4. PULSES

(i) REDGRAM (*Cajanus cajan*)

Climate Requirement

T_Max°C	T_Min°C	Optimum °C	Rainfall mm
30	17	26 - 30	600 - 1400

Tropical and subtropical legumes, suitable for rainfed in semiarid areas due to its deep taproot, heat tolerance and fast growing habit. During vegetative growth, prefers a fairly moist and warm climate. During flowering and ripening stage, requires bright sunny weather for proper fruit setting. Highly susceptible to frost at the time of flowering, hardy, widely adaptable, and drought resistant. It has low tolerance of soil salinity and waterlogging.

CROP IMPROVEMENT

I. SEASON AND VARIETIES

District/season	Varieties
Vaigasi Pattam (May-June) Krishnagiri, Dharmapuri, Salem, Erode, Coimbatore Dindigul, Theni and Madurai	CO (Rg) 7, CO 8 and CO 9
Adi/Avanipattam (June - August) Vellore, Thiruvannamalai, Salem, Namakkal, Perumbalur, Ariyalur, Madurai, Dindigul, Theni, Pudukkottai and Sivaganga June 15th to July 15th sowing	CO 8, CO 9
Purattasipattam (September – October) Vellore, Tiruvannamalai, Dharmapuri, Salem, Namakkal, Erode, Coimbatore, Madurai, Dindigul, Theni Pudukkottai, Sivagangai, Perambalur, Ariyalur	Co (Rg) 7 and VBN (Rg) 3
Markazhipattam (Winter Irrigated) All districts except The Nilgiris and Kanyakumari	Co (Rg) 7 and VBN(Rg) 3
Chithiraipattam (Summer Irrigated) All districts except The Nilgiris and Kanyakumari Wetland bunds	Co (Rg) 7 and VBN(Rg) 3 BSR 1

II.DESCRIPTION OF REDGRAM VARIETIES

PARTICULARS	CO 8	CO 9
Year of Release	2017	2018
Year of Notification	SO.1379(E)/ 27.03.2018	SO.3220(E)/05.09.2019
Parentage	APK 1 x LRG 41	CO6 x IC 525427
50% flowering(days)	120-130	120-130
Maturity(days)	170-180	170-180
Season	Adi pattam	Adi pattam
Grain yield(kg/ha)		
Rainfed	1600 kg/ha	1700 kg/ha
Irrigated	1800 cm	-
Plant height(cm)	165-180	210-240 cm
Plant spread	Erect	Erect
Colour of standard petal	Yellow base with medium pattern of streaks	Yellow base with medium pattern of streaks
Colour of pod	Brown streaks	Green with Brown streaks
Colour of grain	Cremish brown	Brown
100 seed weight(g)	10.22 to 11.44g)	9.9
Pattern of growth	Indeterminate	Indeterminate

Particulars	Co (Rg) 7	VBN(Rg)3	BSR 1
Year of Release	2004	2005	1986
Year of Notification	SO.1177(E)/ 25.08.2005	SO.1572(E)/ 20.09.2006	Not notified
Parentage	Selection from PB 9825	Vamban 1 x Gulbarga	Pureline selection from Mayiladumparai
50% flowering(days)	70-90	65-70	100-110
Duration (days)	120-130	100-105	Perennial
Grain yield(kg/ha)			

Rainfed (kg/ha)	950	880	0.75 to 1.0 kg of green pods/plant
Irrigated (kg/ha)	1168	1530	-
Plant height (cm)	120-130	100-120	150-200
Branches	7-9	3-10	7-10
Plant spread	Semi spreading	Erect, Semi-determinate and open type	Semi spreading
Colour of standard petal	Yellow with light red vein at the base	Yellow with light red vein at the base	Red at dorsal side
Colour of pods	Green with purple streaks	Green with purple streaks	Red with diagonal constriction
Colour of grain	Reddish brown	Reddish brown	Reddish brown
100 grain wt (g)	8.5-11.0	7.0-8.0	12.0
Pattern of growth	Indeterminate	Semi determinate	Indeterminate

CROP MANAGEMENT

SEED RATE

System	Long duration		Short duration	
	Low Fertility	High Fertility	Low Fertility	High Fertility
Sole Crop	8	5	13	10
Mixed Crop	3	3	5	5
Bund Crop	50 g / 100 meter			

