed rape. It is very resistant to *Alternaria brassicae*

Harvesting

Harvesting can be carried out using a conventional combined harvester; the crop stands well up to 6 weeks after maturity and seed loss is generally low. Yields range from 1.2 to 2 t/ha.

End Uses

The crop is used in the cosmetic industry, and in paint manufacturing, with its by-products used in animal feeds. It may also be an alternative source to oilseed rape for biodiesel.

Useful References

- Putnam, D.H., Budin, J.T., Field, L.A. and Breene W.M. *Camelina*: a promising low-input oilseed p. 314-322. In: Janick, J. and Simon, J.E., (eds.), *New Crops*. Wiley, New York

- Smith N.O., Maclean I., Miller F.A. and Carruthers S.P., *Crops for industry and Energy*, The University of Reading, European Commission, Luxembourg
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- Bonjean, A. and Le Goffic, F. (1999) *Camelina sativa*: an opportunity for European agriculture and industry. OCL vol.6 No.1 pp28-33
- Project AIR3-CT94-2178 Alternative oil-seed crop - *Camelina Sativa*. Coordinator: Dr Josef Zubr, Royal Veterinary and Agricultural University, Denmark. Available from: <http://www.nf-2000.org/secure/Air/S210.htm>
- IENICA crops database (2002) *Camelina*: <http://www.ienica.net/cropsdatabase.htm>

Crambe abyssinica

(Crambe)

Crambe is well adapted to a broad range of climates. It can be grown as far south as Venezuela and as far north as Sweden. It is relatively drought resistant due to a long tap root. A temperature range of 15-25°C is required over the main vegetative period. The crop is not frost resistant. Temperatures below 0°C will severely damage or kill plants at any stage. The crop is best suited to spring cropping in colder areas. A frost free period of 60-100 days from emergence is required. Crambe has been grown on a wide range of soil types with preference for sandy loams. pH requirement is 6.0-7.0 or slightly higher.

Sowing

Crambe is usually drilled in rows of around 12-15cm spacing to a depth of 1.5-2.5cm. During establishment it is most important to produce a plant stand which is competitive with weeds. Target plant density should be approximately 100-120 plants/m². A seed rate of around 20kg/ha is usually enough to achieve this in normal conditions.

Nutrition

Fertiliser requirements are similar to other spring oilseed crops; best results may be achieved with around 150kg/N applied to seedbeds.

Pests and Diseases

Young plants may be at risk from slugs depending on soil conditions and birds may cause seed losses at ripening. Seedlings may be attacked by flea beetle (*Phylltreta cruciferae*). Also pollen beetle (*Meligethes aeneus*) may attack young flower buds; a yield response has been observed where bee friendly insecticides were used.

Crambe has been found to be susceptible to *Alternaria* and *Sclerotinia* and a well-timed fungicide application at the mid-flowering stage has had a yield response (up to 1 t/ha) and may also improve oil content. Fungicide dressed seed may also be beneficial. Plants are susceptible to the same range of pests and diseases as those of oilseed rape including beet cyst nematode (*Heterodera schachtii*). This should be borne in mind in planning crop rotations.

Harvesting

Yields are variable ranging from 1.25-3.7t/ha. Crambe can be harvested using a conventional combined harvester; desiccation through swathing or by chemical means may be advisable as maturity can be uneven.

End Uses

The main use of Crambe is based on its erucic acid content which is used as a slip agent in plastics. Erucamide derived from Crambe oil can be used for industrial purposes and in some cosmetic preparations. Processed seed meal can be used in animal feeds. Demand for Crambe oil has seen rapid uptake of the crop recently in the UK.

Useful References

- Plants for a Future Database (2000) Crambe (online). Available from:
<http://www.scs.leeds.ac.uk/cgi-bin/pfaf/>
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- Springdale Crop Synergies – Crambe Grower Information. Available from:
http://www.york.ac.uk/org/cnap/oilcrop/crop_sind/crambe_agro.htm
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<http://www.hort.purdue.edu/newcrop/afcm/crambe.html>
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<http://www.ext.nodak.edu/extpubs/alt-ag/crambe.htm>

Linum usitatissimum

(Linseed)

Linseed is well suited to a cool, humid climate but is susceptible to severe frost as well as drought. Drier environments may need to provide irrigation for full yield expression. Linseed has been grown as a break crop throughout Europe for a number of years.

Sowing

Linseed is suited to a wide range of soil types. Establishment can be difficult on heavy clay soils which are best avoided. A fine tilth and adequate moisture are required to ensure good establishment. Cultivations should minimise soil compaction so that the tap root is able to penetrate down to available water. Optimum pH is 6.0-7.0.

There is no advantage from sowing early into a cold seedbed. Acceptable yields can be achieved from later sowings. Seed should be drilled into rows at a spacing of 9-12cms and a depth of 1.5-2.5cm, or slightly deeper into dry soils. A plant population of 400-500 plants/m² is desirable. At lower plant densities the plants are less competitive with weeds and lead to increased branching and uneven ripening.

Nutrition

The plant is not responsive to phosphorous or potassium. Maintenance dressings of 50kg/ha may be adequate in non-deficient situations. Nitrogen applications should be made to the seedbed at rates of 50-100kg/ha depending upon previous cropping.

