

**Last updated:** October 2005

## **CRAMBE (Abyssinian mustard)**

**Family:** *Cruciferae*

**Genus:** *Crambe*

**Species:** *abyssinica*



Source: Springdale Crop Synergies

### **Contents**

[General Background](#)

[Details of Quality Characteristics](#)

[Current Production and Yields](#)

[Constraints upon Production](#)

[Markets and Market Potential](#)

[Other Information](#)

[Research](#)

[Useful Websites](#)

[BioMat Net](#)

[Contacts](#)

[References](#)

## **General Background**

Crambe is also referred to as Abyssinian mustard, Abyssinian kale, colewart or datran.

A branching annual crucifer with a long, swollen tap root and large leaves that has been adapted as a spring crop. Interest in crambe has resulted because its oil is high in erucic acid. Despite its name it probably originated from the Turko-Iranian area of SW Asia.

Crambe is an erect annual herb with large pinnately lobed leaves similar to mustard leaves. Plant heights vary between 1 and 2 m, depending on the season and the plant density. The crop exhibits an indeterminate flowering habit and may continue to set seed late in the season. Typically the flowering period is approximately 3 weeks. The flowers are white, small and borne on long racemes. The main stem branches near the ground to give up to 30 or more secondary stems which branch again to give tertiary stems. The extent of branching is affected by cultivation method. Extensive branching is considered a disadvantage for mechanical harvesting as each stem ends in a terminal raceme. Branching is more pronounced at lower seed rates as the crop bushes out.

The flowers are numerous and small and produce small brownish seed cases or small capsules of c. 5 mm diameter. The beige capsule consists of two parts - a terminal spherical capsule and a much smaller cylindrical lower segment. Each capsule contains a single spherical seed which is greenish brown in colour and 0.8-2.6 mm in diameter which is very light (30lbs/bushel). The capsule usually remains on the seed after harvest. The first pods will usually remain on the plant until the last pods mature. Delayed harvest, and hard rains or hail near maturation can increase shattering.

Crambe's center of origin is the Mediterranean region, it is also prevalent across Asia and western Europe. Crambe is a plant of moderate rainfall, warm-temperate regions and does not possess a high level of frost resistance. It has adapted to colder or drier areas and in Northern Europe can be grown as a spring crop if sown once the risk of frost has passed. It has been grown commercially and experimentally on a wide climate range. The penetrating tap root which can reach depths of well over 15cm enables the plant to be relatively drought resistant later in the season.

Crambe requires an average of 52 days between planting and flowering. The flowering period usually ends about 12 – 15 days before physiological maturity. Present cultivars of crambe require between 83 and 105 days from date of planting to reach physiological maturity. Heavy commercial crops which have been grown in the UK and received reasonable agronomic inputs including a fungicide may mature slightly later than this depending on the season.

### **Details of Quality Characteristics**

#### **Seed Composition:**

Oil Content 35-60% (35% most common)

Protein Content 20-40% (28-30% most common)

Proportion of fatty acids (%) in crambe oil.

<b>Fatty Acid</b>	<b>% of total</b>
Palmitic C16:0	1.8
Stearic C18:0	0.7
Oleic C18:1	17.2
Linoleic C18:2	8.7
Linolenic C18:3	5.2
Eicosanoic C20:1	3.4
Erucic C22:0	56.2 (58-66)
Brassicic C22:1	0.7
Tetracosanoic C24:0	0.7
Nervonic C24:1	1.6
Others	2.5

The proportion of kernel to husk affects oil yield which is reduced under moisture stress during capsule formation and filling. After pressing the residual meal constitutes 50-60% protein. Heat during extraction can reduce metabolites and can increase the value of the meal as a stock-feed.

### **Current Production and Yields**

Crambe has been the focus of much attention in the past and has reached commercial status in North America where it is grown for its erucic acid content mainly for industrial purposes. In Europe, commercialisation has not come far, but in the UK, Springdale Crop Synergies Ltd (see below for address) has fully commercialized the growing of this crop (2001) and production has reached several thousand hectares.

#### **Crambe cultivated on set-aside areas in the UK (ha)**

	2001	2002	2003	2004
UK	499	1,171	3,596	1,101

Source: IENICA update report from the State of the UK (2004)

There has been considerable EU funding over the past few years aimed at developing the crop as well as finding additional uses for the oil and the seed meal.