Long duration varieties: CO 6, CO 8, Vamban 2, LRG 41

Short duration varieties : CO (Rg) 7, VBN (Rg) 3

Bund Crop : BSR 1

III. MANAGEMENT OF FIELD OPERATION

1. PREPARATION OF THE LAND

Prepare the land to fine tilth and apply 12.5 t FYM/ha or composted coir pith at the time of last ploughing and form ridges and furrows

2. SEED TREATMENT

Treat the seeds with Carbendazim or Thiram @ 2 g/kg of seed 24 hours before sowing (or) with talc formulation of *Trichoderma viride* @ 4g/kg of seed (or) *Pseudomonas fluorescens* @ 10 g/kg seed. Bio control agents are compatible with biofertilizers. First treat the seeds with biocontrol agents and then with rhizobium. Fungicides and biocontrol agents are incompatible.

3. TREATMENT OF THE SEEDS WITH BIOFERTILIZER

a) Fungicide (or) bio control agents treated seeds should be again treated with bacterial culture after 24 hours. Treat the seeds required for sowing 1 ha with 200g each of Rhizobial culture CPR6 / CPR 9, phosphobacteria and PGPR (*Pseudomonas* sp.) using rice gruel, shade dry it before sowing. (or) Treat one hectare of seeds with 25 g each of powder formulation of *Rhizobium* and AM fungi using binder (polymer), shade dry before sowing.

b) If seed treatment is not carried out, apply 2 kg each Rhizobial culture, Phosphobacteria and PGPR (*Pseudomonas* sp.) with 25 kg of FYM and 25 kg of sand, mix uniformly before sowing.

4. APPLICATION OF FERTILIZERS

If soil test is not done, apply fertilizers basally before sowing

a) Apply fertilizers basally before sowing.

Rainfed : 12.5 kg N + 25 kg P_2O_5 + 12.5 kg K_2O +10 kg S*/ha Irrigated : 25 kg N + 50 kg P_2O_5 + 25 kg K_2O + 20 kg S*/ha

*Note : Applied in the form of Gypsum if Single Super Phospate is not applied as a source of Phosphorus

b) Soil application of 25 kg $ZnSO_4$/ha under irrigated condition

c) Soil application of TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade).

d) Foliar spraying to mitigate moisture stress

Foliar spraying of 2% KCl + 100 ppm Boric acid during dry spell as mid season management practice in Black gram during *Rabi* season is recommended to increase the yield over KCl spray alone .

Nitrogen substitution by organic sources for pulses

50 per cent nitrogen can be substituted through organic source (850 kg of vermicompost per hectare). Lime application is recommended for pulses with soil pH less than 6.0.

SOWING THE SEEDS

Dibble the seeds adopting the following spacing.

Variety	Pure crop		Mixed crop
	Low fertility	High fertility	
CO(Rg) 7	45 cm x 30 cm	60 cm x 30 cm	120 cm x 30 cm
Vamban (Rg) 3, APK 1	45 cm x 20 cm	60 cm x 20 cm	120 cm x 30 cm
CO 6, CO 8, Vamban 2, LRG 41	90 cm x 30 cm	120 - 150 x 30 cm	240 cm x 30 cm
Bund Crop	60 cm for BSR 1 and 30 cm for others.		

5. Season

- Long duration varieties (CO 6, CO 8, Vamban 2, LRG 41) : Second fortnight of July and First fortnight of August months.
- Short duration varieties : January - May and September first fortnight.
- Note: Sowing season should be planned in such a way that flowering and pod maturity stage does not coincide with rain.

6. WEED MANAGEMENT

i) Pre emergence application of Pendimethalin 0.75 kg/ha (2.5 litres/ha) on 3 DAS mixed with 500 litres of water using Backpack/Knapsack/Rocker sprayer using flat fan deflector type of nozzle. Then irrigate the field. Following this, one hand weeding may be given on 30-35 DAS

ii) If herbicide is not given, give two hand weedings on 20 and 35 DAS.

iii) In case of labour problem, apply Pendimethalin 0.75 kg (2.5 lit/ha) on 3 DAS followed by early post emergence application of Imazethapyr @ 60 g ai/ha on 15 DAE of weeds (2 - 3 leaves stage of weeds) and Quizalofoz ethyl @ 50 g ai/ha on 20 DAE of weeds (2 - 3 leaves of weeds) are recommended for controlling broad leaved and grassy weeds, respectively. If both the weeds are present, tank mix application of Imazethapyr @ 60 g ai/ha and quizalofoz ethyl @ 50 g ai/ha at 15 - 20 days after emergence of weeds

(2 - 3 leaves stage of weeds) is recommended. Apply Pendimethalin 30% EC + Imazethapyz 2% EC (Valor 32% EC; Readymix herbicide) @ 1,.0 kg a.i. ha^{-1} at 3 DAS.

iv) Apply metalachlor 1.0 kg ha^{-1} on 3 DAS followed by one hand weeding on 40 DAS.

