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# Oilseed crops future in Sindh Pakistan

By Mrs. Farzana Panhwar, March 2005

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**Publisher:** Digitalverlag GmbH, Germany  
www.ChemLin.com

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Edition ChemLin

www.ChemLin.com

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### Introduction

- For the year 1999-00 the total area under groundnut in Pakistan was 101,000 hectares, while in Sindh it was 3200 hectares. Its production in Pakistan was 109,100 tones in Sindh it was 6200 tons. Its yield in Pakistan was 1080 Kg per hectare, while in Sindh it was 1938 Kg per hectare.
- In the year 1999-00 in Pakistan the Sesame cover an area of 85600 hectares, in Sindh it was 1500 hectares. Its production in Pakistan was 38900 tons, in Sindh it was 500 tons. Its yield in Pakistan was 454 Kg/hectare, in Sindh it was 333 Kg/hectares.
- In the year 1999-00 the area in Pakistan under Sunflower was 113998 hectares and in Sindh it was 53387 hectare . For the same year its production in Pakistan was 149502 tons, in Sindh it was 57763 tons.
- In the year 1999-00 in Pakistan the area under Soybean was 1364 hectares in Sindh it was 123 hectares, its production in Pakistan was 1537 tons, in Sindh it was 131 tons.
- In the year 1999-00 total area in Pakistan 266 hectares was under Safflower, while in Sindh it was 65 hectares, its production in Pakistan was 119 tons while in Sindh it was 49 tons.
- In the year 1999-00 the area under Linseed in Pakistan was 7918 hectares, while in Sindh it was 4955 hectares, its production in Pakistan was 4629 while in Sindh it was 2334 tons. Its yield in Pakistan was 585 Kg/hectares in Sindh , its production was 471 Kg/hectare.
- For the year 1999-00 the area under Castor-seed was 7408 hectares, in Sindh it was 2764 hectares , its production in Pakistan was 5571 tons in Sindh it was 1924 tons, its yield in Pakistan was 752 Kg/Hectares, in Sindh it was 696 Kg/hectare.
- In the year 1990-00 in Pakistan the area under Rape-seed and Mustard seed was 333,400 hectares, in Sindh it was 92700 hectares, its production in Pakistan was 281.7 tons in Sindh , it was 72500 tons, its yield in Pakistan was 845 Kg/hectare while in Sindh it was 782 Kgs/hectares.
- The oil seeds are the back bone of agriculture.

### Ground nut crop

#### Botanical description.

Groundnut (*Arachis hypogaea* L) is a member of sub family Pa pilonacear, family Legumminoae. It consists of two subspecies.

Subspecies	Hypogaea
Variety	Hypogaea (the virginia group)
Variety	Hirsta Kohlar
Subspecies	Fastigiata Waldron
Variety	Fastigiata ( the valencia group)
Variety	Vulgaries ( the spanish group)

## The classification of cultivated groundnut

Cultivated groundnut divided in two subspecies hypogaea and fastigiata. These two further divided in to two varieties each in-group as hypogaea and mursuta in hypogaea and fastigiata and vulgaries in fastigiata. The major groundnut producing major countries of the World are India, China, Nigeria, Senegal, Sudan, Burma .

### General

The botanical name of ground nut is *Arachis Hypogaea* Linn. It is derived from Greek words *Arachi's* mean legume and *hypogaea* meaning underground. The groundnut is an annual legume wide variation in the type and strains. Kernel (seed) individual weight ranging from 0.2 to 1.0 g, its shapes varies spherical, elliptical, elongated or flattened , each seed consist of two cotyledons, upper stem axis, epicotyl, lower stem axis and radical, the cotyledons are creamy white with pale yellow in some varieties.

### Roots

It have well developed tap root to the depth of 90-130 cm with many laterals. The plant is considered mesophytes with xerophytic tendencies . Roots also have nodules start developing 15 th days of plantation. *Rhizobium leguminosarium* have range 2.6-3.1 globlar often dark brown colour. A mature plant develop 830 to 4000 nodules. Nodules are located only 15 cm soil.

- Hypocotyl appear second day of germination, its length varies from 1 to 11 cm depending upon the depth of seed sowing, stem is green to purple., cylindrical, hairy more or less angular with age erect- central stem vertical short and erect with numerous upright lateral branches, slightly oblique to the main axis. /The central stems long and erect with oblique upright lateral branches to the main axis. Leaves are pinnate, alternately arranged in 2/5 phyllotaxy with two pair of green to very dark color depend upon the variety. Flower are small, yellow varies from white to deep orange in color.

### Climate

It grows in sub-tropical countries between 45 N° and 35 S° and up to an altitude of 1,000 meter. It is a subtropical crop, it id day neutral , optimum temperature 25-30 C °, Rainfall is about 500-1000mm.

### Soil

The best soil is well drained, light coloured, loose, friable and sandy loam. If grow best in acidic soil pH 6.0-6.5. Lindane or aldrin should be applied at least one week before sowing to control termites.

### Rotation and mixed cropping

It is rotated with wheat, jowar, bajara, gram, castor, paddy and cotton, potatoes, onion, chillies, garlic, ginger and turmeric, pluses like red-gram (arhar), mash and moong are grown mixed with ground nut.

- Application of culture of *Rhizobium* as seed treatment increase nodulation and nitrogen fixation. The application of gypsum at 500 Kg/ha at pegging stage enhance pod formation.

**Improve yield**

- Seeds are treated with fungicides like captan or thirain at the rate of 4 g/kg
- Inoculate seed with culture of Rhizobium soil.
- Sowing at optimum time, optimum seed rate and optimum spacing.
- Use proper amount of fertilizer according to varieties and season.
- Apply 500 Kg of well ground gypsum/hectare at pegging stage.
- Apply micronutrients according to need.
- Adopting timely plant protection to control pest and disease.

**Varities**

Ah 32d, GAUG-1, Ah 334, GAUG 10, Kadiri-71.1, TMV1,2,3,4,5,6,7,8,9,10, Pol 2, S0206, S230, AK12-24, Kopergaon, Karad 4-11, Exotic 5, Punjab 1, C501,M145, M13, Kopergaon 1, Kopergaon 3, AK 12-24. PG1, Rs1, Karad 4-11, T-28, C501, RSB 87, J11, Sbx1, T-64, M-145, Pol-1, S206, S230, Kadiri 7d1-1, Jyoti, Pol2, TG-1(vikram), Mh-1, Dh 3-30< Chandra, Kadiri-2. Kadiri -3, MH2< BG1< BG2, Phule pragati (JL-24), CO-1, M-37, Kisan, KRG-1, M-197, TG,17, Kawan, CG-2, Chitra (MA10)Kaushal (G-201), Co-2, UF-70-103, DH 8, GG-11.

**Comparative characters of virginia (Hypogaea ) and Spanish/valencia (Fastiglata)**

Character	Virgina (Hypogaea)	Valencia/Spanish (Fastiglata)
Seed size	Medium to very large	Small to medium
Seed/pod	Usually 2, occasionally 3	Usually 2 or 4, rarely 5
Seed dormancy	Moderate	Little to none
Vegetative branching patterns	Moderate to profuse	Sparse to moderate
Flowering bud on main axis	Alternate	Sequential
Flowering pattern	Alternate	Sequential
Primary lateral b reaches	Longer than main stem	Shorter than main stem.
Growth habit	Spreading to semi spreading	Bunch
Growth period	Long (130 to 175 days)	Short (90 to 105 days)
Flowering peak age	8-12 weeks	6-10 weeks
Leaf colour	Dark green	Pale green
Leaflet size	Small	Large
Leaflet apex	Pointed	Rounded
Pid distribution	Scattered	Close to the base
Ability to re-grow after seed setting	Usually retains growing power if pod are detached	Usually dies
Linoleic acid	Low	High

## Comparative characters Valencia and Spanish types

Characters	Valencia (Hypogaea)	Spanish (Fastilgata)
Secondary lateral branches	Absent	Present irregularly to primary lateral branches
Stem and petiole colour	Purple	Green
Hairiness	Less	More
Leaflet colour	Dark green	Light green
Inflorescence	Single	Compound
Seed/pod	Usually 3 to 4	2
Constriction, reticulation and beak on pod	Less prominent	More prominent
Shell thickness	Thick	Thin
Testa colour	Red or purple	Rose
Maturity	90 to 95 days	100 to 105 days

### Seed requirement.

Seed requirement for bunch varieties at 30 X 10cm spacing 100 to 110 Kg Kernels per ha. Which give plant population of 333,000 per hectare The spacing and quantity varies with varieties 110 Kg for M13, M145, 65Kgs, M37-100Kgs, M197-100Kgs, T-28-75Kgs of chandra and 95 Kg of T-64 per hectare.