Crops in the UK grown under contract to Springdale Crop Synergies Ltd have produced yields in excess of 3000kg/ha, and well grown crops average approximately 2500kg/ha. Experiments in Italy produced a highest seed yield of 810 kg/ha, although the Italian average seed yields for *C. abyssinica* were 441.3 kg/ha with 1030 kg/ha straw (1). In Germany yields averaging 2t/ha have been recorded at 30 - 40% oil content. As crambe is not included in the Blair House Agreement it can be cultivated on set-aside without restriction.

The following countries have shown a scientific interest in Crambe (where country is followed by (P) indicates growth under Pilot stage/small area)

Austria, Belgium, Denmark, France, Germany (P), Italy (P), Netherlands (P), Portugal, Sweden, UK (P)

### **Constraints upon Production**

Damage by birds during ripening. Not seen as yet in UK production this far. Pigeon damage during the growing season has been sporadic and localized.

Highly sensitive to low temperatures at sowing and at flowering. Newer cultivars show more tolerance to lower temperatures, and in the UK varieties have tolerated temperatures slightly below freezing for a few hours without impacting on final yield.

Drought stress during flowering or seed set may cause loss of yield and reduction in oil content.

The first pods will usually remain on the plant until the last pods mature. Delayed harvest, and hard rains or hail near maturation can increase shattering.

Selected fields should be free of weed problems, due to the lack of registered crambe herbicides (the exception is Teflan). Off label approval of products which have clearance on mustard have been successful, and in the UK a number of pre and post emergence products have been used on crambe.

### **Markets and Market Potential**

#### **Potential uses of Crambe oil**

<b>Oil Product</b>	<b>Uses</b>
Triglyceride (refined oil)	Pharmaceuticals, lubricants, heat transfer fluids, dielectric fluids, waxes, fish food coating agent
Erucic acid	Erucamide, plasticisers, antistats, corrosion

	inhibitors.
Behenic acid	Behenamide, antifriction coatings, mold release agents, processing aids, flow improvers, cosmetics.
Erucyl alcohol	Surfactants, slip and coating agents.
Behenyl alcohol	Surfactants, slip and coating agents.
Wax esters	Lubricants, cosmetics.
Fatty acids	Existing markets for C18-C22 acids and their amides.
Brassylic acid	Nylon, perfumes, plasticisers, synthetic lubricants, coatings, flavours.
Pelargonic acid	Perfumes, plasticisers, synthetic lubricants, coatings, flavours.

Source: <http://www.springdale-group.com/speciality.crops/crambe.htm>

Erucamide has two functions when added to plastics.: as a lubricant to ease the production of plastic parts, and to provide a thin layer of lubrication on the extruded plastic film surface, reducing the coefficient of friction, acting as a ‘slip-agent’

### Potential uses of crambe seedmeal

Seedmeal product	Uses
Processed meal	An animal feed
1-cyano-2-hydroxy-3-butene	A soil amendment for the inhibition of weeds and soil pathogens. (A green manure). (7)

2-(S)-1-Cyano-2-hydroxy-3-butene	Insecticide against the house fly ( <i>Musca domestica</i> ). (8)
Phenylethyl cyanide	Insecticide against the house fly ( <i>Musca domestica</i> ) (8)

The market for high oleic oils for industrial applications has been based on tallow as the source of oleic for which the global technical market in 1997 was 20,000 to 25,000 tones. However, following the BSE crisis there has been a move by some end-users to look for vegetable oil-derived alternatives(6).

The main value of crambe is its erucic acid content, and it is therefore in competition with High Erucic Acid Rape (HEAR). The properties of HEAR lies in its lubricity, wettability, reactivity (oleochemistry), high smoke point, fairly good oxidative stability, biodegradability, and it is thought to have low ecotoxicity.

The largest current applications for High Erucic Acid (HEA) oil are in polymer additives and detergents. As the crude oil is biodegradable it provides an alternative to mineral oil in many industrial applications. It may have application as a lubricant for chainsaws. The market for HEA oil in Europe is currently estimated to rise by 4-5% annually to reach 55 000t by 2005 (10).

UK Official statistics in 1997 put gross margins for crambe at £337.94/ha. However due to the improved varieties and husbandry techniques available the actual Gross Margins achieved by growers far exceed this value. Springdale can be contacted for further detailed information (see contact details section). be: oleochemicals (erucamides >20,000t/yr, erucyl alcohol, behenil alcohol), speciality market 40,000t/yr. HEAR imports from the UK, Germany and France are approximately 10,000t/yr. It is estimated that from the year 2000, 10 - 15,000 tonnes of high erucic acid oil will be required and that Crambe may be able to help meet the extra demand.

