

2017

Improved Production Technology : Pulses

*(Chickpea, Pigeonpea, Mungbean, Urdbean, Lentil, Fieldpea,
Horsegram, Mothbean, Lathyrus, Rajmash, Cowpea, Clusterbean)*

Compiled and Edited by

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सत्यमेव जयते

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Chickpea Production Technology



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CHICKPEA

Botanical Name – *Cicer arietinum* (L.)

Synonym – Chickpea, Bengalgram, Chana

Origin – South West Asia–Afganistan
/Persia.



Introduction

Chickpea is the largest produced food legume in South Asia and the third largest globally, after common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). Bengal gram is widely appreciated as health food. It is a protein-rich supplement to cereal-based diets, especially to the poor in developing countries.

Nutritive Value

Protein	- 18-22%	Calcium	- 280 mg/100 gm
Carbohydrate	- 61-62%	Iron	- 12.3 mg/100 gm
Fat	- 4.5 %	Phosphorus	- 301 mg/100 gm
Calorific value	- 396 Kcal/100 gm		

Crop Status

Globally, India ranked first in area and production, followed by Pakistan, Iran and Australia with respect to area and Australia, Myanmar with respect to production. The highest productivity of 3759 kg/ha is observed in China followed by Israel, Republic of Moldova and Bosnia & Herzegovina. India's productivity was 995 kg/ha (*FAO Stat., 2014*).

During Twelfth Plan (2012-15) the area and production of gram has been 87.62 lakh hectares and 82.15 lakh tonnes. More than 90% gram production comes from 7 states of MP, Rajasthan, MS, Karnataka, AP, UP & CG. MP ranked Ist in area (34.69%) and production (40.60%). Maharashtra rank at IInd in area (16.57%) & IIIrd in production (13.07%) Whereas, Rajasthan stands IInd position in production (14.09%). The highest yield was recorded in A.P. (1522 kg/ha) followed by Punjab (1216 kg/ha) and Gujarat (1193 kg/ha). The lowest yield was recorded in Tamilnadu (648 kg/ha) (*DES, 2015-16*).

State-wise recommended varieties

States	Recommended Varieties	
	Desi	Kabuli
Andhra Pradesh	Phule G-95311, ICCV-32, Kranti, MNK 1, JG-11	ICVV-2
Bihar	KPG-59 (Uday), Pusa-372, KWR-108, Pant G-186	Pusa 1053, Pusa 1003, HK-2, HK-3
Gujarat	GKG-809, GKG-207, GCP-105, GKP-107, Gujarat Chana-4	PKV-2, PKV-4, Raj Vijay Kabuli Chana 202 & 203
Haryana	HK-4, RSG-888 (Anubhav), RSG-931, RSG-963, DCP-92-3, Karnal Chana 1	Haryana Kabuli-1, G-1053
Karnataka	BDN-103, JG-63, MNK-1, ICCV-37	Phule G -0517
Madhya Pradesh	Raj Vijay-201, JG-14, JG-226, JG-63, JG-130, JG-322, JG-218, JG-13, JG-11	Raj Vijay 202 & 201, JGK-2, JGK-3, JGK-1, KAK-2
Maharashtra	AKJ-9303-13, JAKI-9218, BDNG-797 (Akash), Digvijay, WCG-10, JG-16	PKVK-4, Virat, Phule G-0517, Ujjwal
Punjab	GNG-1958, GLK-28127, PBG-5, Pusa-547, GNG-469, Uday, Pusa-362, Rajas	L-551, L550
Rajasthan	RSG-974, RSG-902 (Aruna), RSG-896 (Arpana), RSG-807 (Abha), GNG-1488, GNG 421, Pratap Chana 1	L-550, KAK-2
Uttar Pradesh	GNG-1969, CSJ-515, WCG-3 (Vallabh color Chana), GNG-1581, BDG-72	Pusa 1003, KAK-2, K-4, Haryana Kabuli Chana 2
Uttarakhand	RSG-963 (Adhar), CSG-8962, Phule G 9925-9 (Rajas)	Pant Kabuli-1
Jharkhand	KWR-108, KPG-59, Pant G114	HK-05-169
Chhattisgarh	Pusa 391, Pusa-372, JSC-55, JSC-56, RG 2918 (Vaibhav)	JGK-1, Phule G-0517
West Bengal	Anuradha, Gujrata Chana-4, Uday	Pusa-1003
Tamil Nadu	MNK-1, Phule G-95311, JG-11	Co.-4

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

It's a winter season crop. But Frost at the time of flowering results in the failure of the flowers to develop seeds. It is best suited to areas having moderate rainfall of 60-90 cm per annum.

Soil Type & Field Preparation

It can be grown in coarse-textured sandy to fine-textured deep black soils (vertisols). However, the best suited soils are well drained, deep loams or silty clay loams with a pH ranging from 6.0 to 8.0. The field should have loose tilth and good drainage. The stubble and debris from the previous crop should be removed as these can harbor the pathogens that cause root diseases, such as collar rot.

Field preparation for sowing chickpea is based on the soil type and cropping system. In case of a heavy soil, a rough seedbed is prepared to avoid packing of the cloddy surface due to winter rains and to facilitate soil aeration and easy seedling emergence.

Sowing Time

North India – Rainfed : Second fortnight of October, **Irrigated**: first fortnight of November.

Central & South India - First fortnight of October to first fortnight of November; **Late sowing** (December-January) should be avoided as the late-sown crop may experience moisture stress and high temperatures at the critical stage of pod-filling, leading to reduced yield and seed quality.

Method of Sowing & Seed Rate

Adopt line sowing by double box seed drill or local plough. Also BBF and Ridge & Furrow method in low lying or shallow lands at 8-10 cm depth as the shallow crop is much prone to wilt.

Seed size (100-seed weight)	Seed rate (kg/ha)	Spacing
Small (less than 20 g)	60 kg	Timely Sown: 30 cm X 10 cm
Medium (20 – 30 g)	90 kg	Late Sown-: 25 cm X 10 cm
Large (30 – 40 g)	120 kg	Irrigated areas-:45 cm X 10 cm
Extra-large (more than 40 g)	150 kg	

Seed Treatment

Disease Control: Strictly follow FIR seed treatment with (fungicide, insecticide and *rhizobium*) Seed treated with 2 g Thiram + 1 g Carben-dazim or Carboxin(vitavex) 2 g/ kg to control wilt & root rot; **Insect-Pest**: Thiamethoxam 70 WP @ 3 g/kg seed; **Culture & Micronutrient**: *Rhizobium* 5 g + PSB 5 g/kg of seed & after that apply Molybdenum 1 g/kg of seed.

*If the seed is to be treated with pesticides, always apply fungicides first, followed by insecticides, and finally *Rhizobium* culture/Phosphate Solubilizing Bacteria (PSB) or follow instructions on the packets.

Water Management

Chickpea is mostly sown as a rainfed crop. However, where irrigation facilities are available, give a pre-sowing irrigation. One irrigation at branching and one at pod formation stage. Excess of irrigation enhances vegetative growth and depresses yield.

Fertilizer and Manure

Fertilizer requirements depend on the nutrient status of the field, and thus, vary from field to field. Therefore, the doses of fertilizers should be determined based on the results of soil test. It is better if all the fertilizers are drilled in furrows at a depth of 2 cm and at the side of 5 cm from seed. The generally recommended doses for chickpea include 15- 20 kg nitrogen (N) and 50–60 kg phosphorus (P) per ha. If soils are low in potassium (K) an application of 17 to 20 kg/ ha K₂O is recommended. Total quantities of N, P and K should be given as a basal dose. Foliar spray of 2% urea at flowering has been found beneficial in rainfed crops.

Weed Control

Chickpea is a poor competitor with weeds at all stages of growth. Pre-emergence herbicides Pendimethalin 30% EC @ 0.75 to 1 kg a.i./ha was found effective in controlling early flush of weeds (use within 48 hrs. after sowing). Mechanical and/or manual weeding can be done where wide row spacing is used. One hand weeding or inter-culture with hand hoe or wheel hoe at 25-30 days after sowing.

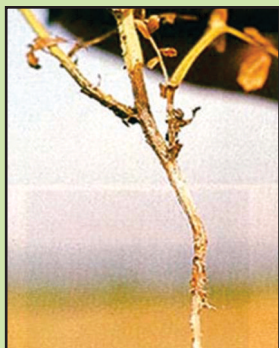
Plant Protection Measures

Disease

The important disease of Chickpea are Collar rot, Wilt, Dry root rot. Symptoms of these disease and their suitable control measures are given below:

1. Collor Rot

Symptoms: The collar region of plant is constricted and begins to rot. White mycelial strands with minute mustard seed-sized sclerotial bodies are seen over the affected tissue. The affected seedlings turn yellow and wilt. It may be seen in seedling & vegetative growth stage.

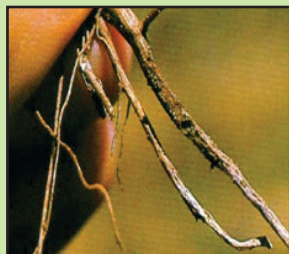


Control Measures

i) Application of calcium fertilizer; ii) Seed treatment with fungicide carboxin @ 3 g /kg of seed; iii) Crop rotations with cereals such as wheat, sorghum and millets, and remove undecomposed debris from the field before sowing.

2. Dry Root Rot

Symptoms: The whole plant dries up and turns straw-colored. Roots become black and brittle and have only a few lateral roots or none at all. It may be seen in flowering & podding stage.



Control Measures

i) Seed treatment with *Tricoderma viride* @ 4g /kg seed or Thiram (2g) + Carbendazim (1g) @ 3 g per kg of seed or Carbendazim @ 2g/kg of seed; ii) Follow crop rotation; iii) Timely sowing to avoid post-flowering drought and heat stresses, which aggravate the disease.

3. Wilt

Symptoms: The main cause of this disease is a fungus (*Fusarium oxysporum*). Plant become yellowish and finally dry out. Roots turn black and ultimately decompose. It may be seen in seedling stage & advance stage of plant growth.



Control Measures

i) Seed treatment with *Tricoderma viride* @ 4g /kg seed or Thiram (2g) + Carbendazim (1g) @ 3 g per kg of seed or Carbendazim @ 2 g/kg of seed; ii) Sowing should be during third week

of October; iii) Deep Planting (8-10 cm) in light soil; iv) In case of heavy incidence avoid cultivation for 03 to 04 years; v) Grow resistant varieties: *Desi*- JG 315, JG 322, JG 16, JG 11, JG 12, JSC 37, JSC 55, JAKI 9218; *Kabuli*- JGK 1, JGK 2, JGK 3 (Gulabi)- JGG 1.

Insect-Pest Management

1. Cutworm

Nature of Damage Serious pest in low lying areas where fields are cloddy. The larvae remains hidden under these clods during the day time & cause damage during night. It may be seen in Seedling, vegetative growth stage & reproductive stage. The caterpillar cut the plants at ground level. Larvae feed on leaves, stems and roots.



Control Measures

i) Summer deep ploughing; ii) Crop rotation; iii) Intercropping with wheat or linseed or mustard; iv) Grow marigold on bunds; v) Apply Phorate 10 G @ 10 kg/ ha before sowing; vi) Spray insecticides like Quinalphos 25 EC @ 2 ml /liter or Profenofos 50 EC @ 2 ml /liter.

2. Gram Pod Borer

Nature of Damage

i) Larvae feed on leaves during the vegetative phase and on flowers and pods during the reproductive phase; ii) Large larvae cut round holes in the pod wall and devour the seed inside.

Control Measures

i) Early sowing, grow short duration varieties; ii) Intercropping with coriander, linseed, marigold, mustard, sunflower or wheat; iii) Use moderate resistant cultivars like ICCV10, Vijay, ICCV 7 and ICCL 86103, PBG-3; iv) Install bird perches @ 40-50 /ha; v) Spray neem seed extract (5%); vi) Apply HaNPV @ 250 LE/ha or Spray indoxacarb @1 ml/lit or Emamectin benzoate 5 SG @ 0.2 g /lit of water at 10-15 days interval if needed



Harvesting, Threshing & Storage

Crop become ready for harvest when leaves begin to fall, stem and pod turn brown or straw in colour and seeds are hard and rattle (most important) with 15% moisture inside them. Over ripening may lead to fall of pods as well as shattering and seed cracking if seed moisture falls below 10% due to delay in harvesting. The crop is allowed to dry for 2-4 days on threshing floor (depending on situation) and threshed by manually or bullock/power drawn thresher followed by winnowing. The clean seed should be sun dried for 3-4 days to bring their moisture content at 9-10%. Now they should be safely stored in appropriate bins and fumigated to protect them from bruchids.

Yield

By adopting good management practices, an average yield of 15-20 q/ha can easily be obtained.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years to eliminate dormant pupae.
- ii) Application of fertilizer based on soil test value.
- iii) Seed treatment with *Trichoderma* (6 g/kg) and Carboxin (Vitavax) (1g/kg).
- iv) Grow wilt resistant/ tolerant varieties of the region: JG 315, JG 12, JG 11, JAKI 9218, JGK 1, JGK 2, JGK 3, KAK2 etc.
- v) Install bird perches @ 50/ha at flowering stage and remove the perches at grain ripening stage.
- vi) Nipping should be done when crop is at 15-20 cm height.
- vii) Two irrigations first at branching and second at pod initiation stage.
- viii) Weed control should be done at right time.
- ix) Seed treatment with Ammonium Molybdate @ 1g/kg of seed in the areas of chickpea- soybean cropping system.
- x) Spray of crude NSKE 5 % or Azadirachtin 0.03 % (300 ppm), Neem oil based WSP 2500-5000 ml/ ha at pre-flowering stage at 15 days interval.

- For technical information of crop production please contact to district KVK/SAUs/RARS.
- To avail benefit from Central and State Run-Schemes on crop development (ploughing, fertilizers, micronutrient, pesticide, irrigation equipment), agricultural implements, storage infrastructure etc., please contact your DDA/SADO office.

- For more information also visit -
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CLUSTER BEAN

Botanical Name – *Cyamopsis tetragonoloba* (L.)

Synonym – Guar



Among Pulse crops cluster bean has a special contribution. It is grown in Rajasthan, Gujarat, Haryana, Uttar Pradesh. In India Rajasthan stands first in terms of area and production of Cluster bean. The crop produces gum which is called guar gum and is exported in foreign countries. Its seeds contain protein-18% and Fibre-32 % and about 30-33 % gum in the endosperm.

Climate Requirement

Cluster bean is a tropical plant. It requires warm growing season. The crop requires 30 to 35°C temperatures at the sowing time for proper germination and 32 to 38°C temperatures encourages good vegetative growth, but high temperature at flowering stage photosensitive and indeterminate crop. Atmospheric humidity encourages the infestation of many diseases like bacterial leaf blight, root rot etc.

Soil

The Cluster bean is grown in medium to light textured soil having a pH of 7.0 to 8.5. Water logged conditions affects the crop growth. Heavy loam soils are not suitable for cultivation of cluster bean. Also the crop growth is affected in the high moisturized area.