Note: At the time of herbicide application, there should be sufficient soil moisture

7. WATER MANAGEMENT

Irrigate immediately after sowing, 3rd day after sowing, bud initiation, 50 % flowering and pod development stages. Water stagnation should be avoided.

8. FOLIAR APPLICATION

a) Foliar spray of NAA 40 mg/l once at pre-flowering and another at 15 days thereafter

b) Foliar spray of DAP 20 g/l or Urea 20 g/l once at flowering and another at 15 days there after

c) Foliar spray of Salicylic and 100 mg/litre once at preflowering and another at 15 days there after

9. HARVESTING THE CROP

1) Harvest the whole plants when 80% of the pods mature.
2) Heap for 2 – 3 days
3) Dry and process.

10. INTER-CROPPING

a) Raise one row of long duration Redgram varieties as inter crop for every six rows of Groundnut (6:1) under rainfed situation.

b) Raise one row of short or medium duration redgram as inter crop for every four rows of groundnut (4:1) under rainfed as well as irrigated condition.

c) **Multistoreyed cropping**: For rainfed Vertisols of Virudhunagar, Tirunelveli, Thoothukudi districts recording more than 300 mm of rainfall during the crop growth period, multistoreyed cropping system Agathi + Redgram (Co 5) + Cotton (MCU 10) + Blackgram (Co 5) is highly profitable. (Agathi in I tier with 1 x 1 m spacing - Redgram in II tier with a spacing of 45 x 20 cm - Cotton in the III tier with a spacing of 45 x 15 cm - Blackgram in the IV tier with the spacing of 30 x 10 cm).

For rainfed Vertisols receiving less than 300 mm of rainfall, Agathi + Sorghum (CO 26) + Cotton (MCU 10) + Blackgram (Co 5) system is ideal. (Agathi in I tier with a spacing of 1 x 1 m - sorghum in II tier with a spacing of 45 x 15 cm - cotton in III tier with the spacing of 45 x 15 cm and Blackgram in IV tier with 30 x 10 cm). For both systems, apply 40 kg N and 20kg P O /ha.2 5

11. REDGRAM TRANSPLANTING

- Select only long duration redgram varieties
- Transplant within the month of August either under rainfed condition or under irrigated condition
- Select poly bag with a size of 6x4 inches and 200 micron thickness
- Fill the poly bag with native soil: Sand: FYM @1:1:1 and put 3-4 holes in the bottom to avoid water stagnation
- Soak the seeds in 0.2% Calcium chloride for one hour and dry it under shade for 7 hours to harden the seeds
- Treat the hardened seeds with *T. viride* @ 4g/kg and 100 g Rhizobium and 100 g phosphobacterium. Sow the seeds @2/poly bag at 1 cm depth
- Sow the seeds in polybags 30-45 days prior to transplanting
- Plough the field deeply to get fine tilth followed by 2-3 harrowings at 3 weeks prior to transplanting
- In medium to deep soils for raising long duration varieties, dig 15 sqcm pits at 5' X 3' for pure crops and 6' x 3' for intercropping under irrigated condition. In rainfed condition dig the pits at a spacing of 5'x3'. For short duration varieties dig 15 sq cm pits at 3' x 2' spacing.
- Under water logging condition, form furrows before digging pits
- Apply inorganic fertilizers @ 25:50:25 kg NPK /ha at 20-30 days after planting as Urea, DAP and Potash around the seedlings
- Apply $ZnSO_4$ @ 25 kg/ ha as basal along with FYM or sand
- Nip (removal of top 5 cm) the plants at 20 – 30 days after planting to arrest the terminal growth
- Foliar Spray of Napthalene aceptic acid (NAA) @ 0.5 ml/litre to control flower dropping in red gram.

12. NUTRITIONAL DISORDERS

Redgram / Greengram/Blackgram/Cowpea

Zinc: Symptom appears within a month of sowing. The plants are stripped with yellow or pale green foliage. Veins and mid ribs of the leaves are green although tissue around them becomes yellow and bronzed.

Iron: Reduced concentration of Chlorophyll in leaves - pale leaf colour may be indistinguishable from deficiency of nitrogen or other elements.

