

Agronomy – Rabi Crops

Gram

Dr. I.P.S. Ahlawat
Head,
Division of Agronomy
Indian Agricultural Research Institute
New Delhi – 110 012

GRAM

Botanical name: *Cicer arietinum*

Family: *Fabaceae (Leguminosae)*

Chromosome number: $2n=14$ (*Deshi*)
 $2n=16$ (*Kabuli*)

Gram commonly known as chickpea or Bengal gram is the most important winter (*rabi*) pulse crop in India. In India, gram accounts for more than one third of the area and about 50% of the production of pulses. India accounts for 65% of the world acreage and 67% production of gram at present (2004).

Dal, *besan* (flour), crushed or whole gram, boiled and parched, roasted or cooked, salted or unsalted, sweet preparation, green foliage and grain as vegetables are the important forms in which it is consumed by the people. Germinated seeds are recommended to cure scurvy. Malic and oxalic acids collected from green leaves are prescribed for intestinal disorders. Soaked grain and husk are fed to horses and cattle as concentrate and roughage, respectively. Straw forms an excellent fodder for cattle. Gram is considered to have medicinal effects, and is used for blood purification. Gram contains 21.1% protein, 61.5% carbohydrates and 4.5% fat. It is also rich in calcium, iron and niacin.



Origin and History

Gram is said to be one of the oldest pulses known and grown from ancient times in Asia. Based on presence of closely related annual species *Cicer reticulatum* and *C. echinospermum*, Vander Maesen (1987) opined that south eastern parts of Turkey, adjoining Syria is the center of origin of chickpea. *C. reticulatum* is believed to be the wild progenitor of cultivated chickpea. There are 43 species of *Cicer* [34 wild perennials, and 9 annuals (8 wild, 1 cultivated)] of which only one is cultivated. Ethiopia is secondary center of chickpea, and *Kabuli* types have evolved in

Mediterranean region. Archaeological evidences from Uttar Pradesh indicate their existence in 2000 BC. Gram is mentioned in Sanskrit, as *chanaka* indicating that it is grown in India from a longer period than any other country in the world.



Geographic Distribution

Globally chickpea is cultivated in over 40 countries with Asia accounting for 91.8% and 90.4% of global area and production, respectively in 2004. India Turkey, Pakistan, Mexico, Ethiopia, Australia and Spain are the major chickpea producers of the world. Globally *Deshi* chickpea accounts for over 85% of the area and chickpea productivity was the highest in Mexico and Myanmar (Table 1). In India, Madhya Pradesh is the largest producing state. The important states of India producing chickpea, their acreage, and productivity are given in Table 2. In the

country, the area (10.34 m ha), production (7.02 m t) and productivity (853 kg/ha) of chickpea was the highest in 1959-60, 1958-59 and 1994-95 respectively.

Table 1. Area, production and productivity of chickpea in major producing countries of the world (2004)

Continent/country	Area (m ha)	Production (m t)	Productivity (kg/ha)
Africa	0.482	0.324	672
Ethiopia	0.168	0.136	809
Malawi	0.088	0.035	398
Morocco	0.072	0.042	583
Tanzania	0.070	0.032	457
N.C. America (Mexico)	0.189	0.291	1545
Asia	10.049	7.771	773
India	7.100	5.770	813
Iran	0.755	0.310	411
Myanmar	0.208	0.230	1106
Pakistan	0.982	0.611	622
Turkey	0.660	0.620	939
Europe	0.103	0.089	862
Spain	0.080	0.057	709
Oceania (Australia)	0.113	0.116	1027
World	10.943	8.597	786

Source: FAO Production Year Book, 2004

Table 2. Area, production and productivity of gram in important states of India (2004-05)

State	Area (000 ha)	Production (000 t)	Productivity (kg/ha)
Andhra Pradesh	341.0	345.0	1012
Assam	2.1	1.1	524
Bihar	72.1	60.2	835

State	Area (000 ha)	Production (000 t)	Productivity (kg/ha)
Chattisgarh	210.5	114.1	542
Gujarat	122.7	98.5	803
Haryana	107.0	91.0	850
Himachal Pradesh	3.0	4.0	1333
Jammu & Kashmir	0.2	0.1	500
Karnataka	418.0	224.0	536
Madhya Pradesh	2746.5	2548.9	928
Maharashtra	830.0	466.0	561
Orissa	32.8	19.9	607
Punjab	5.1	4.4	863
Rajasthan	1035.2	773.0	747
Tamil Nadu	6.7	4.4	657
Uttarakhand	3.0	2.0	667
Uttar Pradesh	738.6	672.2	910
West Bengal	38.0	38.9	1024
India	6714.6	5469.4	815

Source: Fertilizer Association of India, 2006

Classification

Chickpea belongs to the tribe *Cicereae* and genus *Cicer*. The Indian grams have been classified in 2 broad groups.