Field Preparation

After harvesting of rabi crop one deep ploughing from mould board plough or disk harrow followed by 1-2 harrowing or ploughing and planking. Properly leveled field is required for good drainage.

Improved Varieties

For seeds and Gum - HG-365, HG-563, RCG- 1066, RCG- 1003

For vegetables - Durga Bahar, Pusa Navbahar, Pusa Sadabahar

For Fodder - HFG-119, HFG- 156

State-wise recommended varieties

S.No.	State	Recommended Varieties
1	Andhra Pradesh	RGM-112, RCG-936, HG-563, HG-365
2	Gujarat	GC-1, GC-2
3	Haryana	HG-75, HG-182, HG-258, HG-365, HG-563, HG-870, HG-884, HG-867, HG-2-20
4	Madhya Pradesh	HG-365, HG-563
5	Maharashtra	HG-365, HG-563, RCG-936

6	Punjab	AG-112 and varieties from Haryana
7	Rajasthan	RCG- 1033, RCG-1066, RCG-1055, RCG-1038, RCG-1003, RCG-1002, RCG-986, RGM-112, RCG-197
8	Uttar Pradesh	HG-563, HG-365

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-CAZRI, Jodhpur

Time of Sowing

The crop is sown in the first week of July to 25th July. Where irrigation facility is there the crop can also be grown in the last week of June or after the onset of monsoon. During summer it can be grown in the month of March.

Seed Treatment

To prevent crop from soil borne disease seed can be treated by 2 g Thiram and 1 g Carbendazim /kg seed. Seeds can be treated 2-3 day before sowing. After fungicide seed treatment the seed is inoculated with suitable Rhizobium culture @ 600g / 12-15 kg seed.

Planting Distance

Row to Row - 45 cm (normal), 30 cm (single stem variety)

Plant to Plant - 15-20 cm

Intercropping - Cluster bean can be grown with Bajra in intercropping system

Crop Rotation - 1. Guar-Wheat; 2. Guar-Chickpea; 3. Guar- Mustard

Irrigation and Drainage

For good production of the crop one irrigation can be given at the time of flowering and pod formation if crop suffers moisture stress. Cluster bean cannot tolerate water logging condition therefore proper drainage is required in the field

Weed Management

In cluster bean two manual weeding given at 20-25 and 40-45 days after sowing are sufficient to keep the crop weed free. However, sometimes due to non –availability of labour chemical weed control can be done. Before germination of the crop application of Pendimethalin 30% EC @ 0.75 kg/ha a.i. as pre emergence and for post emergence application Imazetapyr 10% SL @ 40g/ha a.i. in 600 litres

of water is applied at 20-25 DAS is suitable for weed control. Wheel hoe and Hand Hoe is used for Inter Culture operation to reduce the expenditure. Flat Fan Nozzle should be used for spraying.

Crop Protection

a) Insect

- 1. Sucking insect:** Jassids, Aphids and White fly are sucking insect. For controlling these insect apply Imidacloprid @ 0.2 ml/liter or Dimethoate @ 1.7 ml/liter of water.
- 2. Termite:** Termites damage plants by eating away root and stem, which cause poor plant stand.

Control Measures

- Use well decompose FYM; ii) Seed treatment with Chlorpyrifos @ 2 ml/kg seed; iii) Application of Chlorpyrifos dust @ 20kg/ha at the time of last ploughing before sowing.

b) Disease

1. Bacterial Blight

Control measure

- Use resistant/tolerant varieties and certified seed; ii) Seed treatment with Streptocycline for that soak the seed in 200 ppm (0.2g/liter) solution of Streptocycline for 3 hours; iii) In standing crop spray of Copper oxychloride @2.5g/liter of water can be use for controlling disease.

2. Anthracnose & Alternaria Leaf Spot

Control measure

For controlling these disease foliar sprays of Mancozeb 75 WP @2g/liter of water can be used and repeat the spray at 15 days interval if needed.

Harvesting & Threshing

For grain purpose crop, harvesting is done when leaves become dry and 50% pod turn brown & dry. After harvesting crop should be sun drying then threshing is done by manually or thressure. For fodder crop, crop cut when crop at flowering stage.

Yield

By adopting improved package of practices, crop can produce 10-15 q

seed yield/ha. If crop grown for fodder purpose 250- 300 q green fodder/ha can be achieved.

Utility of the Cluster Bean

- Green pods can be used as vegetables.
- Green nutritious fodder for animals.
- It is also used as green manure (40-50 kg/ha Nitrogen).
- N- Fixation (25-30 kg/ha) is done by guar.
- Increase soil fertility.
- Gum can be produced from the crop.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
 - ii) Seed treatment should be done before sowing.
 - iii) Application of fertilizer should be based on soil test value.
 - iv) Weed control should be done at right time.
 - v) Adopt integrated approach for plant protection.
-
- For technical information of crop production please contact to district KVK/ nearest KVK.
 - To avail benefit from Central and State Government running schemes for crop production (ploughing, fertilizers, micronutrient, pesticide, irrigation equipment), agricultural implements, storage infrastructure etc., please contact to your DDA/SADO office.

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COWPEA

Botanical Name - *Vigna unguiculata* (L.)

Synonym - Lobia, Barbati, Black eyed pea

Origin - Africa & Asia



Importance

This crop is known as drought hardy nature, its wide and droopy leaves keeps soils and soil moisture conserved due to shading effect. It is also known as black-eyed pea or southern pea etc. and has multiple uses like food, feed, forage, fodder, green manuring and vegetable. Cowpea seed is a nutritious component in the human diet, and cheap livestock feed as well. Both the green and dried seeds are suitable for canning and boiling as well.

Nutritive Value

Protein - 22-24% Carbohydrate - 55-66 %

Iron - 0.005% Calcium - 0.08–0.11 %

Essential amino acids (lysine, leucine and phenylalanine)

Crop Status

In Indian context, it is a minor pulse cultivated mainly in arid and semi arid tracts of grown in pockets of Punjab, Haryana, Delhi, and West UP along with considerable area in Rajasthan, Karnataka, Kerala, Tamilnadu, Maharashtra and Gujarat.

State-wise recommended varieties

State	Recommended Varieties
M.P.	Gujarat cowpea-3, V-240, Gujrat cowpea-4, UPC-622
M.H.	Phule Vithai
Gujarat	Pant lobia - 4, Pant lobia - 3
T.N.	Vamban -1, Co-6, UPC-628
Karnataka	KBC-2, IT-38956-1, PKB-4, PKB-6
Rajasthan	RC-101, RCP-27 (FTC-27), Pant lobia-4 Pant lobia-3
Punjab	CL-367, UPC-622, VRCP-4 (Kashichand)
C.G.	Khalleshwari
U.P.	UPC-622, Swarna harita (IC285143), Kashi chandan, UPC -628, Pant lobia-1
Jharkhand	UPC-628
Haryana	Hisar cowpea 46 (HC 98-46)
U.P.	Pant lobia-1, UPC-628
Uttarakhand	Pant lobia-5, Pant lobia-4, Pant lobia-3, Pant lobia-2

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Varieties – (a) Grain: C-152, Pusa Phalguni, Amba (V-16) (M), Ramba (V240)(M), Swarna (V- 38) (M), GC-3, Pusa Sampada (V-585), Shreshtha (V-37) (M)

(b) Fodder : GFC 1, GFC 2, GFC 3, -Kharif season, GFC-4 Summer (25-35 tonnes/ha), Bundel Lobia-1, UPC-287 and UPC-5286, Russian Giant, K-395, IGFRI-5450 (Kohinoor), C-88(20-35 tonnes/ha in Punjab), UPC 5287, UPC-4200 (NE India), UPC 618, UPC 62, UPC 622, UPC 625 UPC 628.

Climatic Requirements

Cowpea is warm weather and semi arid crop, where temperature ranging from 20°C to 30°C. Minimum temperature for seed establishment is 20°C and above 32°C temperatures development of root is cease. For maximum production day temperature 27°C and night temperature 22°C required. It is sensitive to cold and below 15°C temperature yield adversely affected. It can grow under shade of tree but can not tolerate cold or frost.

Soil Type & Field Preparation

Well drained loam or slightly heavy soil are best suited. In colder climate somewhat sandy soil preferred as crop mature earlier in them. It can grow successfully in acidic soil but not in saline/alkaline soil. In hard soil, one deep ploughing followed by two or three harrowing and planking are sufficient. In normal soil only two harrowing & planking is enough. For summer season crop give a irrigation immediately after harvesting of Rabi crop.

Sowing Time

Kharif- With onset of monsoon ranging from early June to end of July, *Rabi*- October-November (southern India), *Summer* - 2nd to 4th week of March (grain), February (Fodder), Hills: April-May, Green manuring- Mid June to 1st week of July

Seed Rate

For pure crop: 20-25 kg ha (grain), for fodder and Green Manure-30-35

kg/ha. During summer 30 kg/ha for grain and 4- kg/ha for fodder and green manuring.

Spacing: Row to row-30(Bushing) to 45 cm (spreading), Plant to Plant-10 (Bushing) to 15 cm (spreading)

Method of Sowing

Sowing of cowpea is done by broadcasting, line sowing and dibbling of seeds based on the their purpose and season. Line sowing has been better over broadcasting method of sowing. However, for fodder and green manure crop broadcasting method considered better. In high rainfall area, formed 30 cm wide and 15 cm deep drainage channel at every 2 meter interval to drain excess rain water. Sowing of seed a depth of 3-5 cm.

Seed Treatment

Treat the seed with Thiram (2g) + Carbendazim (1g). It is also desirable to treat the seed with *Rhizobium* culture @10g/kg seed.

Crop Rotation

Grain/vegetable	Fodder
Cowpea-Wheat-Mung	Sorghum + cowpea-berseem-maize+cowpea
Cowpea-Potato-urd/bean	Maize-berseem/oat- maize+cowpea
Maize/Rice-Wheat-Cowpea	Sudan grass- berseem/oat- maize+cowpea
Maize-Toria-Wheat-Cowpea	Cowpea-berseem-maize+cowpea
Rice-Rice-Cowpea	
Rice-Cowpea	
Rice-Mustard-Cowpea	

Intercropping

Growing one or two rows of cowpea in widely spaced crops and incorporating the biomass after picking pods can increase soil fertility and yield of companion crop. The improvement in this system can further be made by pairing the rows of main crops and taking one or two rows of cowpea in between two paired rows of either of pigeonpea, maize and sorghum. Here, we can get 5-7 q/ha grain yield of cowpea without any adverse effect on main crop yield.

It can also be grown as floor crop in coconut garden and intercrop in tapioca in Kerala and as sole crop in single or double crop rice fallows in rabi or summer season respectively.

Manure & Fertilizer

Apply FYM/compost 5-10 t/ha as basal with last ploughing. 15-20 kg N/ ha as starter dose in poor soils (organic carbon<0.5%), 50-60 kg/ha P_2O_5 and 50-60 kg K_2O /ha. Phosphorus and potassic fertilizer should be give according to soil test value.

Micro Nutrients

1. **Zinc.** Quantity of Zinc requirement determined according to the soil type & it's availability or status in the soil. Therefore, the doses of zinc should be applied based on the soil type as follows:
 - **Red sandy and loamy soils** -2.5 kg Zn ha⁻¹ (12.5 kg zinc sulphate hepta hydrate/ 7.5 kg zinc sulphate mono hydrate) per hectare.
 - **Black soils** -1.5 to 2.0 kg Zn ha⁻¹ (7.5 to 10 kg zinc sulphate hepta hydrate/ 4.5 to 6.0 kg zinc sulphate mono hydrate) per hectare.
 - **Laterite ,medium and alluvial soils** -2.5 kg Zn ha⁻¹ (12.5 kg zinc sulphate hepta hydrate/ 7.5 kg zinc sulphate mono hydrate) as basal along with 200 kg of farm yard manure.
 - **Low organic carbon content and hilly sandy loam soil** - 2.5 kg Zn ha⁻¹ (12.5 kg zinc sulphate hepta hydrate/ 7.5 kg zinc sulphate mono hydrate) as basal in every alternate year.
2. **Molybdenum** - In clay loam soils, apply 0.25 kg Ammonium Molybdate ha⁻¹ as basal.

Water Management

For summer crop, irrigation is most critical among all inputs followed by weeding and fertilizer. Generally, crop required 5-6 irrigation depending on soil, prevailing weather conditions etc, at an interval of 10-15 days. The response to irrigation is in order of flowering> pod filling>vegetative. Crop can tolerate flooding upto 2 days at flowering and pod setting thereafter, a marked decrease in yield and its attribute.

Weed Control

For higher yield crop should be free from weed upto 25 to 30 day crop stage. Application of pendimethaline 30% EC @ 0.75 - 1 kg a.i./ha combined with one hand weeding at 35 days after sowing is beneficial.

Plant Protection Measures

Diseases

Bacterial Blight

Symptoms : The germinating seedling turn brown-red and die. Irregular to round spots brown in colour with chlorotic halos, appear on leaves, and later spread to stem. Stem may break, pods are also infected leading to shrivelled seeds.



Control Measures

i) Grow resistant varieties; ii) Use healthy and disease free seeds; iii) In case of severe infection, crop may be sprayed with 0.2 % (2g/liter) copper oxychloride (Blitox).

Cowpea Mosaic

Symptoms

It is caused by a virus transmitted by aphids. The affected leaves become pale yellow and exhibit mosaic, vein banding symptoms. The affected leaves become reduced in size and show puckering. Pods are also reduced and become twisted.



Control Measures

i) Use healthy seed from healthy crop; ii) For controlling aphids spray Oxydemeton methyl 25 EC (Metasystox) @ 1 ml/liter or Imidacloprid 17.8 SL @ 0.2 ml/ liter of water and repeat the spray after 10 days of first spray.

Powdery Mildew

Symptoms

Powdery mildew are visible on all the aerial parts of the affected plants. Symptoms first start from leaves and then spread to stem, branches and pods. This white growth consists of the fungus and its spores. Affected leaves become twisted and smaller in size.



Control Measures

i) After harvest, collect the plants left in the field and burn them; ii) The disease can be controlled by spray of wettable sulphur @ 3g/liter or carbendazim @1 g/liter of water.

Insect-Pest Management

Cowpea Pod Borer

Nature of Damage

The caterpillar rolls the leaves and web these with the top shoot. Caterpillar bore into the pods and feed on the seeds, if flower and pods are not available larvae feed on foliage.



Control Measures

i) Collect and destroy the eggs and young larvae; ii) The young caterpillar can be killed by dusting 2% Methyl parathion @ 25-30 kg per hectare or spray of Quinalphos @2 ml/liter of water; iii) Fix 3 feet stick in the field @10/ha bird perches to attract predatory birds.

Hairy Caterpillar

Nature of damage : It is major insect of cowpea. It is cut juvenile plants and eat away all the green matter of the leaves.

Control Measures

i) Collect and burn the eggs and burn the eggs and larva of insect; ii) The young caterpillar can be control by spray of Chlorpyrifos or Quinolphos @2ml/liter of water.

Aphids and Jassids

Nature of Damage

The adult and nymphs of these pests suck the juice from the leaves and the damage is more severe when the plants are young. As a result of sucking of sap, the leaves turn brown and crumbled and the plant look sick.