Pest and Diseases

Linseed does not compete well with weed species and therefore the chemical control of perennial grass

and broadleaved weeds is required. The crop is susceptible to *Sclerotinia sclerotiorum*, *Fusarium oxysporum* (wilt) and *Botrytis cinerea*. Alternative hosts for these pathogens include oilseed rape, peas and beans. At least a 4 year break is required from these crops to control these; additional seed treatments may be advisable. Flea beetle (*Longitarsus paryulusmay*) causes considerable losses and as such should be monitored and where justified insecticides applied.

Harvesting

The seed of the crop matures before the stems dry out and as a result linseed must usually be desiccated chemically. The crop can then be harvested using a conventional combined harvester. However the fibrous stems can cause the harvester considerable problems particularly in incompletely desiccated, wet or lodged crops. Yields range from 1.5-2.5t/ha.

End Uses

Linseed oil is used in paints, varnishes and linoleum manufacture. Edible oil cultivars are being introduced. The by-product of linseed cake can be used in animal feeds.

Useful References

- Halley, R.J., Soffe, R.J. The Agricultural Notebook, 20th Edition, Blackwell Scientific Publications
- HGCA (2002) *Descriptive List of Spring Linseed 2002* (online). Available from: www.hgca.com/default.asp?InitialPage=/varieties/200212/archive.asp
- Plants for a Future Database (2000) *Linum usitatissimum* (online). Available from: <http://www.scs.leeds.ac.uk/pfaf/>

Linum usitatissimum

(Fibre Flax)

Linum usitatissimum is widely grown also as a fibre crop in Europe.

Sowing

Target plant density for fibre crops of linseed is 2000 plants/m², to minimise basal branching and so improve fibre quality.

Cultivars

Cultivars are selected to produce long fibres of good quality. A recent introduction in France has been a winter cultivar that can be grown at temperatures as low as -10°C. This has considerable benefits as retting (see later) can be carried out earlier (June rather than July in France) under more favourable conditions.

Nutrition

Soil phosphate and potassium requirements are the same as for linseed production. Nitrogen applications for fibre production should be much reduced compared to that of Linseed. Flax crops are frequently given no nitrogen at all. This discourages sappy growth improving fibre quality.

Pest and Diseases

Diseases affecting cultivars for flax production are the same as for linseed (see earlier). However the higher plant densities used may increase vulnerability to these diseases.

Harvesting

Flax crops intended for best quality fibre production are 'pulled' when the lower leaves have fallen. This

allows the full length of fibres to be obtained. The crop is then 'retted' on the ground. Dew retting is the process normally used in Northern Europe whereby the action of dew, rain and sun helps to dissolve the outer bark and leads to natural decomposition of the pectins that hold the fibres together. After drying the flax can be rolled and stored.

End Uses

Long fibres are used for weaving, spinning into yarn and geotextiles. Shorter flax fibres are used for packaging materials and plastic alternatives. Dual purpose cultivars are being introduced whereby the crop is harvested using a conventional combined harvester and the resulting straw is processed into specialist paper products, composite materials and biodegradable matting. Yields from fibre flax may exceed 1t/ha.

Useful References

- Wiseman, A.J.L., Finch, H.J.S, & Samuel, A.M. (1993) Lockhart & Wiseman's Crop Husbandry 7th Ed Pergamon Press
- Rowlands, C (1997) A Brief Guide to Good Agronomic Practice in the Production of Fibre Flax ADAS
- IENICA crops database (2002) *Flax*: <http://www.ienica.net/cropsdatabase.htm>
- IENICA report from the state of the United Kingdom: <http://www.ienica.net>

Urtica dioica

(Stinging Nettle)

The common Stinging Nettle is abundant in the wild throughout the temperate regions of Europe and Asia. Nettles have been used throughout history as a source of fibre and recently there has been renewed interest in developing the crop commercially for fibre production.

Sowing

Nettles will grow in most soils although a deep rich soil is preferred for fibre production. Nettles can be sown directly into a field situation in autumn for establishment in spring or propagated in a nursery and then transplanted in autumn. Recent work in Austria has used cuttings rooted in a glasshouse and transplanting into the field after approximately six weeks. The nettles were transplanted into rows 75cm apart with spacing within rows of 50cm.

Nutrition

The crop is very responsive to nitrogen and phosphate fertilisers. Up to 300kg/ha of nitrogen may be required for highest yields.

Cultivars

Modern cultivars are selected for fibre contents of approximately 15% of dry stem mass.

Pests and Diseases

Nettles are very competitive and weed control is not necessary where the crop establishes well. Poorer soils where nettles do not establish as well may allow weeds such as thistles and dandelions to suppress development and create contamination.

The pests and diseases affecting the crop are largely unknown. Mildew has been present on some cultivars; aphids and butterfly larvae have also been observed.

Harvesting

Investigations into harvesting time on fibre quality have been conducted at the Institute for Applied Research of FH-Reutlingen, Germany. Results suggest the optimum to be when a substantial amount of leaves have fallen, but before new shoots have formed. Yarns are produced from the dry stems after decortication. The work from Austria has shown very variable yields, attributable mainly to soil conditions and plant establishment. Plants reached up to 180cm height. Yields of dry stems ranged from 3-4 t/ha on poorer soils and up to 10t/ha on the better plots.

End Uses

The cultivated forms of *Urtica dioica* have similar properties to flax and hemp. Potential applications include textiles, paper, culinary, medicinal and biomass uses. There is no commercial production at the present time.

Useful References

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Send any comments, additions or amendments for this Guide to ienica@csl.gov.uk

Central Science Laboratory, Sand Hutton, York YO41 1LZ
Tel: 0044 1904 462300

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