### Seed treatment

Seed should be treated with thiram at 3g/Kg, carbendazim at 2g per Kg or mancozebs 3g/Kg to control seed borne pathogens.

### Rhizobium inoculation

Some varieties are responsive to some specific Rhizobium strain like Kadiri 3, JL-24 response to No-92 strain of Rhizobium culture at 400g while 100Kgs Kernel to give better result. Rhizobium culture can be mixed thoroughly with seed just before sowing. The granular Rhizobium prepared by mixing peat inoculum with sand by using methyl cellulose as sticker

### Spacing

The bunch varieties at 30 X 10cm .Spacing is 100 to 110 Kg Kernels/hectare, it gives planting population of 333,000/hectare. In case of spreading and semi-spreading varieties spacing 30 X 15cm requires 96-100 Kg/hectare to get plant population on 202,000/hectare.

### Fertiliser requirement

Before land preparation on FYM at the rate of 10 tons/hectare of soil type. It needs 45 Kg N, 12 Kg P<sub>2</sub>O<sub>5</sub> are 34 Kg K<sub>2</sub>O/hectare.

## Calcium

Calcium is required from the fruit began to start until pods are mature calcium , improves the shelling percentage and decrease the number of shrivelled Kernels and pods. Gypsum is the cheapest source of calcium (24%) and sulphur 18.9%. So it should applied about 50-100 Kg/hectare. Zinc sulphate 25-50 Kg/hectare, alternatively 0.2% ZnSO<sub>4</sub>(2g/l) 2-3 time interval 4-5 days starting from 30 days after sowing. Boron is applied 5-10 Kg Borax/hectare or 0.2% spray of Borax.

- Chlorosis is common in ground nut it needed 15g FeSO<sub>4</sub> mixed with 1.5 citric acid in 10 liter of water. Managanese 10-50 Kg/hectares Sodium molybedate 15-500Kg/hectares.

### Irrigation

Irrigation is needed during peak flowering, peg formation or penetration and pod development, otherwise its yield reduce 63%

### Cropping system

Groundnut should be rotate with cereals like bajra, jawar, maize, wheat or minor millets. This not only maintained soil fertility, but this also check the build up of pests, white grubs, nematodes, soil borne diseases, leaf spots, also maintain soil fertility. Ground nut does well after wheat, maize, jawar , bajra and tobacco.

### Harvesting

The bunch type mature in about 100 to 105 days and semi-spreading and spreading types in 125 to 135 days. Maturity checked by yellowing of foliage, dropping of old leaves and pod become hard, but the moisture level of the produce should be brought to 8% as quickly as possible. The filled bags should be piled on wooden planks to avoid fruit from dampness and aflatoxin contamination.

\* Long duration inter-cropping with groundnut are red-gram, cotton, castor, cassava, while short duration crops are sesame, sunflower, cowpea, greengram and blackgram.

## Composition of groundnut kernels

Constituent	Range (%)	Average (%)
Moisture	3.9-13.2	5.0
Protein	21.0-36.4	28.5
Lipid	35.8-54.2	47.5
Crude fiber	1.2-4.3	2.8
Nitrogen free extract	6.0-24.9	13.3
Ash	1.8-3,1	2.9
Reducing sugars	0.1-0.3	0.2
Disaccharide sugars	1.9-5.2	4.5
Starch	1.0-5.3	4.0
Pentosans	2.2-2.7	2.5

## Oil Chemistry

Specification of groundnut oil

Physicochemical properties	Indian Standard (IS:544-1968)
Moisture	0.10-0.25
Specific gravity 30C°	0.909-0.913
Refractive index at 40C°	1.4620-1.4640
Saponification value	188-195
Iodine value	87-98
Acid value	0.5-25.0
Unsatifiable matter (%)	0.8-1.5

## Fatty acid composition of groundnut oil

Glycerides	Spanish varieties (%)	Virginia varieties (%)
Unsaturated		
Oleic	43.7	57.6
Linoleic	35.2	25.8
Saturated		
Palmitic	12.3	9.0
Stearic	3.1	2.4
Arachidic	1.5	1.2
Behenic	2.4	1.9
Eicosenoic	1.1	1.3

## Diseases

Flowering diseases are common in ground nut.

- Early leaf spot ( *Cercospora arachidicola* Hori)
- Collar rot ( *Aspergillus niger* and *A.personla*.)
- Late leaf spot (*Phaeoisoriopsis personata*)
- Rust (*Puccinia arachidis* spg.)
- Crown rot/collarrot ( *Aspergillus niger* V.Tieghem)

- Aflaroot disease or yellow mould (*Aspergillus flavus* link.ex.Fries)
- Charcoal rot (*Macrophomina phaseolina* (*Rhizoctonia bataticola* )
- Stem rot (*Sclerotium rolfsii* Sacc)
- Bud necrosis.
- Peanut mottle virus (PMV)
- Clump disease.
- Aflatoxin problem.
- Kalahasti malady (nematode disease)
- *Tylenchorhynchus brevilineatus* williams.
- White grub ( *Lachnosterna consanquivea*)

#### Field pest

- Termite
- White grub.
- Earwig
- Ground nut root borer .
- Red hairy caterpillar.
- Thrips.
- Jassid or hopper.
- Leaf minor
- Aphid
- Tobacco cterpillar.
- Gram pod borer.

#### Storage pest

- Rust red flour beetle.
- Merchant grain beetle
- Tropical warehouse moth.
- Rice moth.

#### Conclusion

In ground nut ,oil content of the seed varies 44-50% depending on variety and agronomic condition. It is used in soap making and manufacturing, cosmetic and lubricants, olein, stearin and their salts, kernels are eaten raw roasted or sweetened. It is a rich source of Vitamin A and B2 group, it contain 349/100 grams , oil cake contain 7-8% N, 1.5 P<sub>2</sub>O<sub>5</sub> and 1.2%K<sub>2</sub>O used as fertilizer.It also used cattle and poultry feed. The cake also used for manufacturing artificial fiber. The haulms (plant stalks) are feed (green, dried or silaged ) to livestock, groundnut shell is used as fuel for manufacturing coarse bord, cork subsitute. The ground nut crop also used as rotation crop, its root contain N absorb from the atmosphere, so it improve soil fertility.

## Sesame (*Sesamum indicum* Linn)

Its belong to genus *Sesamum*, order Tubiflorae, Family Pelalliccae. This family consist of 16 genera and 36 species. Beside *Sesum indicum* two species *S.prostratum* and *S.lacinlatum* are grown wild. Sesame had a tap root system with profuse lateral branches. Root growth is influenced by the type of soil on which crop is grown, root depth is more in sandy soil, Branching as an average height of 1 to 1.5m. Leaves size varies from 3 to 17.5 cm in length, 1 to 7cm on very short pellicles. Flowers are borne with slightly bilabiate tubular corolla of 5 lobes. Seeds are small, ovate, slightly flattened with testa of variable color ranging from black, white, yellow, reddish brown, gray, dark gray, olive green and dark brown. *Sesamum indicum* have somatic chromosome number is  $2n=26$ .