Control Measures

i) Spray of Oxydemeton Methyl 25 EC (Metasystox) @ 1 ml/ liter or

Dimethoate 30 EC @ 1.7 ml/ liter of water.

Bean Fly /Stem Fly

Nature of damage

Bean fly causes the characteristics swelling of stem at ground level where the maggots burrow onto the stem. The maggots puppets at the base of the plant and the stem grows it often cracks. The petiole often shows dark streaks where the maggots have move through and damage tissue.



Control Measures

i) Keeping the field clean from legume debris; ii) Application of Phorate (Thimet) 10 G @ 10 kg per hectare in furrows at the time of sowing is effective for avoiding infestation.

Harvesting, Threshing & Storage

Green pods for use as vegetable can be harvested 45-90 days after sowing depending on the variety. For grains, the crop can be harvested in about 90-125 days after sowing when pods are fully matured. The crop should be then dried and threshed, threshed grain should be dried in sun before storage.

For fodder, the cutting of the crop depends upon the need and the stage of growth of the component crop sown with it. Generally it should be done 40-45 days after sowing.

Yield

A good crop of cowpea yields about 12-15 q of grain and 50-60 q of straw per hectare. If the crop is raised for fodder purpose 250-350 q of green fodder is obtained per hectare.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
- ii) Seed treatment should be done before sowing.
- iii) Application of fertilizer should be based on soil test value.

- iv) Weed control should be done at right time.
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Horse gram Production Technology



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HORSE GRAM



Botanical Name	- <i>Macrotyloma uniflorum</i> (Lam) Verdc.
Synonym	- Kulthi
Origin	- Peninsular India

Importance

Horse gram is an important crop of south India. Its grain is used for human consumption as 'dal' as well as in preparation of so called 'rasam' and also as a concentrated feed for cattle. It may also be used as green manure. This crop is generally grown when the cultivator is unable to sow any other crop for want of timely rains and also grown in vacant space of citrus orchard.

Crop Status

Horse gram is mainly cultivated in the states of Karnataka, Andhra Pradesh, Orissa, Tamil Nadu, M.P., Chhattisgarh, Bihar, W.B., Jharkhand, and in foot hills of Uttaranchal and H.P., in India. It is also cultivated in other countries mainly Sri Lanka, Malaysia, West Indies etc.

During Twelfth Plan (2012-2015) in India, the total area under Horsegram and its production during this plan was 2.32 lakh hectares and 1.05 lakh tonnes respectively. In terms of area and production, Karnataka is on the first position on all India basis contributing 26.72% and 25.71% respectively followed by Odisha (19.46% & 15.48%) and Chhattisgarh (19.29% & 13.29%). The highest yield was recorded in the state of Bihar (959 kg/ha) followed by W.B. (796 kg/ha) and Jharkhand (603 kg/ha) (DES, 2015-16).

State-wise recommended varieties

State	Recommended Varieties
Rajasthan	KS-2, Pratap Kulthi (AK-42)
A.P.	Palem-1, Palem-2, Paiyur-2, PHG-9
T.N.	Paiyur-2
Karnataka	PHG-9, GPM-6, CRIDA-1-18 R
Gujarat	Pratab Kulthi-1 (AK-42), GHG-5
Uttarakhand	VL- Gahat-8, VL Gahat-10
C.G.	Indira Kulthi-1 , (IKGH01-01)

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

Horse gram is extremely drought-resistant crop. Moderately warm, dry climatic conditions are suitable for its optimum growth. It does not grow well on higher altitudes because of cool and wet climate. Horsegram can be cultivated up to an altitude of 1000 m above the sea level. The temperature range of 25-30°C and relative humidity between 50 and 80% is optimum for its growth. Heavy rains during the initial stages of crop growth affect nodule formation owing to poor aeration in the soil. A well-distributed rainfall of about 800 mm is sufficient for its successful cultivation, but it performs well even under low rainfall areas.

Soil Type & Field Preparation

Generally grown on lateritic soil (poor in fertility) in south India. The crop can be grown on wide range of soils from light to heavy soils which are free from alkalinity. The crop needs minimum field preparations. Only 1-2 ploughings followed by planking provides desirable seed-bed.

Sowing Time

The main season for sowing horse gram is late August-November. As a fodder crop it is sown during June-August. In Tamil Nadu, it is sown in September-November. In Maharashtra, horse gram is sown as a kharif crop, mixed with bajra or sometimes Niger and also in the Rabi in rice fallows. In M.P. it is a Rabi crop. In northern parts it is grown as **kharif** crop. In West Bengal the sowing period is October-November.

Seed Rate & Spacing

Generally sown as broadcast with 40 kg/ha seed rate for dual purpose i.e. grain and fodder. For line sowing 25-30 kg/ha is enough for grain crop. Row Spacing: 40-45 cm during kharif and 25-30 cm during rabi and about 5 cm plant to plant spacing.

Seed Treatment

Seeds must be treated with seed treating fungicide to reduce infection by fungal pathogens found in the soil. Horse gram seeds are treated with carbendazim (bavistin) 2g for every kg of seeds. Now-a-days bio fungicide like *Trichoderma viridi* is recommended for pulses at the rate of 4g per kg seed. After fungicide treatment seed should be inoculate with *Rhizobium* and PSB culture @ 5-7 g/kg of seed.

Fertilizer Management

20 kg nitrogen and 30 kg P_2O_5 per ha as basal application at the time of sowing 2-5 cm below and in the side of the seed with the help of ferti.-seed drill is enough for good management of crop.

Water Management

Irrigation should be applied before flowering and pod formation stage.

Weed Management

Due to luxuriant growth an early weeding/hoeing is enough for weed. Application of Pendimethalin 30% EC @ 0.75-1 kg a.i./ha as pre emergence application. After that, one hand weeding at 20-25 days after sowing.

Plant Protection Measures

Insect Pest/Disease/ Causal Organism	Nature of Damage/ Symptoms	Control Measures
i. Aphids	The adults and nymphs suck the juice from the leaves as a result turn brown and crumpled and the plants look sick.	Spray of Oxydemeton methyl 25 EC @ 1ml/liter or Dimethoate 30 EC @ 1.7 ml/liter water.
ii. Jassids	The adults and nymphs suck the juice from the leaves as a result leaves turn brown and leaf surface become uneven. In severe infection leaves dry up and fall and weaken the plants.	
iii. Pod borer	It is a polyphagous insect. Caterpillar makes hole in pods, sometime also feed seed.	Spray of NPV @ 250 LE/ha. or Quinolphos 25 EC @ 2 ml/liter water.
iv. Yellow Mosaic Virus vector-white fly	The symptoms firstly appear on young leaves in the form of yellow, diffused, round spots scattered on the leaf lamina. The infected leaves turn necrotic. The diseased plants usually mature later and bear relatively few flowers and pods. The pods are stunted and mostly remained immature but whenever seeds are formed they are small in size.	i. Grown resistant varieties. ii. Destroy the infected plants. iii. Spray of Oxydemeton methyl 25 EC @ 2 ml/liter or Dimethoate 30 EC @ 1.7 ml/liter water and repeat after 15 days, if necessary.
v. Root rot	Roots rot and plants show yellowing of the lower-most leaves followed by wilting.	i. Seed treatment with 2g Captan or Carbendazim/kg of seed. ii. Avoid early sowing in prone/infested areas.

Harvesting & Threshing

As usual with other kharif pulses of Vigna group, clean seed should be sun dried for 3-4 days to bring their moisture content at 9-10% to be safely stored in appropriate bins.

Storage

To avoid further development of bruchids and other storage pests it is recommended to fumigate the storage material before onset of monsoon and again after the monsoon with ALP @ 1-2 tablets per tonne. The small quantity of the produce can also be protected by mixing inert material (soft stone, lime, ash, etc) or by smearing edible/non-edible vegetable oils or by mixing plant products like neem leaf powder at the rate of 1-2% w/w basis.

Yield

By adopting improved package of practices one can harvest 6-10 qtls of grain/ha depending upon the monsoon behaviour.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
 - ii) Seed treatment should be done before sowing.
 - iii) Application of fertilizer should be based on soil test value.
 - iv) Weed control should be done at right time.
 - v) Adopt integrated approach for plant protection.
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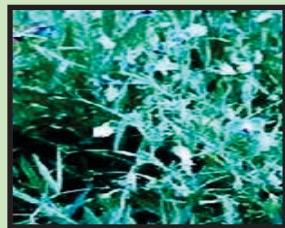
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LATHYRUS



Botanical Name -	<i>Lathyrus sativus</i> (L.)
Synonym	- Grass pea, Chickling pea, Khesari, Teora, Kasari (bengali)
Origin	- South Europe and Western Asia

Importance

Lathyrus is considered as drought-tolerant hardy crop, and is grown in low-rainfall regions under rainfed conditions, during winter when lentil and chickpea are not expected to give good yields. The crop has unique tolerance ability against stress environmental conditions not only drought but also for water logging. In addition to use as dal and chapatti, it is usually grown as fodder crop. Lathyrus leaves about 36-48 kg/ha nitrogen economy for the succeeding crop.

Nutritive Value

Protein	-	31.9%	Fat	-	0.9%
Carbohydrate	-	53.9%	Ash	-	3.2%

Crop Status

During Twelfth Plan (2012-2015) the total area and production of Khesari were recorded at 4.93 lakh hectares and 3.84 lakh tonnes respectively. Chattisgarh ranked first both in area and production (67.26 % and 59.52%), followed by Bihar (13.62 % and 20.09%). Madhya Pradesh ranked third in area (8.80%), whereas in production W.B. ranked IIIrd (9.56%), due to highest yield among the all lathyrus producing state.

Climate Requirement

Being a winter season crop it prefers temperate climate with good adoption under climatic extremities. Generally, crop requires 15 °C to 25 °C temperatures during sowing to harvesting of crop.

Varieties : Bio L-212 (Ratan), Prateek, Maha Teora,

Soil Type and Field Preparation

Thrives well in all types of soils except high acidic soils. It prefers heavy soils belonging to low lying areas which are not suited to other crops. It grows abundantly in loamy and deep black soils and produce

excellent crop. For cultivation of lathyrus under *utera* system (relay cropping), no tillage is required. However, for planting after harvest of rice, one deep ploughing followed by cross harrowing and planking is necessary.

Cropping System

It is grown as single crop of the year in areas where water gets accumulated during rainy season or as a relay crop after paddy often as *utera* / *paira* crop in standing paddy, due to its ability to withstand in high moisture conditions at sowing time and moisture stress during growth period.

Sowing Time

Crop is sown on residual soil moisture after harvest of kharif during last October to early November as pure crop. In *utera* cropping last week of September or first week of October.

Seed Rate & Spacing

70-80 kg/ha for broadcasted sowing in *utera* system and 40-60 kg/ha in line sowing is required. Under *utera* cropping sown as broadcasted in-between the rice rows. Whereas normal spacing 30 cm x 10 cm is recommended.

Seed Treatment

Treat the seed with Thiram 3g / kg of seed. After seed treatment with fungicide seed should be inoculated with *Rhizobium* and PSB culture @ 5-7 g/kg of seed.

Plant Nutrient Management

Under *utera* cropping the crop is grown on residual fertility of rice. However, it responds well to phosphorus up to 40-60 kg /ha except in the case if grown on highly phosphorus fertilized paddy field. For normal crop 100 kg DAP + 100 kg gypsum/ha is a optimum dose of fertilizer applied as basal dose 2-3 cm below the seed with the help of ferti-seed drill, is recommended.

Water Management

The crop is grown as rain fed crop on residual moisture. However,

under high moisture stresses one irrigation at 60-70 days after sowing may be remunerative in terms of production.

Weed Management

For normal sown crops one hand-weeding at 30-35 days after sowing (if soil condition permit). Weeds can also be managed effectively by spray of fluchloralin (Basalin) 50% EC @ 0.75-1 kg a.i./ha in 750-1000 liters of water as pre-plant incorporation.

Plant Protection Measures

Insect Pest/Disease/CO	Nature of Damage/ Symptoms	Control Measures
Aphid	The adults and nymphs suck the juice from the leaves as a result, leaves turn brown and crumpled and the plant look sick.	Spray of Dimethoate 30 EC @ 1.7 ml/liter or oxydemeton methy (Metasystox) 25 EC @ 1 ml/liter of water.
Rust (<i>Uromyces fabae</i>)	Pink to brown pustules appeared on leaves and stems. In severe attack, the affected plants are dry.	<ul style="list-style-type: none"> • Grow early maturing variety. • Seed Treatment with Carbendazim @ 2 g/kg seed. • Spray the crop with Mancozeb 75 WP @ 2 g / liter of water.
Downy Mildew (<i>Peronospora spp.</i>)	Brownish cottony growth of fungus may be seen on the lower surface of leaf. Inside growth yellow to greenish spots are also visible.	Spray the crop with Mancozeb 75 WP @ 2 g / liter of water.
Powdery Mildew (<i>Erysiphe polygoni</i>)	Symptoms first appeared on all the aerial part of plant. While powdery masses of spores formed on leaves which may collapse and cover the whole leaf with powdery growth.	Wettable Sulphur @ 3 g/ litre or Carbendazim @ 1g/ liter or Dinocap @ 1 ml/litre of water.

Harvesting, Threshing & Storage

Harvest the crop, when colour of pods change to brown and grains are at dough stage having approximately 15% moisture in-side them. Harvested produce may be allowed to dry in sunlight for a week. Harvested produce after 3-4 days sun drying is roaped in the bundles and transferred to threshing floors. Threshing is done by beating with sticks or trampling under the feet of bullocks. The clean seed should be sun dried for 3-4 days to reduce their moisture content up to 9-10%. Now the produce should be safely stored in appropriate bins. The small quantity of the produce can also be protected by mixing inert material (soft stone, lime, ash, etc).

Yield

A well managed crop can easily give 8-10 q/ha yields under direct sowing and 3-4 q/ha under utera cultivation.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
 - ii) Seed treatment should be done before sowing.
 - iii) Application of fertilizer should be based on soil test value.
 - iv) In Lathyrus foliar spray of 2% urea or 20 ppm Salicylic acid at flowering and pod formation stage increases the yield.
 - v) Weed control should be done at right time.
 - vi) Adopt integrated approach for plant protection.
-
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LENTIL



Botanical Name	- <i>Lens culinaris</i> (L.)
Synonym	- Masur, Malka (bold seeded), lentil
Origin	- Turkey to South Iran

Introduction

It is a valuable human food, mostly consumed as dry seeds (whole decorticated, seed decorticated and split). In Indian sub-continent mostly consumed as 'Dal' by removal of outer skin and separation of cotyledons, snacks and soup preparation etc. It is easy to cook and easily digestible with high biological value, hence also referred to patient. Dry leaves, stems, empty and broken pods are used as valuable cattle feed.