1. **Deshi or brown gram** (*Cicer arietinum* L.): This is the most widely grown group. Plants are small, erect with good branching. The chromosome number is $2n=14, 16, 24$ and 32 . In this group, the colour of the seed ranges from yellow to dark brown. Seed size is usually small (5-12 mm) with irregular shape having a test weight of 170-260 g.
2. **Kabuli or white gram** (*Cicer kabulium*): It is grown in lesser area than the brown gram. Plants are erect taller than brown gram with moderate branching. The chromosome number is $2n=16$. Grains are bold (test weight >260 g) and attractive. The colour of grain is usually white. Yield potential of this group is poorer than brown gram.



Source: commons.wikimedia.org/

Both these types produce about 50-100 pods/plant and each pod having up to 2 seeds.

Climatic Requirements

Chickpeas requiring cool climate for growth and high temperature for maturity are grown between 10-32°N latitude in the country in the winter season. However, it is a crop of spring season beyond the sub-continent. The crop performs better at 24-32°C temperature. Pod set and seed filling are curtailed both at low (<5°C) and high (>30°C) temperatures. Germination and pollination are adversely affected at low temperature. It can not tolerate frost. This crop with deep root system can be grown on residual soil moisture in areas with 600-1000 mm annual rainfall. Heavy rains at germination and flowering are detrimental to the crop. Hailstorms at maturity are not desirable. Chickpea is quantitatively long-day plant requiring photoperiod >12 hours.

Soils and its preparation

Gram is grown practically on a variety of soil types ranging from very light to heavy ones. In north India, it is cultivated on sandy loam to clay loam soils whereas in south on Deccan plateau and central India or Maharashtra, gram is raised on black cotton soils. The clay loams are the best. The optimum soil pH varies from 5.7-7.2. Soils with an electrical conductivity of >2 dS/m, exchangeable sodium percentage >15 and rooting depth <25 cm are not suitable for chickpea. Soils with high water storage (200-250 mm) are preferred for raising crop on residual moisture.

Gram needs cloddy and rough seed-bed for good aeration in root zone. Hence, a little land preparation is required. Desired seed-bed may be obtained by a deep ploughing followed by 2 harrowings. In *diara* lands, 1 ploughing by country plough brings about desired condition for sowing of crop. A deep summer ploughing is essential for higher retention of moisture in soils, where the crop is grown on residual soil moisture as in *Haveli* system of Madhya Pradesh.

Varieties

A large number of varieties (over 130) were evolved in chickpea using pure line selection (~45), hybridization (~80) and mutation (four) breeding approaches. In recent times, there has been increased emphasis on evolving Kabuli chickpeas. The introduced Kabuli germplasms were used in cultivar development in the country. C 104, L 550, L 144, BG 1003 (from Rabat cv of Morocco), BG 244 (from P 922 of Spain), BG 267 (from USA 163 of USA), BG 1053 (FLIP 88-120 of Syria), BG 391 (from ICC 3955 of Iran) are some of the Kabuli cultivars developed. For *chhollia* (green seeds) purpose ICCV 96029 and ICCV 96030 were found promising. Pusa 408, Pusa 413, Pusa 417 and RSG 2 are the varieties evolved through mutation breeding. The varieties recommended for different states (zones) are given below.

Varieties recommended for different stages and agroclimatic zones of India

State	Variety
Uttar Pradesh	Type 3, K 468, Pant G 114, K 4, K 5, Surya, Avrodhi, Pant G 186, Pragati (K 3256), Radhey, Sadabahar, Sadbhawana (WCG 1).
Punjab	C 214, G 24, G 130, G 543, L 144, JK 92337, Puhle G 9531, Haryana channa 3, GL 769, Hare chhole 1, PBG 1, PBG 3
Haryana	H 208, H 355, Gora Hisari
Madhya Pradesh	JG 1, JG 5, JG 221, Ujjain 24, JG 322, JGG 1, Dahod yellow, JG 218, JG 74