Its oil content varies 46-52%. Its oil is used in cooking and anointing the body, oil is rich source of protein, carbohydrates, minerals, calcium and phosphorus. It is nutritious feed for animals. It is present Africa, Madagascar, Arabia, India, Sri-Lanka, tropical Australia. The seed is dicotyledonous, albuminous and oleaginous. It is inter-cropped with jowar, cotton, black gram, green gram and horse gram.

## Climatic requirement

Sesame is a crop of tropics and sub-tropics. The temperature of 25 to 27C° encourage rapid germination initial growth and flower formation. It needs 10 hours a day and normally flower in 42 to 45 days. It need 500 to 650 mm rainfall, crop is very sensitive to water logging. It can not stand frost and drought. The pH 5.5 to 8.2 is suitable.

## Soil

It grows well in soils having a range of pH 5.5 to 8.0. Sesame is extremely susceptible to water-logging and salinity. It have 11 varieties, its yield is 500 to 600 Kg/hectare.

## Varieties

Gowri, T-85, Mrug-1, Purva-1, Patam 64, G-5, T-4, G-35, No-128, N-32, D7-11-1, N-58-2, N-128, T-85, Chanda-8, Vinayak, Pretap C-50, Type 13, TMV-1, 2, 3, KRR-1 and KRR2, Madhavi, N62-39, T-12, Kalika, Vinayak, Co-1, Tc-289, Soma, Surya, Krishna and Tapi, disease or insect pest resistant varieties, TMV-1, TMV-2, TMV-3, T-4, T-85, Punjab Til-1, Mrug-1, Purva-1, T-13, TMV-4, TMV-5, Phule Til-1, Madhavi, Haryana Til-1, TMV-6, Kanak, Kayam Kulam-1, Thilethama ( Kayamkulem-2) Co-1, Patna-64, N-128, N-8, Soma (cul38-1), Cul-42-1, Krishna, Tapi, TC289.

## Spacing

Row to row spacing 30 to 45 cm and plant to plant spacing 10-15cm. Its average yield 500 to 600Kg/hectare- two or three harrowing are enough followed by leveling seed rate of 5 Kg/ha.

## Fertilizer

N-30, P<sub>2</sub>O<sub>5</sub>-40, K<sub>2</sub>O-20 is required to give better yield.

**Weedicides**

Alchlor	1.75Kg/hectare
Fluchloralin	0.75 Kg/hectare
Pendi methalin	1.0 Kg/hectare

**Irrigation**

Total water requirement 1200 to 2,500 mm/hectare.

**Crop rotation with Sesame**

Paddy- sesame.  
 Sesame-wheat  
 Sesame-horsegram or Bengalgram.  
 Cotton + sesame –wheat.  
 Sesame –wheat-greengram.  
 Groundnut-sesame.  
 Potato-sesame.  
 Rice-sesame.

**Harvesting**

Most of sesame are shattering type.

**Oil chemistry**

Specification of sesame oil.

Physicochemical properties.	Values
Moisture (%)	0.1-1.35
Specific gravity at 30/30C <sup>0</sup>	0.915-0.923
Refractive index at 40C <sup>0</sup>	1.4645-1.4694
Saponification value	185-193
Iodine value	103-120
Bellier turbidity temperature	22C <sup>0</sup>
Un-saponifiable matter(%)	1.2-2.0

**Fatty acid composition of sesame oil.**

Fatty acid	Composition %
Oleic	45.3-49.4
Linoleic	37.7-41.2
Palmitic	7.8-9.1
Stearic	3.6-4.7
Arachidic	0.4-1.1
Hexadecenoic	0.0-0.5
Myristic	0.1
Saturated	12-16

## Diseases

- Phyllody (Mycoplasma disease)
- Bacterial leaf spot (Pseudomonas Sesami Malk)
- Bacterial blight (Xanthomonas Sesami Sabet & Dow)
- Alternaria leaf blight ( Alternaria Sesami)
- Leaf spot (Cercospora Sesami Zim and C.Sesami Cola Moh)
- Leaf blight (Phytophthora parasitica var. Sesami Dast)
- Powdery mildew (Erysiphe cichar acearum Dc)
- Charcoal rot (Macrophomina phaseolina (Tissi)Goid )
- Fusarium wilt ( Fusarium oxysporum)

## Field pest

- Leaf roller and capsule borer.
- Sesame gall fly.
- Bihar hairy cterpillar.
- Sesame sphinx or Sesame hawk moth.
- Tobacco caterpillar.
- Jassid

## Breeding objective

The breeding objective is to evolve high yielding cultivars with uniform maturity, development of drought resistant or tolerant cultivars, insects, pest, disease resistant varieties, development of non-shattering cultivars for minimising the seed loss also equally important. Thermo and photoinensitive cultivars for various agro-climatic regions, improve oil content of the seed (60% or above). Quality of oil and to utilise a large quantum of heterosis show many sesame crosses of developing sesame hybrid, to minimise the oxalic acid content to increase the lysine content for quality meal and to develop varieties rich in antioxidants.

## Safflower(*Carthamus tinctorius* Linn)

Safflower is described as Kusumbha, the name is derived from Kusum. Khusumbha oil is purgative, having same properties as castor oil. The safflower belong to family compositae, tribe Cynaroideae and subtribe Centaureae. Safflower is herbaceous glabrous annula, height ranges from 30-150 cm. The stem colour varies from greenish to white. Leaves are cauline, alternate penta-stichous with unicostate, reticulate, venation, spinulose, serrate and glabrous surface.

About 36 species are identified. Three species found in India and Pakistan are *C.tinctorius*, *C.Oxyacantha*, and *C.lantus*. Cultivated species *C.tinctorius* has been further divided into 63 distinct types.

### Flower colour types in Safflower

Type	Bud	At full bloom	Wilted
1	White	White	Greyish white
2	Light yellow	Light yellow	Greyish white
3	Light yellow	Light orange base	Orange base
4	Yellow	Yellow	Yellow
5	Yellow	Yellow	Orange
6	Deep red	Radish orange	Deep red
7	Yellow, base and tips of lobes orange		Orange

Cultivated Safflower *C.tinctorius* had 12 pairs of chromosomes  $n=12$  and  $2n=24$ . On the basis of chromosome numbers. The genus is divided into four groups as under:

Group I	$N=12$ . <i>C.tinctorius</i> , <i>C.palestinus</i> , <i>C.oxyacantha</i> , <i>C.flavescens</i> (= <i>C.persicus</i> and <i>C.arborescens</i> ).
Group II	$N=10$ . <i>C.glaucus</i> , <i>C.tenuis</i> , <i>C.alexandrinus</i> and <i>C.leucocaulos</i> .
Group III	$N=22$ <i>C.lantus</i>
Group IV	$N=32$ <i>C.baeticus</i> , <i>C.turkestanicus</i> .

*C.oxyacantha* and *C.palaestinus* are mostly likely ancestors of cultivated Safflower.

### Varieties

A-1, A-300, No-7, N 62.8, Nag 7, Tara, K-1 and Manjira (C-438), S-144, K-1, CO-I, Bhima (S-4), Sweta (JSF-I), T-65, Sagarmuthialu (APRR-3), Neera (NRS 209), Malviya Kusum (HUS 305). A-300, A-I, N62-8 its yield 10-20% more than other varieties. CO-I is spineless variety.

## Climate

It favours warm temperature regions. Seed and oil yield have been found to decrease with increasing altitude. Safflower are drought resistant, it needs rainfall 600 mm. It is tolerant to frost.

## Soil

It requires fertile, fairly deep, moisture, retentive and well drained, it is salt tolerant.

## Land requirement

It needs cold free seedbed with firm subsoil and adequate soil moisture for good germination.