Nutritive Value

Protein	- 24-26%	Carbohydrate	- 57–60%
Fat	- 1.3%	Fibre	- 3.2%
Phosphorus	- 300 mg/100 g	Iron	- 7 mg/100 g
Vitamin C	- 10-15 mg/100 g	Calcium	- 69 mg/100g
Calorific value	- 343 Kcal/100g	Vitamin A	- (450 IU)

Crop Status

India ranked first in area and second in the production with 39.79% and 22.79% of world area and production respectively. The highest productivity was recorded in Croatia (2862 kg/ha) followed by New Zealand (2469 kg/ha). Canada rank first in production (41.16%) due to very high level of productivity (1633 kg/ha) as compared to India (611 kg/ha). (*FAO State., 2014*)

During Twelfth Plan (2012-15) the country's area under Lentil was 14.79 lakh hectares with a production of 10.38 lakh tonnes. Madhya Pradesh ranks 1st in acerage i.e., 39.56% (5.85 lakh ha) followed by UP 34.36 % and Bihar 12.40%. While in terms of production UP ranks 1st at 36.65% (3.80 lakh tonnes) followed by Madhya Pradesh (28.82%) and Bihar (18.49%). The highest yield was recorded by the state of Bihar (1124 kg/ha) followed by W.B. (961 kg/ha) and Jharkhand (956 kg/ha). The National yield average was (753 kg/ha). The lowest yield was observed in the state of Maharashtra (379 kg/ha), C.G. (410 kg/ha) followed by and M.P. (634 kg/ha) (*DES., 2015-16*).

State-wise recommended varieties

S.No.	States	Recommended Varieties
1.	Bihar	Pant L 406, PL 639, Mallika (K-75), NDL 2, WBL 58, HUL 57, WBL 77, Arun (PL 777-12)
2.	M. P. & C.G.	Malika (K-75), IPL-81 (Nuri), JL-3, IPL-406, L-4076, IPL-316, DPL 62 (Sheri)
3.	Gujarat	Malika (K-75), IPL-81 (Nuri), L-4076, JL-3
4.	Haryana	Pant L-639, Pant L-4, DPL-15 (Priya), Sapna, L-4147, DPL-62 (Sheri), Pant L-406
5.	Maharashtra	JL 3, IPL 81 (Nuri), Pant L 4
6.	Punjab	PL-639, LL-147, LH-84-8, L-4147, IPL-406, LL-931, PL 7
7.	Uttar Pradesh	PL-639, Malika (K-75), NDL-2, DPL-62, IPL-81, IPL-316, L-4076, HUL-57, DPL 15
8.	Rajasthan	IPL 406 (Anguri), Pant L-8 (PL-063), DPL-62 (Sheri)
9.	Uttarakhand	VL-103, PL-5, VL-507, PL-6, VL-129, VL-514, VL-133,
10.	Jammu & Kashmir	VL 507, HUL 57, Pant L 406, Pant L 639, VL 125, VL 125

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

Lentil requires cold climate. It is very hardy and can tolerate frost and severe winter to a great extent. It requires cold temperature during its vegetative growth and warm temperature at the time of maturity. The optimum temperature for growth is 18-30°C.

Soil Type and Field Preparation

Well drained, loam soils with neutral reaction are best for lentil cultivation. Acidic soils are not fit for growing lentil. The soil should be friable and weed free so that seeding could be done at uniform depth. On heavy soils, one deep ploughing followed by two to three cross harrowing should be done. After harrowing, the field should be levelled by giving a gentle slope to ease irrigation.

Sowing Time

Recommended sowing time for *Rainfed*: First fortnight of October in Central and South India and second fortnight of October in North India; *Under irrigated conditions*- First fortnight of November in North India and for *Late sowing*: First week of December in rice fallows of NEPZ or on fields vacated very late by kharif crops under irrigated condition.

Seed Rate and Sowing

For small seeded: 40-45 kg/ha; *Bold seeded:* 45-60 kg/ha; *Late sown condition:* 50-60 kg/ha; *Utera cropping:* 60-80 kg/ha seed is recommended. Sowing should be done in rows 30 cm apart and it should be sown at a lower depth (3-4 cm). This could be done either by using a Ferti-seed-drill or by seeding behind desi plough.

Seed Treatment

Fungicide: Thiram (2 g) + Carbendazim (1g) or Thiram @ 3 g or Carbendazim @2.5 g per kg of seed; *Insecticide:* Chloropyrifos 20% EC @8 ml/kg of seed; *Culture:* *Rhizobium* + PSB, one packet each for 10 kg seed.

Cropping Systems

Sequential Cropping

The most common rotations under sequential cropping are:

- | | | |
|------------------|---|------------------------|
| i) Kharif fallow | - | Lentil (Rainfed areas) |
| ii) Paddy | - | Lentil |
| iii) Maize | - | Lentil |
| iv) Cotton | - | Lentil |
| v) Bajra | - | Lentil |
| vi) Jowar | - | Lentil |
| vii) Groundnut | - | Lentil |

Intercropping

Most common inter cropping systems are:

- i. Lentil + Sugarcane (Autumn) with two rows of lentil at 30 cm row spacing in between two rows of sugarcane
- ii. Lentil + Linseed (2:2)
- iii. Lentil + Mustard (2:6)

Irrigation

First irrigation should be given at 40-45 days of planting and second at pod filling stage. Most critical stage for moisture stress is pod formation followed by flower initiation. In absence of winter rains and where contribution of soil moisture is negligible viz. in Central India, two light irrigations may be applied for significant yield improvement. More irrigation may affect the crop performance adversely.

Plant Nutrient Management

Generally Nitrogen 20 kg Phosphorus 40 kg and 20 kg Sulphur per hectare in medium to low fertile soils as basal dressing.

Secondary and Micro Nutrients

1. Sulphur

In medium black soils and sandy loam soils apply 20 kg S/ha (equivalent to 154 kg gypsum/ phospho-gypsum/ or 22 kg bentonite sulphur) as basal to each crop. If S deficiency is diagnosed red sandy loam soils, apply 40 kg S/ha (equivalent to 300 kg gypsum/phospho-gypsum/or 44 kg bentonite sulphur) per hectare. This quantity is sufficient for one crop cycle.

2. Boron

In lentil grown in calcareous alluvial soils, apply 1.6 kg of B/ha (16 kg borax/ 11 kg di-sodium tetra borate penta-hydrate) as basal to each crop.

Weed Control

Two manual weeding, one at 25-30 days and another 45-50 days after sowing should be done. Weedicide like Pendimethalin 30% EC @ 0.75-1 kg *a.i.* per hectare may be used as a pre-emergence treatment. A weed-free period of early 45-60 days is important.

Plant Protection Measures

Disease

Seedling Mortality

Symptoms: It is caused by fungi. It appears within a month of sowing when the seedlings start drying up. The drying is mainly two types. (Seedling wilt)- Seedling first turn yellow and dry up. Collar rot- The seedling collapse while still green and then dry out.



Control Measures

i) It can be reduced by delay planting until mid-November; ii) Treat the seed with systemic fungicide Carbendazim @ 2.5 g/kg of seed; iii) Plant resistant varieties like Pant L-406 etc.

Wilt

Symptoms: This is serious disease of lentil in which the growth of the plant is checked, the leaves start yellowing, plant start drying and finally die. The roots of affected plants remain under developed and look light brown in colour.



Control Measures

i) Keep the field clean and follow a three year crop rotation. This will help in reducing the disease incidence; ii) Use tolerant and resistant varieties like Pant Lentil 5, IPL-316, RVL-31, Shekhar Masoor 2, Shekhar Masoor 3 etc; iii) Seed treatment.

Rust

Symptoms: The disease symptoms start as yellowish pustules on the leaflets and pods. Later; light brown pustules appear on both the

surfaces of the leaves and other aerial parts of the plant. The pustules finally become dark brown. The plants give dark brown or blackish appearance visible as patches in the field.



Control Measures

i) After harvest, the affected plant trash should be burnt; ii) In NEPZ, normal and early sowing reduces intensity of rust disease; iii) Grow resistant/tolerant varieties like DPL-15, Narendra Lentil-1, IPL 406, Haryana masur 1, Pant L-6, Pant L-7, LL-931, IPL 316 etc.; iv) Spray the crop with Mancozeb 75 WP @ 0.2 % (2g/liter). 1-2 spray at 50 days after sowing are good for controlling rust.

Insect-Pest Management

Pod Borer

Nature of damage : The caterpillar defoliates the tender leaves and also bores the green pods and feeds upon the ripening grains. It damages almost all the pods in case of severe damage, but causes nearly 25-30% annual yield losses in India.



Control Measures

i) Spray neem seed extract (5%) @ 50 ml/ liter of water; ii) Spray of Profenofos 50 EC @ 2 ml/ liter or Emamectin benzoate 5 SG @ 0.2 g/ liter of water.

Aphids

Nature of Damage: Aphids suck the sap and in case of severe damage the growth is suppressed.



Control Measures

i) Spray of Dimethoate 30 EC @ 1.7 ml/liter or Imidacloprid 17.8 SL @ 0.2 ml / liter of water.

Harvesting, Threshing & Storage

Crop become ready for harvest when leaves begin to fall, stem and pod turn brown or straw in colour and seeds are hard and rattle with 15% moisture inside them. Over ripening may lead to fall of pods as well as shattering and seed cracking if seed moisture fall below 10% due to delay in harvesting.

The crop should be allowed to dry for 4-7 days on threshing floor and threshed by manually or bullock/power drawn thresher. The clean seed should be sun dried for 3-4 days to bring their moisture content at 9-10%. The seed should be safely stored in appropriate bins and fumigated to protect them from bruchids.

Yield

A well manage crop yields about 15-20 quintals of grain per hectare.

Recommendation to achieved higher production

1. Deep summer ploughing once in 3 years.
2. Seed treatment should be done before sowing.
3. Application of fertilizer should be based on soil test value.
4. Wilt resistant/ tolerant –RVL-31, IPL81 (Noori), IPL -316, Sekhar masoor-2, Sekhar masoor-2.
5. Rust resistant/ tolerant –IPL-406, WBL-77, Pant L-6, Pant L-7, Sekhar masoor-2, Sekhar masoor-2, IPL-316.
6. Adopt integrated approach for plant protection.
7. Weed control should be done at right time.

- For technical information of crop production please contact to district KVK/ nearest KVK.
- To avail benefit from Central and State Government running schemes for crop production (ploughing, fertilizers, micronutrient, pesticide, irrigation equipment), agricultural implements, storage infrastructure etc., please contact to your DDA/SADO office.

**- For more information also visit -
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MOTHBEAN

Botanical Name -	<i>Vigna acontifolia</i>
Synonym -	Moth
Origin -	India



Introduction

Mothbean (*Vigna acontifolia*) is a native crop of hot and dry habitats of northern and western parts of India. These very adjusting abilities have rendered this crop as an indispensable component of cropping system prevailing in arid regions. This crop is used as a source of food, feed, fodder, green manuring and green pasture. Green pods are delicious source of vegetables. Being a pulse, it is a cheap source of vegetable protein for balancing nutritional deficiency.

Crop Status

A total of 9.26 lakh hectares and 2.77 lakh tonnes of Moth production was recorded in the country during the twelfth plan (2012-15) period. Area and production of moth bean has been highest in Rajasthan (96.75% and 94.49%) followed by Gujarat (2.38% and 3.6%). However, yield of Rajasthan (292 kg/ha) was below the National average yield of (299 kg/ha).

Climate

It can tolerate high temperature without any adverse effect on flowering and fruit development. Optimum temperature requirement for growth and development is 25-37 °C. Bulk of the cultivation is, confined to dry-lands of arid zone with 250-500 mm rainfall requirement with arrangement of proper drainage.

Varieties

Other than the following specific varieties may be selected from table given below

- Normal maturity group** (> 90 days) Moth Guj. 1 (MG-1), Jadra (IPCMO 943), Jwala (IPCMO-926), IPCMO 880 (26% Protein)
- Medium maturity group** (70-90 days) with uniform rainfall throughout season (ii) IPCMO 912 (ii) CZM 1 (both 75-80 days duration)
- Early maturity group 60-65 days**, higher yield, escape terminal drought especially suitable for late season, drought areas, resistant to YMV.

State-wise recommended varieties

State	Recommended Varieties
Rajasthan	RMO-257, RMO 435, RMO 2004 (RMB 25), RMO 225, RMO 40, FMM-96, Moth 880, Jwala, CAZRI Moth-2 (CZM 45), CAZRI Moth-3 (CZM 99), TMV(Mb-1)
Gujarat	GMO 1, GMO 2, Maru Bahar (RMO 435), RMO-257
Maharashtra	CAZRI Moth -2 (CZM 45), CAZRI Moth-3 (CZM 99), Maru Bahar (RMO 435)
Haryana	CAZRI Moth-2 (CZM 45), CAZRI Moth-3 (CZM 99)

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Field Preparation

In a good rainfall year, one ploughing with mouldboard plough and a cross harrowing serve the purpose in arid conditions of western Rajasthan. Other alternative is Sweep Cultivation with a ferti seed drill (developed at CAZRI) that can also be used for inter cultivation in wide spaced crop.

Sowing Time

With the onset of monsoon. Generally start with first soaking rain to second rain after onset of monsoon. Optimum sowing time 2nd to 3rd week of July. Delay in sowing may result in poor growth, poor germination, increased seedling mortality and incidence of pest and diseases and more conspicuously moisture stress at the flowering, the most critical stage.

Seed Rate & Spacing

10-15 kg/ha (short statured, spreading to erect RMO-40 type) for grain and 4-5 kg for mixed crop. For fodder purpose 20-25 kg/ha seed required. Spacing should be maintained as 30-45 cm x 10-20 cm.

Seed Treatment

Seed treatment with 2 g Thiram + 1 g Carbendazim / kg of seed. After fungicide treatment seed inoculation with *Rhizobium* and PSB culture @ 5-7 g/kg of seed.

Irrigation

It is cultivated in dry land and rainfed condition but in long dry spell one irrigation should be given at pod formation stage.

Cropping System

- Generally grown as single (mono) crop in a year mixed or as a sole crop. However, in a year of good rainfall, it can be rotated with mustard.
- Mixed cropping with pearl millet, cluster bean, cowpea, mung & sesame in risk prone areas during monsoon. Varieties recommended are RMO 40 & FMM 96 of mothbean and HHB 67 of Bajra.
- Inter cropping (2:1) - 2/3 rows of mothbean in between two rows of pearl millet.

Plant Nutrient Management

Besides their N-fixing capacity they have greater power for absorbing less soluble form of 'P'. Recommendation is 20-25 tonnes FYM for improving physical condition and improving water holding capacity of soil along with 10 kg N + 40 kg P_2O_5 /ha as basal at the time of sowing or last field preparation.

Weed Management

Application of Pendimethalin 30 % EC @ 0.75 -1 kg a.i. / ha as pre emergence and one hand weeding at 25-30 days after sowing.