State	Variety
Bihar and Jharkhand	ST 4, BR 65, BG 77, BR 78, RAU 52
Rajasthan	RS 10, RS 11, RSG 44
West Bengal	B 110, B 124, B 104, Mahamaya 2 (B 115)
Tami Nadu	Co 2, Co 3, Co 4
Maharashtra	BDN-93, Chaffa, Dahod yellow, Hirwa Chaffa (AKGS-1), Phule G 12, Sweta (ICCV 2)
Karnataka	Annegiri
Gujarat	Dahod yellow, Gujarat Gram 2 (GCP-107), ICCV 4
Andhra Pradesh	Sweta (ICCV 2)
NWPZ	Alok (KGD 1168), Chamatkar, DCP 92-3, Gaurav (H-75-35), GNG-146, GPF-2, Haryana Channa-1, ICCV 6, K 850, Karnal channa-1 (CSG 8962), L 550, PBG-1, Pusa 256, Pusa 267, Pusa 329, Pusa 362, Pusa 372, Samrat (GNG 469), Surya (WCG 2), Udai (KPG 59), Vardan (GNG 663)
Central Zone	BGD-72 (Dharwad Pragati), Gujarat Gram 2 (GCP 101), ICCV 6, JG 315, KAK-2, Kranti (ICCC 37), Pusa 372, Pusa 391, Vijay Phule (G 81-1-1), Vikas (Phule G2), Vishal (Phule G 87207), Vishwas (Phule G5)
South Zone	Bharati (ICCV 10), JG-11, Kranti (ICCC 37)
NEPZ	Gujarat Gram 4 (GCP-105), KWR 108, Pusa 256, Pusa Kabuli 1003, Uday (KPG 59), Vishwas (Phule G5)

Seed rate and Spacing

The seed rate varies from 80-100 and 50-70 kg/ha in *kabuli* and *deshi* chickpeas. Under late sown conditions, the seed rate may be increased by 25-40%. *Kabuli* types are sown in rows 45 cm apart, while *deshi* types and late sown chickpea are sown in 30 cm rows. The plant to plant spacing vary from 10-12 cm.

Seed should be treated with agrosan GN or thiram @ 2.5 g/kg seed to protect against seed borne diseases. Seed should be inoculated with *Rhizobium* and phosphate solubilizing bacteria.

Time of Sowing

The optimum time of sowing vary from mid-October to mid-November. Rainfed crop should be sown at the earliest in October. Under irrigated conditions, second fortnight is the best. The sowing time in different states vary as is given below.

State	Rainfed	Irrigated
Punjab and Haryana	Second to third week of October	Fourth week of October to 15 November
Rajasthan	First to 15 October	15-30 October in south and south-eastern Rajasthan; 25 October-15 November in Ganganagar district
Bihar and Gujarat	15 October to first week of November	First fortnight of November
Madhya Pradesh, Maharashtra, Uttar Pradesh, Karnataka, Jammu-Kashmir and Tamil Nadu	First fortnight of October	End of October to first week of November

Method of Sowing

Broadcast of seeds should be avoided especially under rainfed conditions. The seeds should be sown in furrows behind the country plough, but the best method is to drill the seeds either by seed drill or by *malabasa* at a depth of 8-10 cm. Under irrigated conditions, shallow sowing (5-6 cm) is recommended.

Manures and Fertilizers

Chickpea removes about 122 kg of primary (67.3 N + 6.6 P + 48 K), 34.7 kg of secondary (18.7 Ca, 7.3 Mg + 8.7 S) and 1000 g of micronutrients/ha (868 Fe + 70 Mn + 38 Zn + 11.3 Cu + 1.5 Mo) for every tonne of grain produced from the soil. Of these, the deficiency of N, P, Fe, B and S was found to limit yields to the tune of 10%, 29-45%, 22-90%, 100% and 16-30%, respectively.

Being a legume, it fixes atmospheric nitrogen in association with *Mesorhizobium ciceri*. In order to meet the initial N requirement of the crop between exhaust of seed N and effective nodule formation, a starter dose of 20 kg N is applied at the time of sowing. However, the crop may require high dose of N (40 kg/ha) when grown after rice, maize, jowar, and under late sown (December) conditions. The chickpea grown after potato and intercropped in autumn sugarcane would not require starter dose of N.

Phosphorus is the most critical nutrient limiting chickpea production. In general, *kabuli* types require more P fertilizer than *deshi* chickpeas. Further, the crop responses to P fertilization are greater in a vertisol (black) than alfisol (red soil) due to higher water holding capacity. The crop requires 0, 30 and 60 kg P₂O₅/ha in soil with available P of >22.5, 15.0-22.5 and <15.0 respectively in India. Placement of P fertilizer 5 cm below the soil is better than broadcast application.