## Seed rate

Seed rate needed 5-6 Kg/ha it can be 15-20 Kg/hectare.

## Spacing

Row spacing 45 or 60 cm.

## Fertilizer

It needs 60Kgs/hectares Nitrogen, 20-30 Kg  $P_2O_5$ /hectare is needed to have better yield.

## Weed control

Alchlor, diuron, nitrofen or trifluralin used as pre-emergence spray.

## Irrigation

Safflower crop is drought resistant, which is suited for dry or semi-arid area. Yield increase 40-60 % by providing irrigation at elongation stage or flowering stage.

## Cropping system

Intercrop with Bengalgram, wheat, linseed, corianders, linseed.

## Various cropping system

Flowing crops grow together.

Greengram	Safflower
Sorghum	Safflower
Setaria	Safflower
Sesame	Safflower
Paddy	Safflower
Maize	Safflower
Ground nut	Safflower
Soyabean	Safflower
Cowpea	Safflower
Pearl millet	Safflower
Wheat	Safflower
Linseed	Safflower

It also intercrop with cereals, pluses and oil seeds.

## Diseases

- Alternaria blight (*Alternaria carthami* chowdhury)
- Wilt (*Fusarium oxysporum*)
- Charcoal rot (*Macrophomina phaseolina*)
- Rust (*Puccinia carthami*)
- Leaf spot (*Cercospora carthami*)
- Mildew (*Erysiphe Cichoracearum*)

## Field pests

- Safflower aphid
- Safflower caterpillar
- Gram pod borer
- Flower head borer
- Fruit fly
- Lucerne caterpillar

Safflower is used for dye, but due to aniline dyes natural product value down. The florets contains mainly two colouring substances Carthamin insoluble and Scarlet red and safflower yellow which is soluble Isocarthamin is also isolated. It is also used as a substitute for saffron (*Crocus Sativus* Linn). It is used for colouring clothes, cosmetics, artificial decoration as well as food and confectionary. Safflower used for edible purpose and for soap manufacture. Oil cake also used as manure, also used for cattle feed.

## Composition of Safflower oil cake

For cattle feed	Oil cake from unde-corticated seed (%)	Oil cake from decorticated seed (%)
Moisture	7.3	8.7
Fat	8.3	10.0
Carbohydrate	27.3	20.1
Protein	28.3	45.4
Fibre	23.1	8.3
Ash	5.7	7.5

The green safflower is used as fodder. The hull or seed husk is used for the manufacture of cellulose insulations, abrasives, etc

## Specification of safflower oil

Physiochemical properties	Indian standard
Moisture(%)	0.25
Specific gravity at 30/30 C°	0.915-0.920
Refractive index at 40 C°	1.4675-1.4690
Saponification value	189-195
Iodine value	138-154
Acid value	2.0-6.0
Unsaponification matter (%)	1.0

## Fatty acid composition of safflower oil

Fatty acid	Composition (%)
Saturated	5-10
Palmitic	6-7
Stearic	2-3
Oleic	12-14
Linoleic	76-78
Linolenic	0

## Conclusion

- To evolve varieties for specific situation
- To develop varieties with high oil content
- Breeding for low husk percentage.
- To develop species resistance against *Alternaria* leaf spot, wilt, powdery mildew, aphid and capsule borer.
- To develop varieties show pest and disease resistant.
- To develop plant types for low branching habit, spinelessness for ease in interculture and harvesting, operations, earliness, large seed size, higher seed weight, winter hardiness or frost resistance, non shattering type, bright colour of florels with high dye content, green fodder quality and saline resistance
- To improve oil quality, protein content, improvement of oil quality and nutritional value of meal.

Its seeds are edible and eaten after roasting. The oil content varies from 24-36% depending upon variety, soil, climate and other condition.

Oil is used for extraction of dye and making soap. It is also used in leather goods. It is used in paints, varnishes and linoleum. The cake is used as concentrated cattle feed. Plant height is 30-150cm. The growing countries are USA, Mexico, Ethiopia, Spain, USSR and Australia. Water-logging effect on seed yield. It is cultivated in all types of soil including sandy soil, it grows well in alluvial loam. The crop is resistant to saline condition. It can grow with wheat, barley, gram, jowar. It is grown in three rows of safflower being planted after every nine, twelve or more rows of main crop. It is grown in rotation with green gram (Moong), black gram (mash), ground nut and coriander. Crop mature in 4-5 months after sowing. The average yield is 400-500 Kg of seed/hectare.

## Sunflower (*Helianthus annuus* Linn)

### Introduction

It belongs to family Compositae, Genus *Helianthus*. There are 67 recognised species in this genus, 17 species are cultivated for ornamental purpose. The commercial varieties cultivated for seed production are grouped to be *H. annuus*, Var. *macrocarpus*, *H. annuus* subspecies *lenticularis* its related species *H. argophyllus* found in wild form. Its root goes up to 3 m, height of stem varies usually it is around 3-6 cm in diameter, height of stem varies normally 1 to 3 cm. The plant of the stem varies in size depending upon the cultivars season, soil types. The colour of achene (seed) varies from black, brown to white. A colour classification widely used in breeding program:

- a) Black
- b) Black with grey stripe
- c) Black with white and light grey stripe
- d) Dark grey with white and light grey stripe
- e) Grey with white stripe
- f) Grey with grey stripe
- g) White

Seed size varies from 10 to 25 mm long, 7.5 to 15mm in width and 3 to 7.5 mm in thickness. Cultivated Sunflower have 34 somatic chromosomes *Helianthus Spp* .have deplod chromosome, Autotetra polids have been produce in breeding programme.

Major Sunflower producing countries are Soviet Union, Argentina, Bulgaria, Rumania, Turkey and South America.

Its oil is used as culinary purpose, it is recommended for heart patient. Its cake is used cattle and poultry feed. Sunflower is protandrous, in which male and female element mature at different time .The crop thrive on variety of soil. It needs pH 6.5-8.5 it required 9-10 irrigation.

## Yield

Rainfed condition it produces 300-500 kg/hectare , under grown under irrigation 800-1200kg/hactares

## Soil

It need soil sand to clay, low in salt tolerance well drained, deep, neutral and highly fertile soil with good drainage.

In Sunflower the identification of cytoplasmic made sterility combine with fertility restores genes allow breeders to develop hybrid Sunflower. The BSH-1 produce more content, increase yield, and resistant to rust .Crops should be grown on ridges and furrows.

## Varities

E.C.68413 (Vnimk 8931), E.C.68414(Peredovick),

E.C. 68415 (Armavirskij), E.C.69874(Armaverts) and Sunrise, E.C.101495 (Cernianka)

Genetic male sterility linked with certain marker gene. This sterility is due to recessive nuclear gene and link the cytoplasm male sterility was first obtained from the interspecific cross *H.petiolaria XH.annuus*. This type is used in developing hybrid Sunflower.

## Improved varieties of Sunflower

Name of variety	Average yield Kg/ha	Oil %	Days to maturity	Remark
EC-68414 (Predovick)	800-1,000	42.46	110	Drought tolerant, suited for late planting, susceptible to rust and Alternaria
EC-68415 (Armaviriski 3497)	800-1,000	42-45	110	Drought tolerant, suitable for Marginal and sub-marginal lands, susceptible to rust and Alternaria
Romson record	700	41.2	108	Dark seeded, broad leaves
BSH-1 (CMS 34+RHA-274)	1,000-1,500	42-45	95	Hybrid, uniform maturity, suited for assured rainfall and irrigated tracts, resistant to rust and fairly tolerant to Alternaria leaf spot
Morden (Cernianka-66)	600-800(R)	42-46	80	Very early maturing. Dwarf variety more self fertile.
Suya (PKV-SUF-72-37)	1,000-1,200	-	95	Better seed filling, increased seed wt. And increased oil yield/ha over E-68414, seeds black with white stripes,
CO-1(SUF-2)	1,100	36.7	85	Dwarf 67-70 cm, suitable for growing as a cash crop in garden land
CO-2(SUF-3)	900(R )	37.4	90	Tolerant to rust
MSFH-1	1,500-2,500	40.0	95	Tolerant to rust
MSFH-8	1,500-2,500	40.0	100	Tolerant to rust
APSH-11	1,500-2,000	4.00	95	-

## Seed rate

It is 7-8kg/hectare in case of varieties and 3-4 kg/hac in case of hybrids. Seeds are treated with thiram at 3g/kg seed to control fungal disease. If seeds are soaked in water for 12 hours, shade drying is helpful for uniform germination.