CROP PHYSIOLOGY

Foliar spray of TNAU Pulse Wonder @ 2 kg/acre in 200 litres of water at flower initiation stage decreases flower shedding, increases yield and offers moisture stress tolerance

CROP PROTECTION

A. Pest management

Pest	ETL
Aphids	20 nos. /2.5 cm shoot length
Pod borers	10% of affected pods
Plume moth	5 larvae /plant
Spotted pod borer	3 larvae /plant

Pest Management strategies

Aphids *Aphis craccivora*	**Spray any one of the following :** Methyl demeton 25 EC 500 ml/ha Dimethoate 30 EC 500 ml/ha
Pod borers **Spotted pod borer** *Maruca vitrata* **Gram pod borer** *Helicoverpa armigera* **Plume moth** *Exelastis atomosa* **Pod fly** *Melanagromyza obtusa*	• For pod borers, raise one row of sunflower as intercrop for every 9 rows of pigeon pea and plant maize as border crop. • Pheromone traps for *Helicoverpa armigera* 12/ha • Bird perches 50/ha • Mechanical collection of grown up larva and blister beetle • Ha NPV 3 x10^{12} POB/ha in 0.1% teepol • *Bacillus thuringiensis* var *kurstaki* 5%WP 1000-1250 g/ha (Note : Insecticide / Ha NPV spray should be made when the larvae are upto third instar) **Apply any one of the following insecticides:** Azadirachtin 0.03 % WSP 2.5kg/ha Benfuracarb 40% EC 2.5l/ha Chlorantraniliprole 18.5% SC 150ml/ha

	Chlorpyriphos 20 EC 1250 ml / ha Emamectin benzoate 5% SG 220 g/ha Ethion 50% EC 1.0 l/ha Flubendiamide 39.35 % SC 100ml / ha Indoxacarb 14.5% SC 350 ml/ha Indoxacarb 15.8% SC 333 ml/ha Lufenuron 5.4% EC 600ml/ha Methomyl 40%SP 750g/ha Monocrotophos 36%SL 625-1250ml/ha Neem oil 2% Quinalphos 1.5%DP 23kg/ha Quinalphos 25 %EC 1400ml/ha Spinosad 45%SC 125 ml/ha Thiodicarb 75 WP 625g / ha
Pod bugs	Dimethoate 30% EC 500ml/ha Methyl demeton 25% EC 500ml/ha

B. Disease management

Seed treatment : Treat the seeds with *Trichoderma asperellum* @ 4 g or *P. fluorescens* @ 10 g or carbendazim 2 g or thiram @ 4 g/kg of seed

Disease	Recommendations
Wilt: *Fusarium udum*	• Apply *P. fluorescens* or *T. asperellum* @ 2.5 kg / ha with 50 kg of well decomposed FYM or sand to soil at 30 days after sowing • Spot drench with carbendazim @ 1 g/ lit
Root rot: *Rhizoctonia bataticola* *(Macrophomina phaseolina)*	
Sterility Mosaic: *Pigeonpea sterility mosaic virus* (Vector : *Aceria cajani*)	• Rogue out the virus infected plants in the early stages of growth • Spray Fenazaquin @ 1ml/ l soon after appearance of the disease and if necessary repeat after 15 days

C. Nematode management

Seed treatment with *Pseudomonas fluorescens* and *Trichoderma viridi* @ 5+5 g/kg seed manages population of Cyst nematode, *Heterodera cajani*.

SEED PRODUCTION
RED GRAM - VARIETAL SEED PRODUCTION

Land requirement

- Land should be free of volunteer plants. The previous crop should not be of the same variety or other varieties of the same crop. It can be the same variety if it is certified as per the procedures of certification agency.

Isolation

- For certified seed production leave a distance of 100 m all around the field from the same and other varieties of red gram.

Pre-sowing seed treatment

- Soak the seeds for 3 hrs. in 100 ppm $ZnSO_4$ (10 g / 100 lit of water) in 1/3 volume before sowing and quickly air dry in shade to their original moisture content.
- Treat the seeds with Carbendazim 75 % WP 2 g dissolved in 5 ml of water per kg of seeds and air-dried.
- Pellet the seeds with *Rhizobium* culture (50 g / kg of seed) before sowing.

Foliar application

- Spray 2 % DAP at the time of flowering and a second spray at 15 days after the first spray.
- Spray NAA 40 ppm at the time of flowering and a second spray at 15 days after the first spray.