The gross returns for Crambe have been estimated as similar to or better than sunflower in the USA. However, profits decrease as transportation distances increase, due to Crambe's light bushel weight. (A. Grombacher et al 1996).

In addition, when crambe seeds are processed for oil, the by-product is a high protein meal for feed use. The meal contains 45-58% protein (with the pod removed) and a well balanced amino-acid content, especially high in lysine and methionine. Protein levels of 28% are achieved when crushing whole seed. In the USA prior to processing, the meal is approved to use with ruminant animals for up to 5% of the daily intake. Some techniques during processing produce proteins free of gls which can be used for animal feed without limitation. These meals can also be used as constituents of plywood adhesives or as sources of protein isolates (1).

### **Advantages of Crambe over HEAR (High Erucic Acid Rape)**

The crop has several advantages over HEAR:

1. As crambe is not a Brassica it is useful in crop rotations for alleviating weed, pest and disease build-up.
2. It cannot cross-pollinate with oilseed rape and so the farmer is not restricted by isolation distances, as with food/non-food varieties of rape.
3. Crambe is a moderate input crop, requiring few pesticides. Pests are easily dealt with by tillage and/or pesticides.
4. HEAR growers cannot go back to LEAR (Low Erucic Acid Rape). This is not a problem for Crambe.
5. The oil profile is of interest to industry as it contains fewer polyunsaturated fatty acids, (PFUAs) than HEAR. These PFUAs cause problems when the erucic acid undergoes further chemical modification 'downstream'. The erucic acid percentage is significantly higher than HEAR.
6. It grows well on all soil types from heavy clays to light sands, and is more tolerant of late season drought.
7. It is stiff strawed and no cases of lodging have been recorded.

8. As crambe is late planted, it allows the control of problematic weeds by cultivations or sprays prior to sowing.

(Source: <http://www.springdale-group.com/speciality.crops/crambe.htm> )

### **Other Information**

The seedbed for crambe should be fine and firm to ensure seed placement is at a uniform depth. Crambe should be drilled using conventional equipment but not broadcast. Successful harvests have been obtained when crambe is planted in rows 12 - 50cm. Row widths of 12 to 30cm give the best yields. Planting depth is important, it should be planted only deep enough to ensure sufficient moisture for rapid, even germination. This varies from 0.5cm to 2.5cm depending on the region. UK commercial sowings are made at approximately 1.25cm. In north western Europe, Soest (1990) suggests spring sowing is the only viable option with current material as there is a very high temperature dependence of field emergence. In Northern Europe sowing can only take place from the beginning of April. A crop density of 75 plants/m<sup>2</sup> minimum is necessary for maximum yield potential (approximately 100 germinable seeds/m<sup>2</sup>, 15kg/ha). For autumn sowings in Italy, the optimum husbandry is to sow 50 seeds / m<sup>2</sup>. In the UK commercial sowing rates range from 10-20kg/ha depending on variety and thousand grain weight.

Crambe grows on a variety of soils, the highest yields being on sandy loams and soils with a pH of 6.0 and above, although reasonable crops have been obtained on soils with pH 5.0 in Ethiopia. Crambe does not grow as well on stony and shallow soils. When Crambe is grown on soil with poor internal drainage, good surface drainage is essential. Tolerance of crambe to saline soils is less than barley but greater than wheat. Crambe is best suited to silt-loam soils that do not crust.

The use of N fertilisers and effect of fertilisers in European climates is still unclear, but 75 kg/ha P<sub>2</sub>O<sub>5</sub> have been recommended. Currently commercial crops in the UK achieve optimum yield from an application of at least 150kg/ha N applied in the seedbed, and responses to S have also been seen.

A temperature range of 15-25°C is required over the main vegetative period although higher temperatures are tolerated except at flowering. Some crambe varieties can tolerate a temperature

of -6 for a few hours without significant damage, although a frost free period of 60-90 days is desirable from emergence.

Although branching may increase individual plant yield, it also extends the flowering period and may increase loss from frost and pests or number of immature seeds harvested. The time of flowering would appear to depend on accumulated day degrees, and flowering lasts 7-10 days per raceme from the lower part of the raceme, upwards. The flowers are generally self-pollinated, but cross-pollination is not uncommon. The capsule or silique is initially pale green, becoming yellow and then beige with maturity. The greater the number of seeds/plant the smaller the diameter - 1000 seed weight can vary between 6-10 g. Seed size is also affected by rainfall and soil fertility.