Plant Protection Measures

Pest and diseases in mothbean and their management

S.N.	Common Name	Active Period	Incidence	Control Measures
Sucking Pest				
i.	Jassids	II week of August to harvest	Regular	i. Early sowing of crop. ii. Inter-cropping with Pearl Millet (1:4). iii. Spray of Dimethoate 30 EC @ 1.7 ml/ liter or Thiomethoxam 25 WG @ 0.2 g/liter or Imidacloprid 17.8 SL @ 0.2 ml /liter of water.
ii.	White fly	II week of August to harvest	Regular	
iii.	Thrips	II week of August to harvest	Regular	
iv.	Aphid & mite	II week of Aug. to I week of Sept.	Sporodic minor pest	
Soil/Foliage Pest				
v.	White grub	II week of August to harvest	Sporodic minor pest	i. Undecomposed FYM or composed should not be used.
vi	Termite	Entire cropping Season	Sporodic minor pest	ii. Soil application of Phorate 10 G @ 10 kg/ha or Chloropyriphos 1.5 % dust @ 20-25 kg/ha before sowing.

	Storage Pest			
viii.	Pulse beetle (<i>Calosobruchus chinensis</i>)	During storage	Regular	i. Carry Seed moisture level below 10% before storing. ii. Fumigation-Mixing/Smearing with neem leaves /cake & edible oils.

YMV= Yellow Moosaic Virus

Name of Disease/ Causal Organism	Disease Symptoms	Control Measures
Bacterial leaf spot/ blight	Many small, large and irregular brown necrotic spots appear on leaves and In the extreme cases, leaf may fall down	i. Soak the seeds in 500 ppm (0.5g/ liter) Streptocycline solution for 30 min. before sowing followed by two sprays of Streptocycline (0.01%) combinnd with 3 g of Copper Oxychloride per litre at an interval of 12 days is recommended.
Yellow mosaic virus	Diseased plant leaves are yellow and small in size.	i. For controlling white fly spray of Dimethoate 30 EC @ 1.7 ml/liter or Imidacloprid 17.8 SL @ 0.2 ml / liter of water and repeat the spray after 15 days interval.
Anthrachnose (<i>Collectotrichum spp.</i>)	Circular, black sunken spots with dark centres and bright red or orange margins on leaves and pods. In severe infection affected parts wither off.	i. Seed treatment with Thiram 3 g/kg of seed. ii. Spraying the crop with Mancozeb 75 WP @ 2.5 g/litre of water.

Harvesting, Threshing & Storage

Crop is ready to harvest when pods get mature and turn brown. Plant show drying symptom or yellowing of leaves. Estimated Post harvest losses are 9-10% during threshing transportation, processing and storage. Sun drying, heat treatment, and storage at low temperature with low moisture percentage in seeds (8-9%), is recommended.

Yield

With adoption of improved technology 6-8 quintal grain yield and if it is cultivated for fodder 12- 25 q/ha green fodder yield (depend on variety) can be achieved.

Recommendation to achieved higher production

- I) Deep summer ploughing once in 3 years.
- ii) Seed treatment should be done before sowing.
- iii) Application of fertilizer should be based on soil test value.
- iv) Weed control should be done at right time.
- v) Adopt integrated approach for plant protection.

- For technical information of crop production please contact to district KVK/ nearest KVK.
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MUNGBEAN

Botanical Name - *Vigna radiata* (L.) Wilczek

Synonym - Moong

Origin - India and Central Asia



Introduction

Green gram is excellent source of high quality protein. Moong is consumed as whole grains, sprouted form as well as dal in a variety of ways in homes. It is also used as green manuring crop. Moong can be used as a feed for cattle even husk of the seed can be soaked in water and used as cattle feed. In India these crops are cultivated in three different seasons, viz., kharif, rabi and summer. Summer moong can be grown after harvesting of pea, gram, potato, mustard, linseed. Cultivation of Jayad Moong is important to increase soil fertility in these areas where paddy–wheat crop rotation is used.

Crop Status

During Twelfth Plan (2012-2015) the total area covered under moong in India was 30.41 lakh hectares with a total production of 14.24 lakh tonnes. The coverage of area and its production was maximum in Rajasthan (29.68 % & 25.51 % of the total area and production). Maharashtra ranked second in area coverage (12.98 %) and third in production (11.92 %). Andhra Pradesh ranked third in area (8.74 %) and second in production (12.43 %). The highest yield was recorded by the state of Punjab (838 kg/ha) followed by Jharkhand (680 kg/ha) and Tamil nadu (675 kg/ha). The National yield average was 468 kg/ha. The lowest yield observed in the state of Karnataka (247 kg/ha) followed by CG (269 kg/ha) and Odisha (337 kg/ha). (DES, 2015-16).

Nutritive Value

Protein	- 24-25%	Calcium	- 124mg/100g
Fat	- 1.3%	Phosphorus	- 326mg/100g
Minerals	- 3.5%	Iron	- 7.3 mg/100 g
Fiber	- 4.1%	Calorific value	- 334 Kcal/100 g
Carbohydrate	- 56%	Moisture	- 10%

State-wise recommended varieties

State	Recommended Varieties		
	Kharif	Rabi	Summer
Andhra Pradesh	Madhira 429, Pusa -9072, WGG-2, IPM -02-14, OUM 11-5, CoGG-912,	LGG-460, LGG-450, LGG-407, TM 96-2,	
Assam	IPM 2 -3, Pant Mung 4, Pant Mung 2, Narendra Mung 1, SG 1,	-	HUM-16, PDM-139, Meha, Pant Mung -5, HUM-12, Pusa vishal, TBM-37
Bihar & Jharkhand	IPM 2-3, MH 2 -15, Pant Mung-4, HUM -1, Narendra Mung 1 , Pant Mung 2, Sunaina, PDM -139, MH-2-15	-	HUM 16, PDM 139, Meha, Pant Mung 5, Pusa vishal, TBM-37, HUM -12
Gujarat	Gujarat Mung 3, Gujarat Mung 4, K -851, PKVAKM-4	-	-
Haryana	IPM 2-3, MH 2-15, Muskan	-	SML 668, Pant Mung 5
H.P. & Jammu & Kashmir	Pusa 672, KM-2241, Shalimar Mung 1	-	SML 1115
Karnataka	IPM 02-14 & 2-3, HUM 1, PKVAKM-4, COGG 912, KKM 3, LGG 460, TARM-1, OBG 52,		
M.P. & C.G.	HUM 1, TJM 721, BM 4, Meha	-	Virat (IPM 205-7)
Maharashtra	HUM 1, BM 2002 -1, PKVAKM -4, BM 4, TARM 2	-	-
Odisha	PDM 139, OUM 11-5, COGG 912, IPM 2-3	PDM 139, LGG 460, TARM 1, OBG 52, IPM 2-3	-
Punjab	IPM 2-3, MH 2 -15, ML 818, ML 613	-	SML 668, IPM 2-3, Pant Mung 5
Rajasthan	SML 668, IPM 2-3, RMG 492, MH 2-15	-	SML 668, PDM 139, Meha
U.P.& Uttarakhand	Pant Mung 5, Pant Mung 4, Narendra Mung 1	-	HUM 16, IPM 2 -3, PDM 139, Meha, HUM 12
Tamil Nadu	IPM 2-3, Co-6, TM 96-2, Vamban 2, Vamban 3 ,		ADT-3, Sujata (Hybrid 12-4), Virat (IPM 205 -7),
West Bengal	MH 2 -15, Pant Mung 5, Pant Mung 4, Narendra Mung 1	-	HUM 16, IPM 2-3, PDM 139, Meha, Pusa vishal, Pant moong-5, TMB-37, HUM-16

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

The crop needs high temperature, less humidity and moderate rainfall of about 60-80 cm. Water logging is fatal for root development and nitrogen fixation during early vegetative stage. Crop is generally grown as rain fed but under assured irrigation during summer in Indo Gangetic plains of Northern India.

Soil Type & Field Preparation

Best soil for its cultivation is loam soil with good drainage. The crop should not be raised on alkaline, saline or waterlogged soils. A well prepared seedbed is required for proper germination and establishment of the crop. For this give 2–3 ploughings followed by planking to make the seedbed free from clods and weeds. For the summer/spring cultivation after the harvesting of last crops, the tillage should be done after irrigation.

Sowing Time

Mungbean should be sown during the last week of June to mid or first week of July. For the summer or spring crop, mungbean should be sown after the harvest of last crop (potato, sugarcane, mustard and cotton, etc). The first fortnight of March is most suitable for spring/summer cultivation. Late sown mungbean takes more loss at the time of flowering stage due to high temperature and yield affected.

Seed Rate, Spacing & Method

During Kharif season 15-20 kg seed/ha should be sown in rows 45 cm apart while during Rabi and Summer 25-30 kg seed /ha sown in rows 30 cm apart. As a companion crop with sugarcane seed rate should be 7-8 kg/ha. The plant-to-plant distance should be maintained (atleast 5 cm). Sowing can be done behind the local plough or with the help of seed drill.

Seed Treatment

Treat the seed with Thiram (2g) +Carbendazim (1g) or Carbendazim & Captan (1g+2g) to control the soil & seed germinated disease. For sucking pest control seed treatment with Imidacloprid 70 WS @ 7g/ kg seed. It is also desirable to treat the seed with Rhizobium and PSB culture (5-7g/kg seed).

Manure & Fertilizer

Mungbean is generally grown on the basic fertility of soil. If available 8-10 tonnes of compost or farm yard manure should be applied before 15 days of sowing. For mungbean, 15-20 kg nitrogen, 30-40 kg phosphorus should be applied at sowing time. It is advisable to use fertilizers on the basis of soil test and recommendations, normally 100 kg DAP/ha is enough for one hectare the fertilizer should be applied by drilling either at the time of sowing or just before sowing in such a way that they are placed about 2-3 cm below the seed.

Water Management

Generally the kharif crop requires one life saving irrigation, which may be applied during the early pod formation stage. For the summer/spring mungbean, 3–4 irrigations are required. Apply first irrigation after 20-25 days of sowing and repeat after 10-15 days as per need. One irrigation before flowering and another at pod-filing stage would ensure healthy seeds. Water logging in the field should be avoided at all cost. No irrigation should be given when the crop is in full bloom stage.

Weed Control

Two weeding should be given to keep the crop free from harmful weeds. First weeding should be done 20-25 DAS and Second 40-45 DAS. Use Pendimethalin (Stamp) 30% EC @ 0.75- 1 kg a.i. per ha in 400-600 liter of water a pre-emergence application . Always flat nozzle is used during spraying of weedicide.

Plant Protection Measures

There are several important disease of mung, yellow mosaic, leaf crinkle, leaf curl, anthracnose, cercospora leaf spot are important one.

Diseases

Yellow Mosaic Virus

Symptoms

This disease is caused by the mung bean yellow mosaic virus (MYMV) belonging to Gemini group of viruses, which is transmitted by the whitefly (*Bemisia tabaci*). The tender leaves show yellow mosaic spots, which increase with



time leading to complete yellowing. Yellowing leads to less flowering and pod development. Early infection often leads to death of plants.

Control Measure

Diseased plants should be rogued out to prevent further spread of the disease; ii) In order to prevent whitefly (*Bemisia spp.*) infestation spray with triazophos 40 EC @ 2.0 ml/l or malathion 50 EC @ 2.0 ml/l or oxydemeton methyl 25 EC @ 2.0 ml/l at 10-15 days intervals if required; iii) Grow tolerant/resistant varieties like Narendra Mung1, Pant Mung 3, PDM 139 (Samrat), PDM 11, MUM 2, ML 337, IPM 02-14, MH 421, SML 832 etc.

Leaf Curl

Symptoms

The symptoms are visible first in third leaf after three to four weeks of sowing. These are characterized by enlargement of leaves followed by their crinkling. Later the leaves become thicker and leathery. The affected plants, however, do not die till the harvest of the crop.



Control Measures

i) Treat the seeds with imidacloprid 70 WS @ 5ml/kg; ii) Foliar spray of insecticide (dimethoate 30 EC @ 1.7ml/ha) on 30 days after sowing; iii) Rogue out the infected plants and Field sanitation; iv) Use resistant varieties like D-3-9, K 12, ML 26, RI 59, T-44.

Insect-Pest Management

Numerous insect pests attack the mungbean. The loss in the production caused by them may reach up to 70% depending upon the severity of attack. Some common insect pests of mungbean and their management are as follow:

White Fly

Nature of damage: The infested plants become very weak showing downward cupping of the leaves giving a sickly look and the plant may die. Insect secretes honey dew on leaves results



blackening of leaves, drastically reducing photosynthetic rate and drying of leaves. Whitefly is a vector of number of viral diseases especially mungbean yellow mosaic virus (MYMV).

Control Measures

i) Seed treated with Dimethoate 30 EC @ 5ml/kg; ii) Foliar spray of Triazophos 40 EC @ 2.0 ml/l or Malathion 50 EC @ 2.0 ml/l at 10-15 days intervals if required; iii) Grow cotton as a trap crop one month earlier between the mungbean rows; iv) Grow maize, sorghum or pearl millet as a barrier crop to minimize the incidence of whiteflies; v) Install Sticky trap; vi) Opt resistant varieties e.g. ML 1256, ML 1260 and ML 1191

Stem Fly

Nature of Damage

Stem fly (*Ophiomyia phaseoli*) maggots mine the leaf petiole or tender stem resulting in withering and death of plant. The characteristic symptoms are drooping of the first two leaves and yellowing of petioles. 20% damage in mungbean.



Control Measures

i) Follow clean cultivation, crop rotation, earthing up, growing trap crop, destroying alternative hosts like *Solanum nigrum* to minimize the stem fly incidence; ii) Opt for resistant varieties (Mungbean: CoGG 912 & CoGG 917; Urdbean: CoBG 671 & AC 222); iii) Seed soaking either in Imidacloprid 17.8 SL @ 5.0 ml/kg seed in 100 ml water for one hour or Thiomethoxam 25 WG @ 5.0 g/kg seed in 100 ml water to avoid early incidence of stem fly is recommended; iv) Spray either Imidacloprid 17.8 SL @ 0.2ml/l or Thiomethoxam 25 WG @ 0.3g/lit at 15 days after sowing.

Bihar Hairy Caterpillar

Nature of damage

Female moths lay eggs on plants in a field. Young caterpillar eat away all the green matter of the leaves and it can be easily recognized by perforated, dusty white coloured



leaves in the field. The grown-up caterpillars feed voraciously on leaves, soft stems and branches. The insect totally denude the crop within few days resulting in total failure of the crop.

Control Measures

i) Uproot the damaged plants along with the young larvae at the gregarious phase and bury under the soil; ii) Spray of Quinalphos 25 EC @ 2.5 ml/liter or Dichlorvos 10 EC @ 1.0 ml/ liter or Fenvalerate 20 EC @ 1.87 ml/ liter of water or dusting with Fenvalerate 0.4% @ 15 kg/ha.

Harvesting , Threshing & Storage

Mung should be harvested when more than 80 per cent pods mature. One or two rounds of picking of pods are also recommended to avoid losses due to shattering. The plants are cut with the sickle and dried on the threshing floor. These are then threshed by beating with sticks or by trampling with bullocks. The clean seeds should be sun dried for 3-4 days to bring their moisture content at 8-10% to safely store in appropriate bins.