Pre-harvest sanitation spray

- Spray (0.05 %) Malathion 50 EC 3 - 5 days before harvest to minimize the carryover of Bruchid infestation from field to storage.

Harvest

- Harvest the pods at physiological maturity stage (approximately 40 days after 50 % flowering).
- Collect the seeds from first and second pickings for quality seeds.

Drying

- Dry the pods to about 15 % moisture content.
- Dry the seeds to 10 % moisture content.

Seed grading

- Size grade the large seeded varieties using BSS 5 x 5 or BSS 6 x 6 wire mesh sieve.
- Discard the discoloured and broken seeds for seed purpose.

Pre-storage seed treatment

- Treat the seeds with Carbendazim 2 g using 5 ml of water / kg of seed (or) dry dress the seeds with Halogen mixture ($CaOCl_2$ + $CaCO_3$ + *arappu* (*Albizzia amara*) leaf powder at 5:4:1 ratio @ 3 g / kg of seed.

Storage

- Store the seeds with a seed moisture content of 10 - 12 % in gunny or cloth bags for short term storage (8 - 9 months).
- Store the seeds with a seed moisture content of 8 - 9 % in polylined gunny bag for medium term storage (12 - 15 months).
- Store the seeds with a seed moisture content less than 8% in 700 gauge polythene bag for long term storage (more than 15 months)

RED GRAM HYBRID SEED PRODUCTION

Land requirement

- Select fertile land with good drainage and irrigation facilities.
- Field should be free from volunteer plants. Hence, the previous crop should not be the same or different variety / hybrid of redgram.

Isolation

- For foundation seed production (parental lines seed production), leave a distance of 200 m all around the field from the same and other varieties / hybrids of redgram.
- For hybrid seed production from the same and other varieties / hybrids of redgram, leave a distance of 100 m all around the field.

Planting ratio

- Sow the female and male lines at a ratio of 4:2.

Border rows

- Sow 2 rows of the male parent all around the field for effective pollination.

Spacing

- 45 x 15 cm.

Fertilizer

- Apply NPK @ 25:50:25 kg / ha^{-1} as basal application.

Roguing

- Pull out all male fertile plants in female rows for genetic purity maintenance.

Pre-storage seed treatment

- Treat the seeds with carbendazim @ 2 g using 5 ml of water / kg of seed.
- Dry dress the seeds with Halogen mixture ($CaOCl_2$ + $CaCO_3$ + *arappu* (*Albizia amara*) leaf powder mixed in 5:4:1 ratio @ 3 g / kg of seed.
- Treat the seeds with Turmeric rhizome powder (or) Neem leaf powder at 1:50 ratio against bruchid infestation as an eco-friendly seed treatment.

PERENNIAL REDGRAM

Variety	:	BSR 1
Economic uses	:	Tender beans are pinkish green in colour and can be cooked as curry or added to Kurma or Sabji. When the beans mature they can be used as Dhal. Recommended for growing in kitchen gardens, backyards, farm road sides, as border crop in sugarcane, banana and betelvine and as a shade crop in turmeric and as a bund crop in paddy double cropped wetlands.
Season	:	June – July Height of the plant: 150 - 200 cm Number of branches 7 - 10
Flowering	:	Five months from date of sowing
Pit Size	:	Small pits are dug 90 cm apart and the pits are filled with a mixture of well decomposed manure or compost and soil.

Fertilizer application	:	Urea 15 g and Superphosphate 30 g / pit.
Planting methods	:	Two to three seeds are dibbled per pit and watered. When they grow six inches height one plant may be retained in each pit.
Irrigation	:	Need based
Harvesting	:	If harvested when the pods are tender the beans will be fit for making curry. Each plant will yield two to three kg of green pods at an average seed yield of 750 g to one kg per plant. After the first harvest the branches are pruned and allowed to grow further. In another 45 - 60 days the plants produce the second flush. For pure crop, about 3 kg of seeds may be required.

(ii) BLACKGRAM (*Vigna mungo*)

Climate Requirement

T_Max°C	T_Min°C	Optimum °C	Rainfall mm	Altitude m MSL
40	20	27 - 30	400 – 600	1800

Tropical and subtropicalhot and humid growing season. It is generally grown in kharif/rainy and summer season. Heavy rains during flowering stage are harmful to yield of pea crop.

CROP IMROVEMENT

1. SEASON AND VARIETIES

District/Season	Varieties
Adipattam (June-August) All districts except Kanyakumari and Nilgiris	VBN 6, VBN 8