Crambe can be cultivated alongside oil seed rape as the two are not cross-pollinated. However, pests and diseases of rape can also attack crambe (see oilseed rape). Flea beetle and pollen beetle have been seen to attack crambe in some cases, but can be easily controlled with a range of insecticides. Seed treatments are being evaluated for use on crambe. Crambe is susceptible to beet western yellows virus, 'luteovirus'. Treflan is the only herbicide registered for use on crambe, however a number of herbicides are available off label as crambe is a mustard. Weeds can be a major problem in production fields. Early-planted narrow stands of crambe are an effective way of defeating many weed problems, and a stale seedbed sprayed off with a non selective herbicide prior to planting gives a good start.

Crambe meal contains glucosinolates. Glucosinolates are thioethers. Thioethers are compounds of a sugar entity (b-D-thioglucose) with an ester bond to an organic aglycone which is an alkyl group yielding compounds such as nitrile or thiocyanate, under hydrolysis. It is these compounds that contribute to the 'hot', bitter taste of a number of condiments e.g. mustard. Although poisoning can occur when the crambe plant tissue is crushed (through mastication by animals such as poultry and swine), glucosinolates and their derivatives may have potential to fight human cancers.

## **Research**

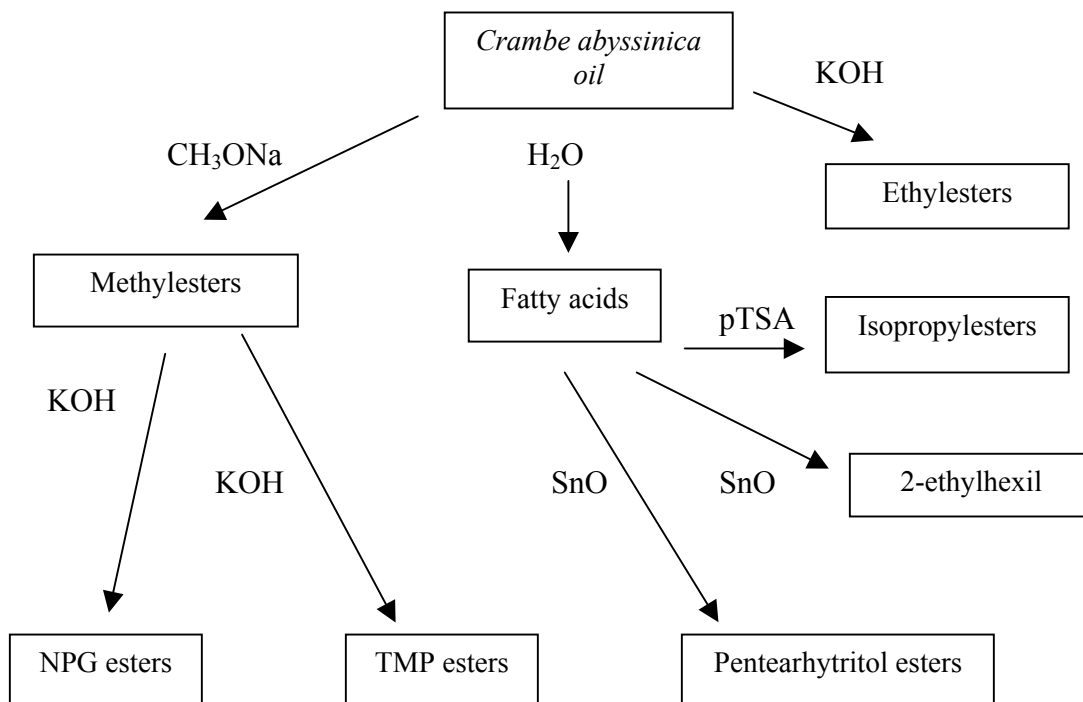
The seedmeal, which remains after the oil from crambe has been extracted, can be used as an animal feed. New varieties are also being bred in Holland, which have improved amino acid

profiles. Research is also currently being carried out to determine the effects of crambe seedmeal as a soil amendment for the inhibition of weeds and soil pathogens (5). A phytotoxin (1-cyano-2-hydroxy-3-butene, (CHB)) has been isolated which is primarily responsible for the inhibition of weeds. Because CHB should break down rapidly in the environment and is of relatively low toxicity to humans, crambe seedmeal may be a viable weed control alternative to organic farmers, home garden and landscape use.