The crop rarely responds to K fertilization. However, in red and alluvial soils, 15-30 kg K₂O/ha is necessary for higher yields. In acidic soils, Ca and Mg deficiency may limit crop performance. Liming of such soils (with pH 5.5) is promising. Application of 20-30 kg/ha of S as gypsum (acidic soils) and sulphur (non-acidic soils) is also necessary. Soil application of 20 kg ZnSO₄/ha is necessary for better crop performance in Zn deficient soils. Boron deficiency is also reported in the states of Orissa, Bihar, Uttar Pradesh and Gujarat. In such areas 0.5 kg B/ha application is necessary for arresting flower drop and enhancing yield. Similarly, Mo is found

deficient in vertisols of Madhya Pradesh and Gujarat. Seed treatment with 3.5 g sodium molybdate or 1 kg Mo/ha as soil application is necessary to overcome its adverse effects on yield. Its toxicity is common in saline and alkali soils.

Water Management

Gram is mostly grown as a rainfed crop and is capable of extracting moisture from deeper layers. Most of its roots are usually confined within upper 2 feet of soil. However, where irrigation facilities are available, one pre-sowing irrigation (*palewa*) may be given for proper germination and better crop growth. In absence of winter rains, one irrigation each at pre-flowering and pod development stage may be applied. In no case, first irrigation should be given earlier than 4 weeks after sowing. No irrigation should be applied at flowering time of crop. The crop should always be given light irrigation (50-60 mm) because heavy irrigation is harmful to crop. The water requirement of the crop varies from 250-400 mm. At present 30.6% of total chickpea acreage of the country is under irrigation.

Nipping

Under irrigated condition, crop may sometimes make vigorous vegetative growth adversely affecting the development of reproductive structures. The practice of nipping may be required under such conditions. In this process, the apical buds of the crop are plucked, when the plants get a height of 15-20 cm i.e., 50 days after sowing. This helps in developing more lateral branching bearing flowers and pods. Nipping can also be attained through spraying of 75 ppm TIBA (Tri-iodo-benzoic acid).

Weed Control

Gram, being a dwarf statured crop suffers severely by weed infestation. Uncontrolled weeds may limit chickpea yields by 40-87%. The initial 2 months period is critical for crop-weed competition. Of the 60 species invading chickpea, the dominant weeds include:

Chenopodium album L., *Melilotus indica* Pers., *Lathyrus aphacas* L., *Medicago denticulata* Wild, *Trigonella polycerata*, *Polygonum phlebilium*, *Asphodelus tenuifolius* Cavan, *Euphorbia dracunculoides* Lamk, *Trichoderma indicum*, *Phalaris minor* Retz., *Cyperus rotundus* L.

The best time for weeding and hoeing is between 25-30 days after sowing. If the weeds persist after first weeding, another weeding should be done at about 60 days after sowing. Weeds can also be controlled effectively by herbicides for which fluchloralin @ 1.0 kg/ha should be used as pre-plant incorporation or pendimethalin @ 1.0 kg/ha as pre-emergence or oxadiazon @ 0.75 kg/ha as pre-emergence may be used. Intercropping chickpea with mustard reduces weed menace drastically.

Cropping Systems

Gram is grown mixed with wheat, barley, rapeseed and mustard crop. It is grown mixed with *toria* in *tarai* region. The promising intercropping systems in different parts of the country are:

Intercropping system	Row ratio
Chickpea + mustard	6:1
Chickpea+wheat	2:1
Chickpea+safflower/linseed	3:1
Chickpea+autumn sugarcane	2:1

Gram is grown after the harvest of *kharif* crops like paddy, maize, sorghum, pearl millet etc. Gram in rotation with several crops also helps in controlling soil-borne diseases. The most common rotations are:

- Paddy-gram (irrigated lowland) Pearl millet-gram (irrigated uplands)
- Sorghum-gram (irrigated uplands) Maize-gram (irrigated upland and lowland)
- Cotton-gram (rainfed upland)

Harvesting and Threshing

Crop becomes ready for harvest when leaves turn reddish-brown and start shedding. Plants are either plucked out by hand or cut with sickle. The crop is allowed to dry in sun on threshing floor for about 5-6 days. Thereafter threshing is done either by beating the plant with stick or by trampling by bullocks.

Yield

A well managed deshi chickpea crop yields about 2.0-2.5 t grain/ha, while kabuli types yield 2.5-3.0 t/ha under irrigated conditions. Under rainfed conditions, the crop yields are generally 30-50% of the irrigated crop. The major yield attributes of chickpea were given below:

<i>Attributes</i>	VALUE
Pods/plant	38.9
Seeds/pod	1.2
1,000 seed weight(g) – deshi	<250
Kabuli	250-400 g