Yield

A well managed crop, as indicated above, may produce 8-10 quintals and in mixed crop yield 3-5 quintals grains per ha. In rainy season crop produce 10 qtls/ha. and in summer crop produce 12-15 qtls/ha. In mixed cropping 3-5 qtls/ha.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
- ii) Seed treatment should be done before sowing.
- iii) Application of fertilizer should be based on soil test value.
- iv) In kharif season sowing should be done by ridge & furrow method.
- v) Yellow mosaic resistant/ tolerant varieties Narendra Mung1, Pant Mung 3, PDM 139 (Samrat), PDM 11, MUM 2, ML 337, IPM 02-14, MH 421, SML 832 etc choose as per suitability of region.
- vi) Weed control should be done at right time.

vii) Adopt integrated approach for plant protection.

- For technical information of crop production please contact to district KVK/ nearest KVK.
- To avail benefit from Central and State Government running schemes for crop production (ploughing, fertilizers, micronutrient, pesticide, irrigation equipment), agricultural implements, storage infrastructure etc., please contact to your DDA/SADO office.

**- For more information also visit -
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FIELDPEA

- Botanical Name - *Pisum sativum* (L.)
Synonym - Matar, Pea
Origin - Mediterranean Region of Southern Europe & Western Asia



Introduction

The mature seeds are used as whole or split into dal and put to use in various ways for human consumption. Besides vegetable purposes, it is also grown as a forage crop for cattle and cover crop to prevent soil erosion but mainly for matured seed for human consumption.

Nutritive Value

Protein	-	22.5%	Calcium	-	64 mg/100g
Fat	-	1.8%	Iron	-	4.8 mg/100g
Carbohydrate	-	62.1%	Moisture	-	11%

Crop Status

Pea is the third most important pulse crop at global level, after dry bean and chickpea and third most popular rabi pulse of India after chick pea and lentil. India occupy fourth position in area (10.53 %) and 5th position in production (6.96 %) (*FAO Stat.*, 2014).

In India field pea is grown over an area of 11.50 lakh ha with a production of about 10.36 lakh tonnes during XIIth Plan period (2012-2015). Uttar Pradesh is the major field pea growing state. It alone produces about 49 % of pea produced in India. Besides, Uttar Pradesh, Madhya Pradesh, Bihar and Maharashtra are the major pea producing states (*DES*, 2015-16).

State-wise recommended varieties

State	Recommended Varieties
Maharashtra	JP-885, Ambika, Indra (KPMR-400), Adarsh (IPF 99-25), IPFD 10-12
Gujarat	JP-885, IPFD 10-12, Indra, Prakash,
Punjab	Jay (KPMR-522), Pant pea-42, KFP-103 (Shikha), Uttra (HFP-8909), Aman(IPF5-19)
Haryana	Uttra (HFP-8909), DDR-27 (Pusa panna), Hariyal (HFP-9907 B), HFP-9426, Alankar, Jayanti (HFP-8712), Aman(IPF5-19)
Rajasthan	DMR-7 (Alankar), Pant Pea-42

M.P.	Prakash (IPFD 1-10), Vikas (IPFD -99-13)
U.P.	Swati (KFPD-24), Malviya Matar-15 (HUDP-15), Vikas, Sapna (KPMR-1441), IPF 4-9
Bihar	DDR-23 (Pusa Prabhat), V L Matar -42
C.G.	Shubhra (IM-9101), Vikas (IPFD -99-13), Paras
Uttarakhand	Pant Pea-14, Pant Pea-25, V L Matar -47
Jharkhand	PL Matar-42, V L Matar -42

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

Being a winter season crop it requires a cool growing season with moderate temperature throughout the life. High temperature is more injurious to pea crop than frost. Frost can damage the plants during flowering stage. High humidity associated with cloudy weather results into spread of fungal diseases like damping-off and powdery mildew. Optimum monthly temperature suitable for growth is 13-18°C.

Soil Type and Field Preparation

A well-drained loamy soils free from excessive soluble salts with neutral pH range of 6.5 to 7.5 is suitable for successful cultivation of the crop. Prepare a level field for even distribution of irrigation water, free from stubbles and crop residues of previous crops by one deep ploughing through disc or mouldboard plough followed by 2-3 harrowing and planking after each operation. To ensure good drainage and aeration in the field, powdery seedbeds must be avoided.

Sowing Time : 15th October to 15th November

Seed Rate & Spacing : Tall varieties - 70-80 kg/ha & 30-45 X 10 cm
Dwarf varieties - 100 kg/ha & 22.5X10 cm

Depth : 4-5 cm

Intercropping

It can be sown as intercrop with autumn sugarcane as two rows of pea at 30 cm row spacing in the centre of two sugarcane rows at 90 cm apart.

Water Management

Fieldpea is mostly grown as rainfed/un-irrigated on residual soil moisture and can sustain drought conditions up to some extent. One or two irrigations at 45 DAS and if needed, at pod filling stage, may be the best recommended irrigation schedule.

Plant Nutrient Management

Apply 20-30kg/ha nitrogen in tall types and 40kg/ha nitrogen in dwarf types as a starter dose of basal dressing. The phosphorus and potassic fertilizer should be apply as basal dose based on soil test value. If soil is deficient in these nutrients, apply 40 kg/ha and 40-60 kg/ha P_2O_5 in tall and dwarf, respectively with 20-30 kg K_2O and 20 kg sulphur per hectare. Mixture of all the fertilizers should be given 4-5 centimeter away from the rows and deeper from seed. In zinc deficient soils apply Zinc sulphate 15 kg/ ha should be applied. In acid soils, *Rhizobium* inoculated seed should be treated with 1.5 kg of finally powdered lime ($CaCO_3$, 300 mesh).

Weed Control

The field pea crop should be free from weeds for the period up to 40-50 days after sowing for that two hand weeding at three and six weeks after germination. For chemical weed control application of Pendimethalin 30% EC @ 0.75-1 kg a.i./ha as pre-emergence and for post emergence apply Metribuzin 70 % WP @ 0.25 kg a.i./ha at 15-20 day after sowing in 400-600 liter of water.

Plant Protection Measures

Disease

Wilt

Symptoms

The symptoms may be seen in seedling stage. The symptoms are premature yellowing and withering of young leaves during seedling stage and advance stage. Disease caused maximum loss if crop is early sown.



Control Measures

- i) Seed Treatment with Thiram (2g)+Carbendazim (1g) /kg of seed; ii) Adopt crop rotation; iii) Avoid early sowing in badly infested areas.

Powdery Mildew

Symptoms

The symptoms first appears on the leaves then on other green parts of the plant. They are characterized by patchy growth on both the surfaces of the leaf and also on the tendrils, pods and stem. In case of severe

infestation the plant dies prematurely.

Control Measures

i) Adopt resistant var. like Pant Pea-5, Malviya-15, JP-885, HUP-2 etc.; ii) Spraying with Karathane @ 1 ml/litre or wettable sulphur @ 3 g/litre or Dinocap @ 1 ml/litre of water and repeat after 10-15 days, if necessary; iii) Avoid late planting; iv) After harvest collect the plants left in the field and burn them.



Rust

Symptoms

It is caused by fungus. The stem of the plant becomes malformed and the affected plant dies out. All the green parts of plant are affected. Yellow spots having aecia in round or elongated clusters. Then the Urededo pustules develop which are powdery and light brown in appearance.

Control Measures

i) After harvest, the affected plants trash should be burnt; ii) Spray the crop with Mancozeb 75 WP @ 2 g / liter of water.

Insect-Pest Management

Leaf Miner

Larvae of the insect makes tunnel in the leaf causing severe damage. The damage is more during the month of Dec.to Mar.

Control Measures

i) 1 liter of Oxydemeton methyl (Metasystox) 25 EC in 1000 liter of water per hectare when the attack begins and repeat at 15 days intervals.

Pea Aphids

They suck the sap of the cells, owing to which the leaves turn pale and yellow. In case of severe infestation the plant growth is checked. Ultimately plant growth get stunted.

Control Measures

i) Spray 1.25 liter of Dimethoate 30 EC or



oxydemeton methy (Metasystox) 25 EC in 1000 liter of water per hectare. Repeat the spray after 10-12 days.

Spiny Pod Borer

It is a polyphagous insect. Caterpillar makes hole in pods feed upon developing seed. Late varieties are prone to more damage than earlier one.

Control Measures

i) Picking of green pods should be done 15 days after spraying; ii) Spray of 1.25 liter of cypermethrin in 1000 liter of water per hectare is safe and effective.



Harvesting, Threshing & Storage

Field peas should be harvested when they are fully ripe and threshed after sufficient drying in the sun. The clean seed should be sun dried for 3-4 days to reduce their moisture content up to 9-10% to be safely stored in appropriate bins.

To avoid further development of bruchids and other storage pests, it is recommended to fumigate the storage material before onset of monsoon and again after the monsoon with ALP @ 1-2 tablets per tonne. The small quantity of the produce can also be protected by mixing inert material (soft stone, lime, ash, etc) or by smearing edible/non-edible vegetable oils or by mixing plant products like neem leaf powder at the rate of 1-2% w/w basis.

Yield

With improved package of practices, field peas can produce 20-25qtls of grain per ha (irrigated) and 10-15 qtls grains per ha (rainfed) condition.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
- ii) Seed treatment should be done before sowing.
- iii) Application of fertilizer should be based on soil test value.
- iv) Weed control should be done at right time.
- v) Powdery mildew resistant varieties : VL matar -42, VL matar -

47, IPF - 4-9, Pant P -14, Paras, Prakash(IPFD-1-10), Aman, Gomati(TRCP-8), HFP- 529, HFP-715.

- vi) Late planting should be avoided for preventing powdery mildew.
 - vii) Choose the best suitable variety for your area and condition.
 - viii) Adopt integrated approach for plant protection.
-
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PIGEONPEA

Botanical Name - *Cajanus cajan* (L.) Millsp.
Synonym - Red gram, Tur, Arhar
Origin - India & Africa



Introduction

Pigeonpea (Arhar) commonly known as red gram or tur is a very old crop of this country. After gram, arhar is the second most important pulse crop in the country. It is mainly eaten in the form of split pulse as 'dal'. Seeds of arhar are also rich in iron, iodine, essential amino acids like lycine, threonine, cystine and arginine etc.

Crop Status

India ranked first in area and production in the world with 79.65% and 67.28% of world's acreage and production respectively. In productivity, Saint Vincent & Grenadines ranked first with 7926 kg/ha followed by Trinidad & Tobago and Malawi. The productivity of India was 587 kg/ha (*FAO Stat.*, 2014).

During Twelfth Plan, the country's total area coverage and production of tur were 38.49 lakh hectares and 28.66 lakh tonnes respectively. More than 80% of tur production comes from 6 states of MS, MP, Karnataka, UP, Gujarat and Jharkhand. The state-wise trend shows that Maharashtra ranked Ist both in area and production (29.68% and 27.86%). Karnataka stand IInd for area (18.58%) and IIIrd in production (14.75%). Madhya Pradesh ranks IInd in production (15.87%). The highest yield has been recorded by Bihar (1695 kg/ha) followed by West Bengal (1450 kg/ha), Haryana (1100 kg/ha) and Gujrat (1082 kg/ha). The lowest yield has been observed in the state of A.P. (536 kg/ha) followed by C.G. (575 kg/ha) and Karnataka (591 kg/ha) (*DES*, 2015-16).

Nutritive Value

Protein	- 22.3 %	Calcium	- 73 mg/100 g
Fat	- 1.7 %	Phosphorus	- 304 mg/100 g
Minerals	- 3.5 %	Iron	- 5.8 mg/100 g
Fiber	- 1.5 %	Moisture	- 13.4%
Carbohydrate	- 57.6 %	Calorific value	- 335Kcal/100g

State-wise recommended varieties

State	Recommended Varieties
Andhra Pradesh	Laxmi, LRG-41, LRG-38, WRG-27, WRG-53, Bahar, Pusa-9, NDA 1, WRG 65, Surya (MRG 1004)
Bihar	MA-6, Ajad, DA-11, IPA -203, Bahar, Pusa-9, Narendra Arhar-2
Madhya Pradesh	JKM-189, TJT-501, JKM-7, TT-401, BSMR-175, ICPL-87119, BSMR-736
Chhattisgarh	Rajiv Lochan, MA-3, ICPL-87119, Vipula, BSMR-853
Gujarat	GT-100, GT-101, Banas, BDN-2, BSMR-853, AGT 2
Haryana	Paras, Pusa-992, UPAS-120, AL-201, Manak, Pusa-855, PAU-881
Karnataka	Vamban-3, CORG-9701, ICPL-84031, BRG-2, Maruti (ICP-8863), WRP-1, Asha (ICPL 87119), TS -3, KM 7
Maharashtra	BDN-711, BSMR-736, AKT-8811, PKV Tara, Vipula, BDN -708, Asha, BSMR 175, Vaishali (BSMR 853)
Punjab	AL-201, PAU-881, Pusa-992, UPAS-120
Uttar Pradesh	Bahar, NDA-1, NDA-2, Amar, MA-6, MAL-13, IPA -203, UPAS-120
Rajasthan	UPAS-120, PA-291, Pusa-992, Asha (ICPL-87119), VLA -1
Tamil Nadu	Co-6, CORG-9701, Vamban-3, ICPL-151, Vamban 1, Vamban 2
Jharkhand	Bahar, Asha, MA-3
Uttarakhand	VLA-1, PA-291, UPAS-120

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

Pigeonpea is predominantly a crop of tropical areas mainly cultivated in semi arid regions of India. Pigeonpea can be grown with a temperature ranging from 26°C to 30°C in the rainy season (June to October) and 17°C to 22°C in the post rainy (November to March) season. Pigeonpea is very sensitive to low radiation at pod development, therefore flowering during the monsoon and cloudy weather, leads to poor pod formation.

Soil Type & Field Preparation

It is successfully grown in black cotton soils, well drained with a pH ranging from 7.0-8.5. Pigeonpea responds well to properly tilled and well drained seedbed. A deep ploughing with soil turning plough in fallow/waste lands, zero tillage sowing under intensive cropping system and Broad Bed Furrow/Ridge-furrow planting in low lying as well as intercropping areas is recommended. Raised Bed method of planting by dibbling at 2 inches depth with Row to Row distance 4 to 5 feet also 15 feet gap (2 pairs of Tur on bed) under intercropping of

soybean under transplanting (Dharwad method/SPI), 5 X 3 and 3 X 1.5 feet spacing is recommended.

Sowing Time & Method

Early Maturing varieties- First fortnight of June; *Medium & Late Maturing Varieties*-Second fortnight of June. Line sowing by seed drill or desi plough or by dibbling on the ridge and beds, both are recommended as per the area.

Seed Rate & Spacing

The seeding rate of pigeon pea depends on the desired plant density for a genotype (early, medium or late), cropping system (pure crop, mixed crop, or inter crop), germination rate of seed and mass of seed.

Early Maturing Var. - 20-25 kg/ha (Row to Row-45-60 cm & Plant to Plant-10-15 cm)

Medium/Late Maturing Var. - 15-20 kg/ha (Row to Row- 60-75 & Plant to Plant-15-20 cm)

Seed Treatment

Fungicide: Thiram (2g) + Carbendazim (1g) or Thiram @ 3 g or *Tricoderma viridis* 5-7g /kg of seed; *Culture*: *Rhizobium* and PSB culture each @ 7-10 g /kg seed.