## Spacing

Row spacing 60 cm, plant to plant spacing 30cm for short duration varieties spacing 45x 20cm

- Its sowing at 5 cm depth, thinning is done 15 to 20 days after sowing
- Fertiliser requirement 60-80 kg N, 60-90kg P<sub>2</sub>O<sub>5</sub> and 40kg K<sub>2</sub>O/hactare.
- Herbicides like alachlor 1.5kg/hactare, it should be sprayed on the day of sowing or 1-2 days after sowing.
- Depending on the soil type and season 6-10 irrigation are needed for raising crop.

## Inter-cropping pattern

Hybrid jowar +Sunflower (4:2)

Ragi/ground nut+ Sunflower (6:2)

Ground nut + Sunflower (6:2)

Blackgram +Sunflower (6:2)

Cotton + Sunflower (4:2)

Groundnut + Sunflower (1:1)

## Use

Sunflower seeds are eaten by human after roasting crude Sunflower oil is used as edible oil, it is low in saturated fatty acids, oil used as lubricant and soap, oil cake, is a good source of protein, is used in beef and cattle feeds.

## Oil chemistry

Physiochemcial properties	Indian Standard
Moisture	0.1-0.5
Specific gravity	-
Refractive Index at 40C°	188-194
Sponification value	100-140
Iodine value	100-140
Acid value	0.5-5.0
Unsaponifiable matter (%)	1.5-2.0

**Fatty acid composition of Sunflower oil**

Fatty acid	Composition (%)
Palmitic	7.2
Stearic	4.1
Oleic	16.2
Linoleic	72.5
Linolenic	0
Eicosenoie	0

**Diseases**

- Rust (*Puccinia helianthi*)
- Downy mildew (*Plasmopara helianthi*)
- Alternaria blight (*Alternaria helianthi*)
- Charcoal rot (*Macrophomina phaseolina*)
- Sclerotium wilt or rot (*Sclerotium rolfsii*)
- Powdery mildew (*Erysiphe Cichoracearum*), (*Erysiphe Cichoracearum*), (*Sphaerotheca Fulginea*)
- Rhizopus head rot (*Rhizopus sp*)
- Biodeterioration
- Angular bacterial leaf spot (*Pseudomonas Syringae*)
- Sunflower mosaic(Viral)
- Yellow ring (Viral)
- Yellow spot (Viral)

**Field pests**

- Jussidas
- White flies
- Aphid
- Bihar hairy caterpillar
- Tobacco caterpillar
- Head borer
- Root weevil

**Conclusion**

Breeding objective is to increase the yield, increase oil content, insect, pest and disease resistant, Sunflower show tolerance to salinity .Sunflower classified as insesitive to photoperiod because it can flower through a wide range of daylength .Sunflower leaves are photoropices with a leg of 12°Behind the Sun's azimuth.

## Soybean (*Glycine max*(L)Merr)

### Introduction

The genus *Glycine* has two primary genus, Africa and Australia origin. The genus *Glycine* belong to family Papilionaceae leguminose includes 30-50 species. *Glycine ussuriensis* is cultivated species. Soybean plant have 75cm in height, its tap root length is 1.5m, nodules are found on the main root and laterals. Bacterium *Rizobium Japonicum* produced nodules. Nodulation start after 7-10 days of planting. Stem is less than 75cm in height, leaves are 3-14cm long, 2.5-10cm broad. Inflorescence produces up to 20 small purple or white flowers, Calyxis 5-7mm long. Fruit is 2-10cm broad, seeds are 2-3 pods, small hard, round to ovoid 5-10mm in diameter. Seeds contain 15-25% oil and 40-50% protein. It is consider diploid *Glycine max* is synonymous with soya mx, *Glycine hispida* or *Dolichos Soja* having 40 diploid chromosomes.

Soybean grown an altitude of 2000, is highly photosensitive, little variation in day length effect on flowering. Optimum temperature for growth is 30-33C°, day temperature less than 25C° in extending the flowering. Rainfall of 500-750mm provide high yielding. Well drain sandy loamy soil with pH6-6.5 provide good growth, its show low salinity tolerance.

### Improved varieties of soybean

Variety	Plant type	Days to maturity	Average yield kg/ha	Grain quality	Oil content (%)	Resistant/tolerant to
Clark-63	Dwarf	77-85	1500-2000	Medium size	18-20	Waterlodging
Bragg	Semi draf	120	2000-2500	Bold seeded	20	Bacteria pustules
Lee	Dearf	105-110	1500	Medium size	20	-
Ankur	Tall	135	2500-3000	Small seed	19-20	Rust
Hardee	Semi dwarf	100-105	1800	Bold seeded	19.5	-
Type 49	Tall	130	2000-2500	-	20-22	-
Alankar	Semi dwarf	120	2500-3000	Bold seeded	20-21	-
Punjab 1	Erect	90-95	1800-2000	Small seeded	20-22	Bacterial pustules
Davis	Erect	90-100	1500-2000	-	20-22	Bacterial pustules
Improved Pelican	-	115	1500-2000	-	20-22	-
Monetta	Semi dwarf	76-80	1600-1800	Medium size	21	-
VL-Soya-1	Medium tall	113	2000-2500	-	21	Cercospora leaf spot
PK 308	Semi dwarf	115	2500-3000	Medium size	21	Yellow mosaic
SL4	-	106	1600	Medium size	20	-

Variety	Plant type	Days to maturity	Average yield kg/ha	Grain quality	Oil content (%)	Resistant/tolerant to
PK 416	Tall	120	3200-3700	Medium size	23	Yellow mosaic
Shilajeet	Dwarf	105	2000-2500	Bold seeded	20-22	Yellow mosaic and bacterial pustules
CO 1	Erect	85	1600-1700	Medium size	20	bacterial pustules
Durga	Erect	100-105	1700-2000	Bold seeded	18-20	bacterial pustules
Gaurav	Dwarf erect	105-110	2000-2200	Medium seeded	18-20	Caterpillar and green semilooper
Jowhar soyabean-2	Semi-dwarf	90-95	1800-2500	Medium seeded	18-20	Seedling blight
KHSb-2	Semi-dwarf	115-120	2500	-	22.5	Bacterial pustules
KM-1	Semi-dwarf	95-100	1000	Small seed	20	-
MACS-13	Semi-dwarf	90-100	2000-3000		18-22	Mosaic and bacterial pustules
L.S.2	Semi-dwarf	110-115	1600	Bold seeded	22	-
Kalitur	Slightly	120-135	700-1000	Small seeded	20	Mosaic and bacterial pustules
Pusa-16	Tall	105-110	2500-3500	Medium size	21	Rhizoctonia and bacterial pustules
Jupiter	Tall	110	1500-2000	-	20	-
Birsa soybean.1	Dwarf erect	106	2800-3300	-	21	Cercospora and bacterial pustules
Gujurat soy 1	Tall	105-110	1500-2800	Bold seeded	22-24	Lodging
PK 262	Semi -dwarf	130	2200-3800	Bold seeded	22	bacterial pustules Rhizoctonia and yellow mosaic
PK-327	Semi -dwarf	110	2500-3500	Medium size	21	Bacterial pustule and rhizoctonia.