Crambe seedmeal has also been analysed for insecticidal activity against the house fly, *Musca domestica*. The active components were identified as 2-(S)-1-Cyano-2-hydroxy-3-butane (SCHB) and phenylethyl cyanide (PEC) (8. C. J. Peterson et al 2000)

Ongoing research at the Italian PRisCA (Research Project on Alternative Cultures) has studied crambe oil as a starting material for synthetic lubricants (P. Bondioli et al 1997).

Figure 2. The synthetic paths used for different ester preparation from Crambe oil.



## **Useful Websites**

### **BioMat Net**

[Crambe \(Crambe abyssinica\)](#)

[AIR3-CT94-2480 Crambe abyssinica, a comprehensive programme](#)

[Crambe abyssinica, a comprehensive programme - Workshop - Part 1 -Introduction and Economics](#)

[Crambe abyssinica, a comprehensive programme - Workshop - Part 2 -Agronomy and Breeding](#)

[Crambe abyssinica, a comprehensive programme - Workshop - Part 3 -Processing](#)

[AIR3-CT94-2480 Crambe abyssinica, a comprehensive programme - Workshop - Part 4 - Utilisation](#)

[AGRE-0046 - Vegetable Oil for Innovation in Chemical Industries VOICI](#)

[Crops for Bulk Chemicals](#)

[AIR3-CT94-2199 - The Use of Enzymes in the Processing of New Oilseeds \(UEPNO\) to Industrial Raw Material](#)

[FAIR-0260 - High Quality Oils, Proteins and Bioactive Products for Food and Non-Food Purposes Based on Biorefining of Cruciferous Oilseed Crops](#)

### **Contacts**

Springdale Crop Synergies Ltd,

Mr Simon Meakin or Mr James Mackey, Springdale Crop Synergies Ltd, Rudston, Drifffield, East Yorkshire, YO25 4DJ

Telephone: +44 (0) 1262 421100

Website: [www.springdale-group.com](http://www.springdale-group.com) Email : [info@springdale-group.com](mailto:info@springdale-group.com)

[EU concerted action AIR3-CT94-2480, 'Crambe abyssinica, a comprehensive programme'](#)

[Coordinator : Elsie Titonel, ENSAD Dijon, France.](#)

Crambe, 2001. Farm Diversification Information Service, Bendigo. see:  
<http://www.nre.vic.gov.au>

## References

1. Laghetti G., Piergiovanni A.R, and Perrino, P. 1995. Yield and oil quality in selected lines of *Crambe abyssinica* grown in Italy. In: Industrial crops and products 4 205-212 pp.
2. Askew, M. F. 1993: Novel oil, fibre and protein crops in UK. A future perspective; Brighton Crop Protection Conference 1993. 6A-2 pp 658.
3. Soest, L. J. M. (1990). Introduction and breeding of new oil crops. Biotechnology and fatty acids: New perspectives for industry. Proceedings of a discussion meeting Wageningen, The Netherlands
4. A. Grombacher, L. Nelson and D. Baltensperger. Crambe Production. Neb guide, Published by cooperative extension, Institute of agriculture and Natural Resources, University of Nebraska-Lincoln. 1996. or see : <http://www.ianr.unl.edu/pubs/fieldcrops/g1126.htm>
5. S.F. Vaughn and M. A. Berhow. 1998. 1-cyano-2-hydroxy-3-butene. A phytotoxin from Crambe seed meal. 24. (6). pp 1117
6. Actin Newsletter no 4 – page 3. January 1997. <http://www.actin.co.uk/newsletter>
7. P. Bondioli, L. Inzaghi, G. Postorino and P. Quarticcio. 1997. Crambe assinica oil and its derivatives as renewable lubricants: synthesis and characterization of different ester based on Crambe fatty acids. La Rivista Italiana Delle Sostanze Grasse. Vol LXXIV. pp137-141
8. C. J. Peterson, A. Cossé, J. R. Coats. 2000. Insecticidal components in the meal of Crambe abyssinica. J. Agric. Urban Entomol 17 (1) : pp27 – 36.
9. Glucosinolates. Cornell University – Poisonous Plants Informational Database.  
<http://www.ansci.cornell.edu/plants/toxicagents/glucosin.html>
10. IENICA Summery Report for the European Union. 2000.
11. [www.nf-2000.org/secure/Air/F706.htm](http://www.nf-2000.org/secure/Air/F706.htm)