Method of Sowing

Three systems of sowings are practiced for pigeon pea. The common is flat sowing, the other methods are broadbed-furrow (BBF) for extra-early group and ridge-and-furrow for the late maturity group. Bund cultivation of pigeonpea in rice fallow areas have also been adopted in CG, MP and some rice fallow areas. The latter two methods are useful in fields with poor surface drainage and water logging. The raised beds or ridges also provide better aeration and nodulation in comparison to the flat sown crop. At ICRISAT a broad bed and furrow system is used for sowing extra-early genotypes, and ridges-and-furrows are used for medium and late duration genotypes.

Fertilizer and Manure Application

The doses of fertilizers should be determined based on the results of soil test. All the fertilizers are drilled in furrows at a depth of 5 cm and at the side of 5 cm from seed. Apply 25-30 kg N, 40-50 kg P₂O₅, 30 kg K₂O per ha area as Basal dose at the time of sowing.

Irrigation and Drainage

Being a deep rooted crop, it can tolerate drought. But in case of prolonged drought there is need of three irrigation 1st at branching stage (30 DAS) 2nd one in flowering stage (70 DAS) and 3rd at the time of podding stage (110 DAS). A pre-requisite for the success of pigeonpea is proper drainage. Ridge planting is effective in areas where sub-surface drainage is poor. This provide enough aeration for the roots during the period of excess rainfall.

Weed Control

The first 60 days is very critical and harmful for the arhar crop. Two mechanical weedings one at 20-25 days and another at 45-50 days after sowing but before flowering. The Pre-emergence application of Pendimethalin 30% EC @ 0.75-1 kg a.i. per ha in 400-600 liter of water. Kills the germinating seedlings of weeds and keep the field weed free for the first 50 days. If weed found from long time use Fluchloralin 50 % EC (Basaline) 1 kg of a.i. per ha in 800-1000 liter well incorporated in the soil before sowing or Alachlor 50 % EC (Laso) 2-2.5 kg a.i. per ha in 400-500 liter of water as pre-emergence.

Plant Protection Measures

Disease

The important diseases of Pigeon pea are Wilt, Sterility mosaic disease, Phytophthora blight, Alternaria blight, Powdery mildew. Symptoms of these disease and their suitable control measures are given below:

1. Wilt

Symptoms

Xylem gradually develops black streaks, dark purple bands appear on

the stem surface plants extending upwards from the base. Main stem of such plants is split open, intensive blackening of the xylem can be seen. In humid weather, a pinkish mycelial growth is commonly observed the basal portions of the wilted plants. It may be seen in seedling, flowering & vegetative stage.



Control Measures

i) Seed Treatment with *Trichoderma viride* @ 10 g/kg of seed or Thiram (2 g) + Carbendazim (1g)/kg of seed; ii) Soil application-T. viride–2.5 kg/ha + 50 kg of well decomposed FYM or sand at 30 days after sowing; iii) Mixed cropping with sorghum; iv) Uproot wilted plants; v) Avoid over or under watering plants; vi) Amendment of soil with oil cakes, appliances of trace elements such as boron, zinc and manganese and heavy dose of green leaf manure crops; vii) Grow resistant varieties like Amar, Azad, Asha (IPCL-87119), Maruthi, C-11, BDN-1, BDN-2, NP-5, JKM-189, C-11, JKM-7, BSMR-853 & BSMR-736 etc.

2. Sterility Mosaic Disease

Symptoms: It is caused by mosaic virus & spread from plant to plant under field conditions through *Eriophyid* mite. Leaves become small and cluster near branch tips & reduced in size. Plants are pale green and bushy in appearance, without of flowers and pods. Diseased plants are usually in groups. It may be seen in Vegetative growth & Pre-flowers stage



Control Measures

i) Spray Fenazaquin 10 EC (Magister) @ 1 ml/liter of water on 45 and 60 DAS; ii) Rogue out the infected plants in the early stages of growth; iii) Crop rotation with non host crop like, tobacco, sorghum, pearl millet, cotton; iv) Grow resistant varieties like Pusa-885, Asha, Sharad (DA11), Narendra Arhar1, Bahar, BSMR-853, BSMR 736, Rajeev Lochan, BDN-708.

Insect-Pest Management

1. Pod Borers

Nature of Damage

It is widely distributed and is the most injurious pest of early and medium maturing varieties. The larvae, after hatching, feed on tender leaves and twigs but a pod formation they puncture pods and feed on developing grains. It may be seen in vegetative & podding stage.



Control Measures

i) Use *H. armigera* pheromone trap @ 12/ha; ii) Spray the crop with Emamectin benzoate 5% SG @220 g/ha or Indoxacarb 15.8% SC @333 ml/ha; iii) The caterpillar should be picked by hand after shaking the plants and destroyed in the early stages of attack.

2. Tur Pod Fly

Nature of damage: Stripes can be seen on the surface of the affected grains, while the attacked pods are somewhat twisted or deformed. In case of severe damage, as many as 80 per cent pods and 60 per cent grains may be damaged.



Control Measures

i) Spraying Neem seed kernel extract (NSKE) 5 per cent at 50% flowering stage to manage the insect's populations; ii) Pest can be controlled by spraying the crop with Monocrotophos (Nuvacron) 36 SL 1 liter in 800-1000 litres of water per hectare.

3. Plume Moth

Nature of damage: The larvae damaged seeds as well cause flowers, buds and pods to drop. The caterpillar is greenish-brown in color and fringed with short hairs and spines. It also enters into the pod and feeds on developing grains.



Control Measures

i) Apply the Neem oil 2%; ii) Spray the crop with Azadirachtin 0.03 % WSP 2500-5000 g/ha or Emamectin benzoate 5% SG @ 220 g/ha or Indoxacarb 15.8% SC @ 333 ml/ha.

Harvesting, Threshing & Storage

With two third to three fourth pods at maturity judged by changing their colour to brown is the best harvesting time. The plants are usually cut with a sickle within 75-25 cm above the ground.

Harvested plants should be left in the field for sun drying for 3-6 days depending on season. Threshing is done either by beating the pods with stick or using Pullman thresher. The proportion of seed to pods is generally 50-60%.

The clean seeds should be sun dried for 3-4 days to bring their moisture content at 9-10% to safely store in appropriate bins. To avoid further development of bruchids and other storage pests, it is recommended to fumigate the storage material before onset of monsoon and again after the monsoon with ALP @ 1-2 tablets per tonne. The small quantity of the produce can also be protected by mixing inert material (soft stone, lime, ash, etc) or by smearing edible/non-edible vegetable oils or by mixing plant products like neem leaf powder at the rate of 1-2% w/w basis.

Yield

With use of improved technology of agronomic practices pigeon pea may yield about 25-30 q/ha from irrigated condition and 15-20 q/ha from un-irrigated condition. (depending upon maturity group of variety and climate) and 50-60 q/ha of sticks for fuel, as well.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
- ii) Application of fertilizer should be based on soil test value.
- iii) Seed treatment should be done before sowing.
- iv) Use wilt and Sterility Mosaic disease (SMD) resistant /tolerant varieties BSMR 736, 853, 846, ICPL 96053, BDN 2010, ICPL 43, 44, IPA 203, 204, 234 and IPH 09-5 as per suitability of

region.(IIPR AICRP Pigeonpea).

- v) Wilt resistant varieties VL Arhar -1, Vipula, JKM -189, G.T.-101, Pusa 991, Azad (K-91-25), BSMR-736, MA-6 etc.
- vi) Use hybrid varieties PPH -4, ICPH-8, IPH 09-5, ICPH -2740 as per suitability of region.
- vii) Weed control should be done at right time.
- viii) Adopt integrated approach for plant protection.

- For technical information of crop production please contact to district KVK/ nearest KVK.
- To avail benefit from Central and State Government running schemes for crop production (ploughing, fertilizers, micronutrient, pesticide, irrigation equipment), agricultural implements, storage infrastructure etc., please contact to your DDA/SADO office.

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Swasth Dhara, Khet Haraa



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RAJMASH



Botanical name - *Phaseolus vulgaris* (L.)
Synonym - Kidney bean, Common bean, Snap bean and French bean
Origin - Central America and south Mexico

Importance

Rajmash, an important pulse crop, with high yielding ability as compared to gram and pea, require focussed attention both at the development and policy front. It is grown in Maharashtra, H.P., U.P., J&K., and NE states covering 80-85 thousand ha area. However, its cultivation during rabi and summer is also gaining popularity in northern Indian plains. Traditionally Rajmash is grown during kharif in Hills of Himalayas, however; high yield is attainable in Rabi in plains due to better management.

Nutritive Value

Protein	- 22.9%	Calcium	- 260 mg/100g
Fat	- 1.3%	Phosphorus	- 410 mg/100g
Carbohydrate	- 60.6%	Iron	- 5.8 mg/100g

State-wise recommended varieties

S.No.	State	Recommended Varieties
1.	U.P.	HUR-137, Malviya Rajmash-137
2.	M.H.	Varun (ACPR-94040), HPR-35
3.	Bihar	IPR 96-4 (Amber)
4.	Rajasthan	Ankur
5.	Karnataka	Arka Anup
6.	Gujrat	Gujrat Rajma-1
7.	Uttarakhand	VL Rajmash 125, VL Bean-2

Source: Seednet GOI, Min. of Agri. & FW & ICAR-IIPR, Kanpur

Climate Requirement

In the hilly region it is grown during kharif and in lower hills/tarai region, sown as spring crop. In north-east plains and hilly tracts of Maharashtra, it is cultivated during rabi. It is highly sensitive to frost and water logging. The ideal temperature range for proper growth of this crop is 10-27°C. Above

30°C, the flower drop is a serious problem. Similarly, below 5°C the flowers and developing pods and branches are damaged.

Soil Type & Field Preparation

The crop can be grown in light loamy sand to heavy clay soil under adequate moisture. Among various pulses. Soil must be free from excessive soluble salts and neutral in reaction. Rajmash having bold and hard seed coat needs a good seed bed accomplished by thorough primary tillage like ploughing, harrowing or discing and planking. A good seed bed have friable but compact soil adequate moisture and free from weeds and plant debris of earlier crop. Acidic soils of the hills must be treated with lime before sowing.

Sowing Time

Kharif (Hills) last week June to first of July; Rabi (Plains) 2nd fortnight of October and for spring (Lower hills) 2nd fortnight of March.

Seed Rate & Spacing : 100-125 kg/ha

Kharif (Hills) - 45-50 cm x 8-10 cm;

Rabi & Spring - 40 cm x 10 cm (irrigated) ; 30 cm x 10 cm (Rain fed)

Plant Nutrient Management

Unlike other Rabi pulses, Rajmash is very inefficient in biological nitrogen fixation owing to poor nodulation due to non availability of suitable and efficient Rhizobium strain for Indian plains. Hence, it requires relatively higher doses of fertilizer N. For enhanced productivity, application of 90-120 kg N ha⁻¹ has been found optimum. Half of the nitrogen should be applied as basal during sowing and rest half as top dressing after first irrigation. Rajmash responds well to phosphorus application like cereals. Its P requirement is distinctly higher than other pulse crops, significant response to P application has been obtained up to a level of 60-80 kg P₂O₅ per ha.

Water Management

Rajmash is the most irrigation responsive pulse crop due to its shallow root system and high nutrient requirements. It requires 2 to 3 irrigations in NEPZ and 3 to 4 irrigation in CZ for achieving highest productivity. Irrigation at 25 days after sowing is most critical followed by irrigation at 75 days after sowing.

Weed Management

One hand weeding/hoeing at 30-35 days after sowing or application of a pre-emergence herbicide like pendimethalin 30% EC @ 0.75 to 1 kg a.i./ha in

500-600 liters of water immediately after sowing helps to keep the losses by weeds below ETL (Economic Threshold Level).

Plant Protection Measures

Diseases

Anthracnose

Symptoms

Pale brown sunken spots may appear on the cotyledons of infected seedlings. Lesions on leaves are dark brown. They are restricted to the veins on lower leaf surface. On stems, lesions are elongated and sunken.



Control Measures

i) Seed treated with Carbendazim & Thiram (1:1); ii) Spray Mancozeb 0.25 % or Carbendazim 0.1 % of 2-3 foliar spray at 45, 60, 75 DAS; iii) Remove from the field and destroy crop debris after harvest; iv) Practise a 2 to 3 year rotation; v) Avoid overhead irrigation; vi) Avoid movement of workers in the field when wet

Stem Blight

Symptoms

Small water-soaked spots are first symptoms observed on leaves & appear within 4 to 10 days of infection. Develop, centre spots becomes dry and brown. The lesion is surrounded by a narrow band of bright yellow tissue.



Control Measures

i) Foliar spray of Carbendazim @ 0.2 % is recommended ; ii) Early or timely sowing; iii) Planting in well drained soil; iv) Avoid dense planting.

Angular Leaf Spot

Symptoms

Fungus produces a grey mould on the lower surface of the spots. Infected pods have brown blotches. The spots may increase in size, join together, and cause yellowing and necrosis of the affected leaves.



Control Measures

i) Seed treated with Carbendazim @ 2-3 g/kg of seeds; ii) 3 Foliar spray of Carbendazim @0.1% (1 gm/lit.) starting at the appearance (5-6 weeks after sowing) at 15 days interval; iii) Plough under bean debris after harvest; iv) Practice a 2-3 year crop rotation without legumes; v) Do not work in bean fields when the plants are wet.

Insect-Pest Management

Leaf Miner

Nature of damage

Severely mined leaves may turn yellow and drop. Severely attacked seedlings are stunted and may eventually die. It may be seen in vegetative stage.



Control Measures

i) Spray of Oxydemeton methyl (Metasystox) 1 ml/liter of water and repeat at 15 day interval if required; ii) Roughing of infected plants; iii) Handpick & destroy mined leaves; iv) Whenever necessary spray the crop with neem products; v) Neem water extracts and neem oil give good control of leaf miners; vi) Remove and destroy crop residues and all plant parts with symptoms of damage by bean flies.

Stem Fly

Nature of damage

Stem becomes to swell and split and reducing formation of lateral roots. Attacked plants produce adventitious roots in compensation. Young seedlings and plants under stress wilt and die.



Control Measures

i) Seed Treated with Chlorpyrifos @8ml/kg seed; ii) Soil application by Phorate 10 G @ 10 kg/ha; iii) Mulch (e.g. with straw and cut grasses) helps conserve moisture, promote adventitious root development and enhances tolerance to maggot damage; iv) Avoid planting beans near cowpea, soybean and many other leguminous crops, that may be the source of bean flies.

Black Aphids

Nature of damage

Aphids feed by sucking plant sap. Heavily infested plants usually have wrinkled leaves, stunted growth and deformed pods. Plants, in particular young plants, may dry out and die under heavy aphid attack.



Control Measures

i) Bio treat.-Inundative release of *Coccinella septempunctata* @ 1000 adult/400 sqm; ii) Practice a 2-3 year crop rotation without legumes; iii) Spraying the systemic insecticide like Dimethoate or Oxydemeton methyl @1 ml/liter of water.