## Land preparation

One deep ploughing and two harrowing will ensure proper tilt. It require seed 65-75 Kg/hactares and around 3,00,000 plant/hectare.

## Seed treatment

Fungicide thiram at 3g/kg seeds

Captan at 3g/kg seed

Carboxin at 1-2g/kg seeds

Rhizobium should be impregnated with active charcoal or peat for the inoculation

Increase nitrogen application improve seed protein .It requires 20:40:40 kg N:P:K/hectare. Rhizobium culture given at the rate of 400g/65-70kg seeds.

## Weed control

Alachlor or pre-emergence at 2-3 kg/hectare control weeds. Pre-emergence application of Trifluralin at 1 to 1.5kg, fluchlorlin 1-1.5 kg or metribuzin at 0.25 to 0.50kg/hectare.

At harvesting moisture content should be 14%, during threshing 300-400 rpm need 11-12% moisture

## Oil chemistry

Physiochemical properties	Pakistan standard
Moisture (%)	0.10-0.75
Specific gravity	-
Refractive index at 40C°	1.4650-1.4710
Saponification value	189-195
Iodine value	125-140
Acid value	0.5-2.5
Un-saponification matter (%)	1.0-2.0

### Fatty acid composition of soybean oil

Fatty acid	Composition (%)
Palmitic	11.5
Stearic	3.9
Oleic	24.6
Linoleic	52.0
Linolenic	8.0

## Diseases

- Mosaic virus
- Yellow mosaic
- Bacterial diseases like bacterial blight, bacterial pustule
- Anthracnose- *Colletotrichum truncatum*
- Leaf spot-*Cercospora sojina*
- Soybean rust-*Phakopsora pachyrhizi*
- Charcoal rot-*Macrophomina phaseolina*
- *Sclerotium rolfsii*
- Aerial blight –*Rhizoctonia solani* Kuhn

## Field pest

- Girdle beetle
- Stem borer
- Seedcorn maggot
- Black cutworm-*Agrotis ipsilon* Hfn
- Bihar hairy caterpillar-*Spilosoma obliqua*
- Tobacco caterpillar-*Spodoptera litura*
- Lucerne caterpillar-*Spodoptera exitqua*
- Semilooper-*Plusia orichalcea*
- Gram pod borer-*Heliothis armigera*
- Leaf roller
- Leaf miner-*Aproaeremna modicella*
- White fly.

## Uses

Seeds are used for oil and protein, immature seeds are used as vegetable. Soya milk, curd or cheese is derived from it, Soya sauce made from mature fermented beans. Oil is used in industries in manufacturing of paints, linoleum, oil dlothy, painting ink, soap, insecticide and disinfectant. Lecithin phospholipid by-product of oil industry are used as wetting and stabilising agent in food, cosmetic, pharmaceutical, leather, paint, plastic, soap and detergent industries. Soya meal is used in preparation of biscuit, protein rich bread and other confectionery and bakery, high protein livestock feed. Meal of soybean protein is used for manufacturing of synthetic fibre, adhesive, textile size, water proofing, fire fighting foam. The vegetable protein of plant is used for silage, hay, pasture or fodder.

## Conclusion

These are the breeding objectives of soybean.

- High yield, more protein and oil in it.
- Development of photosensitive varieties makes the crop fit in different cropping sequences.
- Development of non-shattering habit will help to minimise loss during harvest.

## Linseed (*Linum Usitatissimum* Linn)

Its decedent *L.mysorense*, *L.pertenne* and *L.strictum*. The genus *Linum* having family *Linaceae* six species of *Linum* are present. There these are: *L.usitatissimum*, *L.mysorence*, *L.pernne*, *L.strictum*, *L.angustifolium* and *L.grandiflarum*. Howard and Khan, classified the *Linum usitatissimum* into 123 types on the basis of seed size, colour of the flowers, stamens, anthers and styles.

It has very deep taproot system has been observed in peninsular varieties which may be xerophytic or mesophytic ecological groups. The fibre varieties are thin, tall growing, less tillering less branched where as oilseed varieties are dwarf highly tillering and much branched at the base or top near the inflorescence region. The plant height varies 40-70 cm. The seeds are oval, lenticular, smooth, shining and 4-6 mm length and 2-3 mm breadth. The seed colour varies from pure yellow, yellowish with brownish tinge, deep fawn and light fawn, light brown to deep brown. The fruit is 5-10mm in diameter.

The genus *Linum* nearly have 100 species and cultivated linseed species *L.usitatissimum* possess 30 somatic chromosome ( $2n=30$ )

### Improved varieties of linseed

Name of variety	Average yield kg/hactare	Oil percent	Days to maturity	Remark
K2	1,100	46	175	Brown, bold seeded, tolerant to rust and will but susceptible to powdery mildew
C 429	1,000	44	125	Moderately susceptible to powdery mildew, moderatly tolerant to wilt and rust
T 397	1,100	44	125	Brown small seeded, spreading type tolerant to rust, wilt and drought suitable for rainfed crop
Hira	1,200	43	135	Brown, bold seeded, spreading type, tolerant to rust, wilt and drought suitable for rainfed crop
Mukta	1,200	45	130	Brown, medium bold seeded, compact growing tolerant to rust and wilt.
S 36	500	44	-	Dwarf green stem, susceptible to capsule borer.
LC 185	500	46	170	Yellow, medium seeded, resistant to wilt and rust and tolerant to frost, suitable for paira or utera sowing
Himalinl	1,310	42	165	Brown, medium seeded, aairly resistant to wilt, rust and powdery mildew
Jawahar 18	800	43	-	Brown, bold seeded, resistant to rust
Jawahar 7	300	43	118	Dull, brown, bold seeded, resistant to rust, moderate susceptible to wilt, highly suitable utera conditions

Name of variety	Average yield kg/hactare	Oil percent	Days to maturity	Remark
LC 54	1,320	42	165	Brown ,medium seeded, fairly resistant to wilt, rust and powdery mildew
Neela (B67)	850	41	130	Brown, medium bold seeded, moderately tolerant to rust, susceptible to powdery mildew
Neelum	1,500	43	145	Medium tall, erect, brown, very bold seeded tolerant to wilt and rust, highly suitable for irrigated and high fertility conditions
Jawahar 2552	900	44	120	Medium tall, erect, brown, very bold seeded tolerant to wilt and rust, highly suitable for irrigated and high fertility conditions
JLS(j)1	900	44	120	Escape linseed gall-fly attack, resistant to rust, moderately resistant to wilt and powdery mildew
SPS 77/23-10	700	-	105	Medium tall, erect, brown, very bold seeded tolerant to wilt and rust, highly suitable for irrigated and high fertility conditions
Jawhar	750-835	44	120	Resistant to wilt, rust, powdery mildew lodging frost and shatering.
Linseed -23	1,200	44	130	Resistant to wilt, rust, powdery mildew lodging frost and shatering
Garima (LHCK-39)	1,500	42.5	125	Resistant to rust , lodging and frost tolerant to powdery mildew, Alternaria blight , wilt and moisture stress.
Subhra	1,150	44.5	125	Resistant to rust, lodging frost and mositure stress, excellent oil quality
(LHCK 131)	900	44	140	Resistant to rust, lodging and frost
Lammi 27	1020	45	110	Resistant to powdery mildew
Pusa 2	1,300	43.0	140	Widely adaptable to peninsular and north western region
Pusa 3	1,350	42.0	145	Responsive to fertiliser and irrigation.

Best time of sowing is October –mid November Seed rate around 40Kg/hectare

## Seed treatment

Seeds must be treated with 2g/kg with carbendazim or agrosan GN at 3g/kg seed or thiram at 3g/kg to protect the soil for soil borne diseases. Optimum row spacing is 25 cam. It need fertiliser 90Kg N, 30-40 kg/P<sub>2</sub>O<sub>5</sub> and 30kg K<sub>2</sub>O .It need 2 irrigation one after 35 days of sowing , second 65 days of sowing

## Various intercropping system

Linseed + Bengalgram  
 Linseed + Safflower  
 Linseed + durum wheat  
 Linseed + lentil

## Harvesting

The crop is threshed either by beating with sticks or trampling under the feet of bullocks.

## Specification of linseed oil

Physicochemical properties	Pakistani standard
Moisture %	0.10-0.25
Specific gravity at 30° /30 C°	0.923-0.928
Refractive index at 40C°	1.4720-1.4750
Saponification value	188-195
Iodine value	170
Acid value	0.5-10.0
Unsaponifiable matter (%)	1.5-2.0

### Fatty acid composition of linseed oil

Fatty acid	Composition (%)
Palmitic	4.2-15.9
Stearic	0.3-10.3
Oleic	13.0-35.4
Linoleic	8.1-27.0
Linolenic	35.8-65.8

### Diseases

- Rust (*Melampsora linn*)
- Wilt (*Fusarium oxysporum*)
- Leaf spot (*Alternaria lini*)
- Powdery mildew (*Oidium lini skoric*)

## Field pest

- Linseed gall midge/capsule borer
- Lucerne caterpillar
- Linseed semi-looper
- Cut worm

## Conclusion

The breeding objectives are:

- To improve seed yield and high oil content
- Rust or wilt resistant
- Pest and disease resistant
- Improve in quality as linseed means is used as animal feed
- It grows altitude of 800m, need annual rainfall of 500-800mm
- It prefer clay loam.

## Rapeseed and Mustard

It is also called yellow sarson (*Brassica campestris* Linn). It belongs to the family cruciferae. The oil seeds are classified into 4 groups namely, rai (raya or lata), sarson, toria and taramira. Rai is described as *Sinapis ramosa* or *Brassica Juncea* Coss. Sarson or Indian claza is divided into race, varieties and species on the basis of seed colour, direction of pedicel and number of locules.

Taramira name is (*B. erucoides*) it includes genus *Eruca* as *E. sativa*. The rapeseed and mustard cover rai, sarson, toria and taramira. Rapeseed refers to toria, yellow and brown sarson mustard to rai.

### Rapeseed (yellow Sarson, brown sarson and tori)

Rapeseed is an annual herb of 45-150cm height with dichotomous to lateral branches at an angle of 10° to 40° giving various shapes. Anthers are tetralocular. Fruit is siliqua with 2-3 and 4-septa. Seed colour varies from pale yellow, yellow, deep yellow to reddish brown.

## Morphological differences between brown sarson and toria

Brown sarson	Toria
<b>Leaves and stems</b> Low leaves more or less hairy and similarly lower part of the stem, leaves thin	Leaves and stem glabrous, leaves somewhat fleshy
<b>Seeds</b> Mucilaginous, dark coloured	Non-mucilaginous, normally light coloured
<b>Maturity</b> Atleast 15 days late in flowering and maturity than toria	At least 15 days earlier in flowering and maturity than brown sarson.
<b>Lowermost 1-2 leaves</b> Lamina prominent up to the base of the leaf.	Lamina absent in the basal half
<b>Leaves colour and texture</b> Dark green, glaucous, fleshy	Palegreen, glaucous, thin
<b>Branching</b> Branches, erect, asend angle between primary branches and main stem varies from 10-20°	Branches erect to spreading, angle between primary branchbhes and main axis varies from 23-43°
<b>Anthers</b> All six anthers intro's in bud as well as in open flower	Six anthers introrse in bud but in open flower four anthers are medium stamens extrorse
<b>Pods</b> Thick and broad, never torulose	Thin and narrow, occasionally torulose
<b>Seeds</b> Dingy white or yellow, non-mucilaginous	Dark brown, brown, or reddish brown, mucilaginous
<b>Fertility</b> Self –fertile	Highly self fertile

### Climatic requirement

Oilseed rape is basically a temperate crop. The rapeseed and mustard crop grown well in areas receiving 250 to 400 mm rainfall. Raya (*Brassica Juncea*) and Toria (*Brassica Campestris*) are grown in medium and high rainfall areas , where as sarson (*Brassia campestris var.sarson*) and taramira (*Eruca Sativa*) preferred in low rainfall area.

### Soil

Mustard can be grown in any type of soil, but rapeseeds need light loamy soils and taramira still lighter soil. These crops are more tolerant to acidity than alkalinity. Mustard needs alkalinity to fairly high degree

## Improved varieties

In 1980 more than 10 varieties of toria, 6 varieties of brown sarson, 6 varieties of yellow sarson, 11 varieties of mustard, 2 varieties of taramira.

## Name of varieties

Seeta (B85), BR 40, Laha 101, Varuna, Shekhar, Krunti (PR-15), Patan 67, Durgamani, RL18, Pusa Bold, Prakash, RH 30, RLM 198, RLM 514, Vaibhav (PK 1418), RLM 619, Vardan (PK-1467), Rohini (KRV 24), Bhagirahi (RW 351), BS 2, RS 70, Pusa Kalyani, BSH 1, Kosal, Benoy (B-9), 66-197-3, T 151, K 88< Patan Sarson 66< Ys P1024, M-27, Ts 29, Agrani (B-54), BR 23, T-9, T-36, Sangam, Itsa, TL 15, DK-1, PT 303, Bhawani (TK 8401), T 27, Gobi sarson, Ludhiana 1(GSL1)

### Spacing

Castor is a drought resistant crop. The crop of 240 days duration need 6-8

Castor is a drought resistant crop. The crop of 240 days duration need 6-8 irrigations.

## Intercropping with

- Castor + groundnut
- Castor + cowpea
- Castor + Redgram
- Castor + Black gram
- Castor + Green gram
- Castor + Lathyrus
- Castor + turmeric
- Castor+ Sunflower
- Castor + redgram

The spike get ready in 90-100 days.

## Specification of castor oil

Physicochemical properties	Pakistani standard
Moisture (%0	0.25-1.0
Specific gravity at 30°/30C°	0.954-0.960
Refractive index at 40C°	1.470-1.474
Saponification value	177-185
Acidic value	2-6
Acetyl value	143.0
Iodine value	82-90
Unsaponification matter(%)	0.8-1.0

### Fatty acid composition of castor oil

Fatty acid	Composition (%)
Ricinoleic	89.5
Linoleic	4.2
Oleic	3.0
Stearic	1.0
Palmitic	1.0
Dihydroxy stearic	0.7
Eicosanoic	0.3
Linolenic	0.3

### Diseases

- Seedling blight (*Phytophthora parasitica* Dast)
- Blight (*Alternaria ricini*)
- Leaf spot (*Cercospora ricinella*)
- Seedling blight, root rot, dieback or wilt (*Fusarium oxysporum*) ( *Macrophomina phaseolina*)
- Rust (*Melamosra ricini*)
- Mildew (*Leveillula taurica*)
- Fruit rot or blossom blight (*Botrytis cinerae*)
- Bacterial leaf spot (*Xanthomonas ricinicola*)

### Field pest

- Castor semilooper
- Achara janta
- Ophinsa algira
- Castor shoot and capsule borer
- Tobacco caterpillar
- Castor Jassiads
- Castor hairy caterpillar (*Euroetis lunata*), (*E.guttata*), (*E.scintillans*)
- Castor gall fly
- Red spider mite
- Bihar hairy caterpillar
- Red hair catterpillar

### Uses

It is used in paints, varnish industry, wetting agent, detergent, sebacic acid, secondary octyl alcohol, heptaldehyde, undecylenic acid. It is used purgative, laxative, act as lubricant in soap industry. Turkey red for dyeing and finning textile for electrical condenser impregnation, carbon paper, ointment, cosmetics, hair dressing, as oxidising oil for plasticising oil, cloths, artificial leather, in brake fluids, printing ink, plant cytogenetics, is used for synthetic flower scents and fruit flavours.