Harvesting & Threshing

The crop matures in 125-130 days. Plants are cut with sickles after attaining full maturity judged by severe leaf fall, changing colour of pods and hardness of the grains. Harvested materials after 3-4 days sun drying, is collected in bundles to the threshing floors. Threshing is done by beating with sticks or trampling under the feet of bullocks. The clean seed should be sun dried for 3-4 days to bring their moisture content at 9-10%.

Yield

A well managed crop can easily give 20-25qtls/ha yields under irrigated conditions of plain and 5-10 q /ha under rainfed conditions of hill with 40-50qtls/ha of straw for cattle's.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
 - ii) Seed treatment should be done before sowing.
 - iii) Application of fertilizer should be based on soil test value.
 - iv) Weed control should be done at right time.
 - v) Adopt integrated approach for plant protection.
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URD BEAN

Botanical Name - *Vigna mungo* (L.) Hepper
 Synonym - Urd, Biri, Mash
 Origin - India



Introduction

Black gram is one of the important pulse crops grown throughout India. It is consumed in the form of 'dal' (whole or split, husked and un-husked) or perched. It is used as nutritive fodder specially for milch animals. It is also green manuring crop. High values of lysine make urdbean an excellent complement to rice in terms of balanced human nutrition.

Nutritive Value

Protein	- 24%	Calcium	- 54 mg/100 g
Fat	- 1.4%	Phosphorus	- 385 mg/100 g
Minerals	- 3.2%	Iron	- 9.1 mg/100 g
Fiber	- 0.9%	Calorific value	- 347 Kcal/100 g
Carbohydrate	- 59.6%	Moisture	- 10.9%

Crop Status

During the twelfth Plan (2012-2015) the total production was 18.29 lakh tonnes on an area of 31.29 lakh hectares. As regards the total contribution from states, Madhya Pradesh stand first in respect of area (19.40%) followed by U.P. (17.88%) and Andhra Pradesh (11.69%), whereas in production U.P. stands first (16.98%) followed by Andhra Pradesh (16.75%) and Madhya Pradesh (15.07%). The highest yield was recorded by the state of Bihar (898 kg/ha) followed by Sikkim (895 kg/ha) and Jharkhand (890 kg/ha) the National yield average was (585 kg/ha). The lowest yield was recorded in the state of C.G. (309 kg/ha) followed by Odisha (326 kg/ha) and J&K (385 kg/ha) (DES, 2015-16).

State-wise recommended varieties

State	Recommended Varieties		
	Kharif	Rabi	Spring/Summer
Andhra Pradesh	Pant Urd-31, IPU 2-43, LBG 685, LBG 625, Tulsi (LBG-787)	TU 94-2, LBG 623, LBG 709, LBG 611, Tulsi (LBG-787)	TU 94-2, LBG 623, LBG 709, LBG 611, Tulsi (LBG-787)
Assam	PU-30, WBU -108, IPU 94-1 (Uttara)	-	-
Bihar & Jharkhand	Pant Urd 31, WBU 108, IPU 94-1 (Uttara), Birs Urd 1, PU-30	-	Pant Urd 31, WBU-109, KU 91-2 (AZAD Urd 1)

Gujarat	KU 96-3, TPU-4, AKU-4 (Melghat), GU-1, KUG-479, UH 01, Mash-414	-	-
Haryana	KU-300 (Shekhar 2), IPU 94-1 (Uttara)	-	-
H.P.	Pant Urd 31, Pant Urd 40	-	-
Karnataka	IPU 02-43, WBU-108, KU-301, LBG 402, Tulsi (LBG-787)	IPU 2-43, WBU-108, KU-301, Tulsi (LBG-787)	Tulsi (LBG-787)
M.P. & C.G.	Pant Urd-30, JU-3, KU 96-3, TPU-4, JU-2, Khargone-3	Pant Urd 31	Pant Urd 31
Maharashtra	KU 96-3, TPU 4, AKU-4 (Melghat), AKU-15	-	-
Odisha	IPU 02-43, WBU-108, KU 301	B-3-8-8, OBG-17, Mash 338	B 3-8-8, OBG 17, Mash 338
Punjab	WBU 108, IPU 94-1 (Uttara), Mash 338, Mash 414	-	KU 300 (Shekhar 2), KUG 479
Rajasthan	Pant Urd-31, WBU 108, IPU 94-1 (Uttara)	-	KU 300 (Shekhar 2), KUG 479
U.P. & Uttarakhand	Pant Urd-40, WBU-108, IPU 94-1 (Uttara)	-	KU 300, WBU 109, KU 91 (Azad Urd 2) KUG-479, Narendra Urd 1
Tamil Nadu	IPU 02-43, Vamban-4, Vamban-7, Tulsi (LBG-787)	Vamban-3, TU 94-2, Tulsi (LBG-787)	Vamban 3, TU 94-2, Vamban 5, Vamban 2, Tulsi (LBG-787)
West Bengal	Pant Urd 31, WBU 108, IPU 94-1 (Uttara)	Pant Urd-31, WBU-190, KU-92-1 (Azad Urd-1)	Pant Urd 31, WBU 109, KU 91-2 (AZAD Urd 1)

Source: Seednet GOI, Min. of Agri. & FW, & ICAR-IIPR, Kanpur

Climate Requirement

Being a crop of tropical region, it requires hot and humid climate for best growth. It is basically a warm weather crop. In North parts of the country where the temperatures during winter are quite low, it is cultivated generally during rainy and summer season. In the Eastern states, it is also grown during winter. In Central and Southern states, where there is not much variation in the climate, it is cultivated during winter and rainy seasons

Soil & Field Preparation

Black gram can be grown on variety of soils ranging from sandy soils to heavy cotton soils. The most ideal soil is a well drained loam with pH of 6.5 to 7.8. Black gram cannot be grown on alkaline and saline soils. Land is prepared like any other kharif season pulse crop. However during summer it requires a thorough preparation to give a pulverized free from stubbles and weeds completely.

Sowing Time & Method

Kharif : In kharif season sowing is done with the onset of monsoon in later part of June or early part of July.

Rabi : Second fortnight of October (upland) second fortnight of November (Rice fallow)

Summer : The sowing could be done from the third week of February to first week of April. Sowing should be done in furrows opened at a distance of 20-25 cm, seed drill could be used for this purpose.

Seed Rate & Spacing

i) **Kharif** : During kharif season 12-15 kg seed/ha. The crop should be sown at a distance of 30-45 cm with 10 cm plant spacing.

ii) **Rabi** : About 18-20 kg seed/ha for upland and 40 kg/ha for Rice fallows with a crop geometry of 30 cm x 15 cm. Higher seed rate in rice fallow is used due to delayed in sowing.

iii) **Summer** : About 20-25 kg seed is required per ha. Plant to plant spacing should be kept at 5-8 cm depending upon sowing time and varietal behaviour.

Seed Treatment

Treat the seed with Thiram (2g) + Carbendazim (1g) or Carbendazim @2.5 g/kg seed to control the soil & seed germinated disease. For sucking pest control seed treatment with Imidacloprid 70 WS @ 7g/ kg seed . It is also desirable to treat the seed with *Rhizobium* & PSB culture (5-7 g/kg seed).

Fertilizer

For sole crop 15-20 kg/ha Nitrogen, 40-50 kg/ha Phosphorus, 30-40 kg/ha Potash, 20 kg/ha Sulphur is should be applied at the time of last ploughing. However phosphatic and potassic fertilizer should be applied as per soil test value. Fertilizer should be applied by drilling either at the time of sowing or just before sowing in such a way that they are placed about 5-7 cm below the seed. Use of gypsum @ 100 kg/ha would ensures availability of calcium and sulphur at economical rates.

Water Management

In kharif season irrigation not required, if rainfall is normal & if moisture deficit at pod formation stage irrigation should apply. In summer 3-4 irrigation required according to crop requirement. Generally, the crop should get irrigation at an interval of 10-15 days. From flowering to pod development stage, there is need of sufficient moisture in the field.

Weed Control

One or two hand weedings should be done up to 40 days of sowing depending upon the weed intensity. Weeds can be controlled by the use of chemicals too. Use Pendimethalin 30% EC @ 0.75-1.00 kg a.i. per ha in 400-600 liters of water as pre-emergence application.

Plant Protection Measures

There are several important disease of Urdbean, Yellow mosaic virus, Powdery mildew, leaf blight etc. are important one.

Diseases

Yellow Mosaic Virus

Symptoms

This disease is caused by the mung bean yellow mosaic virus (MYMV) belonging to Gemini group of viruses, which is transmitted by the whitefly (*Bemisia tabaci*). The tender leaves show yellow mosaic spots, which increase with time leading to complete yellowing. Yellowing leads to less flowering and pod development. Early infection often leads to death of plants.



Control Measures

i) Diseased plants should be rogued out to prevent further spread of the disease; ii) In order to prevent whitefly (*Bemisia spp.*) infestation spray with triazophos 40 EC @ 2.0 ml/lit. or malathion 50 EC @ 2.0 ml/lit. or oxydemeton methyl 25 EC @ 2.0 ml/lit. at 10-15 days intervals if required; iii) Grow tolerant/resistant varieties like IPU 94-1 (Uttara), shekhar 3(KU 309), Ujala(OBJ 17), VBN(Bg) 7, Pratap urd 1 etc.

Powdery Mildew

Symptoms

The disease appears on all the part of plants above soil surface. Disease initiates as faint dark spots, which develop into small white powdery spots, coalescing to form white powdery coating on leaves, stems and pods. At the advance stages, the color of the powdery mass turns dirty white. The disease induces forced maturity of the infected plant causing heavy yield losses and its intensity increases in stress condition.



Control Measures

i) Adopt clean cultivation by destroying diseased plant refuge; ii) Delayed sowing of mungbean and urdbean with wider spacings considerably reduce the disease severity; iii) Opt for resistant varieties as per recommendation of local agricultural authorities Urdbean: COBG10, LBG 648, 17, Prabha, IPU 02-43, AKU 15 and UG 301); iv) Spray with NSKE @ 50 g/liter of water or neem oil 3000 ppm @ 20 ml/lit. twice at 10 days interval from initial disease appearance. Spray with eucalyptus leaf extract 10% at initiation of the disease and 10 days later also if necessary; v) Spray with water soluble sulphur 80 WP @ 4 kg/liter or Carbendazim 50 WP @ 1 g/lit.

Leaf Blight

Symptoms: In pre-emergence stage, the fungus causes seed rot and mortality of germinating seedlings. In post emergence stage, seedling blight disease appears due to soil or seed-borne infection. The fungus attacks the stem at ground level, forming localized dark brown patches which coalesce and encircle the stem. Black dot like sclerotia are formed on the surface and below the epidermis on the outer tissue of the stem and root. The pathogen is most favoured at a temperature of 30°C and 15% moisture.



Control Measures

i) Basal application of zinc sulphate @ 25kg/ha or neem cake @ 150 kg/ha or soil application *P. fluorescens* or *T. viride* @ 2.5 kg/ha + 50 kg of well decomposed FYM at the time of sowing helps in prevention

of the disease; ii) The diseased plants should be uprooted and destroyed so that the sclerotia do not form or survive; iii) Spray with Carbendazim 50 WP @ 1 g/liter of water at an interval of 15 days with the appearance of the symptoms.

Insect-Pest Management

Aphids

Nature of Damage: Nymphs and adults are seen in large numbers on young plants, leaflets, stem and pods. Young leaves of seedlings become twisted. Excretion of honey dew attracts sooty mold. The adults are black and shiny, upto 2 mm long and some are winged. Nymphs are covered with waxy coating that makes them grey and dull.



Control Measures

i) Spray with 5% crude neem extract or 2% neem oil 3000 ppm; ii) Spray with Dimethoate 30 EC (1.7 ml/ lit.) or Imidacloprid 17.8 SL @ 0.2 ml/liter of water ; iii) Conserve coccinellid beetles, their grubs and Chrysoperla.

Tobacco Caterpillar

Nature of damage: Newly hatched tobacco caterpillar (*Spodoptera litura*) feed gregariously on the leaf surface for about 2-3 days and leave behind the whitish membranous leaf only. The larvae makes irregular holes on the leaf surface and in severe infestation, they skeletonize the foliage. They are voracious feeders of the foliage and remain hidden in cracks and crevices or plant debris in the soil during day time. The maximum damage is caused to the young plants, which are often totally destroyed



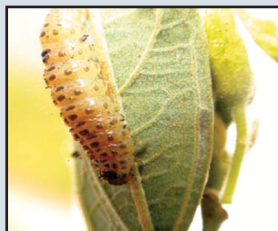
Control Measures

i) Collection and destruction of egg masses and newly hatched larvae along with skeletonized leaves can reduce infestation; ii) Spray of microbial pesticides like SINV [500 LE/ha or or *Bacillus thuringiensis* formulations in synchrony with early larval instars is effective against the pest; iii) Spray Malathion 50 EC @ 2.0 ml/lit. or

foliar application of Novaluron 10 EC @ 0.75 ml/lit., chitin synthesis inhibitor against eggs of *S. litura*; iv) Spray extract of custard apple as feeding deterrent against the pest.

Spotted Pod Borer

Nature of Damage: The larva webs the leaves, inflorescence and feed inside the flowers, flower buds and pods. Eggs are laid on or in the flowers (inserted between the petals). Young larvae feed inside the flowers before moving to developing pods when mid-sized. A larva may consume 4-6 flowers before larval development is completed. Third to fifth instar larvae are capable of boring into the pods and feeding the developing grains. Seeds in damaged pods are totally or partially eaten out by larvae.



Control Measures

i) Spray *Bacillus thuringiensis* 5 WG @ 1.0 g/liter of water; ii) foliar spray of Profenofos 50 EC @ 2.0 ml/liter of water; iii) Spray of spinosad 45 SC @ 0.2 ml/liter of water is most effective in controlling this pest; iv) Physical shaking of the infested plants over the vessels of oil and water or oily cloth help reduce the population.

Harvesting, Threshing & Storage

Urd should be harvested when 70-80 % pods matured & most of the pods turn black. Over maturity may result in shattering. Harvested crop should be dried on threshing floor for few days and then threshed. Threshing can be done either manually or by trampling under the feet of bullocks. The clean seeds should be sun dried for 3-4 days to bring their moisture content at 8-10% to safely store in appropriate bins.

Yield

A well managed crop of Urd may produce 12-15 quintals grains/ha.

Recommendation to achieved higher production

- i) Deep summer ploughing once in 3 years.
 - ii) Seed treatment should be done before sowing.
 - iii) Application of fertilizer should be based on soil test value.
 - iv) In kharif season sowing should be done by ridge & furrow method.
 - v) Yellow mosaic resistant/ tolerant varieties IPU 94-1 (Uttara), shekhar 3(KU 309), Ujala(OBJ 17), VBN(Bg) 7, Pratap urd 1 etc choose as per suitability of region.
 - vi) Weed control should be done at right time.
 - vii) Adopt integrated approach for plant protection.
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