The protein from castor seed is used to produce distempers, oil bound water paints, adhesives for wood, product similar to casein plastics, fibre used in paper industry. It is also used as edible oil –seed meal and oil cake, plastic products, Husk and capsule, Shells as source for hydrolysis, It is also used in production of rubber, specific lubricating greases, preparation of radio condensers, mechanical engineering (Coolant mixture), transformer oil, production of cable as plastic compounds, medicine as laxative, drying oil, lacquers, dressing paints, printing inks, colour preparation of block, alizarin oil (textile), for oiling silk yarn, softener of skins, hydraulic brake fluid, lubricant for motor working and dehydrated oil. It is also used in perfumery, tanning industry, the production of plastic and metal works, while processing castor oil sulfuric acid, alizarin oil is obtained which is used in mordant dyeing of yarn. It is also used dialectic as result of hydrogenation, Oleowax is used as an insulator in radio technology, it is also used to get sebacic acid and nylon, vinyl resins, glycerol, esters of phthalic and maleic acid. It is also used in brake fluids.

## Conclusion

The breeding objectives are:

- High yielding varieties
- Development of short duration variety of 100 to 120 days increase the yield potential per unit area per time.
- High yielding varieties need rainfall 400-750mm, any type of soil is suitable, it can tolerate to pH 8.0 saline soil unsuitable to grow castor

## Cotton seed oil

Cotton belongs to *Gossypium arboreum*, *G. herbaceum* and *G. hirsutum*. Cotton seeds are by-product of cotton ginning industry. Cotton seeds contain 18-20% oil.

### Physicochemical properties of cotton seed oil

Character	Value
Specific gravity at 15°C	0.913
Refractive index	1.4668-1.472
Solidifying point	3-4°C
Saponification value	189-198
Iodine value	103-115
Unsaponifiable matter	0.6-1.6%

**Fatty acid composition of cotton seed oil**

Fatty acid	Percentage
Arachidic	0.1-1.5
Linoleic	34-55
Myristic	0.5-3.0
Oleic	18-44
Palmitic	17-23
Palmitoleic	0.8-2.5
Steraric	1.3

It contains 21-25% Saturated, 16-74%unsaturated fatty acid. The major Glycerides present are palmito-Oleodilinolein Refined cotton seed oil contains 0.09% tocopherol S.Lecithins and Cephalins phospholipids are present in cotton seed oil

**Coconut oil****Physicochemical character of coconut oil**

Character	Value
Specific gravity at 20C°	0.917
Refractive index at 40C°	1.453-1.458
Melting point	23-28C°
Saponification value	250-264
Iodine value	81-91
Unsaponifiable matter	0.2-0.5%

**Fatty acid composition of coconut oil**

Fatty acid	Percent
Arachidic	0.2-15
Capric	5-10
Caporic	0.2-0.8
Caprylic	5-9
Lauric	44-51
Linoleic	Trace-2.5
Oleic	5-8
Palmitic	7-11
Palmitoleic	Trace-1.3
Steraric	1-3

The glyceride composition is terisaturated glyceride 84%, disaturated mono-unsaturated 12% and mono-saturated and di-unsaturated 4%.

## Palm oil

Oil palm (*Elaeis guineensis*)

### Physiochemical characters of palm oil

Character	Value
Specific gravity at 15C°	0.921-0.925
Refractive Index at 40C°	1.4531-1.458
Melting point	27-50C°
Saponification value	195-205
Iodine value	44-58
Un-saponiable matter	0.2-0.8%

### Fatty acid composition of palm oil

Fatty acid	Percentage
Linoleic	5-11
Myristic	0.5-6.0
Oleic	40-50
Palmitic	35-40
Stearic	2-8

Glyceride percent in palm oil are: Oleodipalmitin 45, palmitodiolen 30, Oleo-Palmitosterarin 10, linoleodiolein 6-8, tripalmitin and diplamitostearin 6-8%. Palm oil is rich in Vitamin A mostly used for edible purpose also used in soap and candle industries.

## Rice Bran oil

Crude commercial rice (*Oryza Sativa*) contains 3-5 % wax.

### Physicochemical characters of rice bran oil

Fatty acid	Percent
Linoleic	29-42
Linolenic	0-1
Myristic	0.4-1
Oleic	40-50
Palmitic	13-18
Stearic	1-3

It contains antioxidants used in Oleic and linoleic acid manufacturing

## Appendix

### Fatty acids

Type	Common name	Carbon chain length	Systemic name
Saturated	Lauric	12	Dodecanoic
	Myristic	14	Tetradecanoic
	Palmitic	16	Hexadecanoic
	Stearic	18	Octadecanoic
	Arachidic	20	Eicosanoic
	Behenic	22	Docosanoic
Mono-unsaturated	Oleic	18.1	Cis-9-Octadecenoic
	Eruic	22.1	Cis-13-Docosenoic
Di-unsaturated	Linoleic	18.2	Cis-cis 9,12, Octadecatrienoic
Tri-unsaturated	Linolenic	18.3	Cis-cis 9,12, 15-Octadecatrienoic

## Average tocopherol content of some vegetable oils

Oil	Total tocopherol Mg/g of oil	Individual tocopherols Alpha	Individual tocopherol Gamma	Individual tocopherol Delta
Groundnut	0.93	36.4	64.1	0
Sesame	0.66	38.9	61.5	Traces
Safflower	0.89	51.5	21.9	26.2
Soybean	0.96	12.0	61.8	26.2
Cotton seed	0.92	55.4	44.6	0
Castor	0.45	Traces	51.2	48.8

## Nutritive value of oilseed protein

Protein source	Protein efficiency ratio at 10% level
Groundnut flour	1.65
Mustard seed flour	2.34
Sesame	1.50
Soybean	2.37
Safflower	1.40
Sunflower	2.02
Milk protein	3.0

## Anti-nutritional/toxic constituents in oil seeds.

Oil seed	Antinutritional/toxic constituents
Groundnut	Aflatoxin, goitrogenic factors (red skin)
Rapeseed	Glucosinolates
Mustard	Glucosinolates
Sesame	Oxalates (husk)phytates
Soybean	Trypsin inhibitors, haemagglutinins, goitrogenic factors
Safflower	Bitter and cathartic factors
Sunflower	Polyphenols
Cotton seed	Gossypol

## Specifications for edible oilseed flours

Constituents	Upper limit
Aflatoxin (groundnut )	30ug/kg
Glucosinolates (Mustard)	0.15%
Free gossypol (cotton seed)	0.065%
Total gossypol (cotton seed	1.10%
Oxalic acid (Sesame)	0.5%
Urease activity (soybean)	To pass test

## Essential aminoacid content of some oilseeds (g/16gN)

Amino acid	Ground nut	Rapeseed and mustard	Sesame	Soybean	Safflower	Sunflower	Niger
Isoleucien	4.11	5.2	4.18	5.38	3.97	4.70	4.00
Leucine	6.08	6.1	7.38	7.71	6.13	6.40	6.08
Lysine	3.57	6.9	2.56	6.32	2.48	3.20	3.68
Methionine	0.88	1.6	2.80	1.34	1.62	1.64	1.44
Cystine	1.50	1.5	2.18	1.78	1.70	1.71	1.60
Phenylalanine	5.06	6.5	6.40	4.94	4.32	4.50	4.80
Tyrosine	3.58	2.6	4.72	3.18	2.48	2.38	-
Threonine	2.69	3.4	3.10	3.94	3.10	3.36	3.36
Tryptophan	1.10	1.6	1.46	1.38	-	1.26	-
Valine	4.98	6.2	3.90	5.25	5.46	4.99	5.12

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**Publisher:** ChemLin  
http://www.ChemLin.com  
  
Mar 11, 2005

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