

PRODUCTION TECHNOLOGY AND POST-HARVEST HANDLING OF SUMMER GREEN GRAM IN CENTRAL INDIA

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¹Venkteshwar Jallaraph*, ²Pragya Singh and ²Rajendra Verma

¹ICAR - Agricultural Technology Application Research Institute, Zone-IX, Jabalpur (M.P.),
India.

²Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya, Gwalior (M.P.), India.

Email: vjallaraph@gmail.com

Green gram is one of India's most valuable pulse crops. Green gram is a native of India and Central Asia and has grown in these regions since prehistoric times. Green gram is widely cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia, South China, and Formosa. Green gram (*Vigna radiate*) is an annual herb with a height of 45-75 cm that belongs to the Leguminosae family. It is an erect to sub-erect, deep-rooted, heavily branched, and very hairy annual herb. Plants are usually branched, and the cultivated types' habits range from erect to sub-erect. It may tend to twine sometimes. The stem is furrowed, squarish, and hairy with green and purple pigmentation, and the root system is an extensive taproot. Nodules on the roots fix atmospheric nitrogen through a symbiotic relationship with the bacterium *Rhizobium*. When mature, the pod colour ranges from brown to light grey. Green gram is a high-protein (around 25%), which is almost three times that of cereals and low-carbohydrate staple food. It meets the protein needs of the country's vegetarian population. In addition to being an essential source of human and animal nutrition, green gram helps to maintain soil fertility by enhancing soil physical properties and fixing atmospheric nitrogen. It is a drought-resistant crop that is well-suited to dryland farming and is commonly used as an intercrop.

Soil and Climatic Requirements

Green gram thrives in rich, sandy loam soils with excellent internal drainage and a pH of 6.3 to 7.2. For best results, it requires slightly acidic soil. On more alkaline soils, it cannot withstand salinity and can develop extreme iron chlorosis symptoms as well as micronutrient deficiencies. On heavy clays, root growth can be restricted. Green gram is a warm-season crop that takes 60-65 days to mature from seed to harvest in the summer season. The ideal

temperature range for plant growth is 27°C to 35°C. Green gram is heat and drought resistant since it can withstand higher temperatures. The green gram responds to the day length. Short days result in early flowering, while long days result in late flowering. Different green gram varieties vary in their photoperiod response.

Field Preparation

For proper germination and crop establishment, a well-prepared seedbed is needed. To make the seedbed free of clods and weeds, 2–3 ploughings followed by planking are needed. For summer cultivation after the harvest of preceding crops, pre-sowing irrigation before tillage should be ensured. If there is no wheat straw in the field, summer green gram can be grown without any preparatory tillage after the wheat harvest with the aid of a zero-till drill. Zero tillage saves time, resources, and money. Carbaryl 5 percent powder should be mixed during the last stage of field preparation in sandy soils where termite infestation is common.

Choice of Variety

The choice of variety depends on the prevalent cropping system, time of sowing, and source of irrigation in the area of cultivation. The varieties which mature in 60-65 days are appropriate for the summer season. Cultivation of short-duration varieties in summer ensures that the succeeding crop is sown well in time besides saving the crop from damage due to early summer monsoon showers, which may lead to deterioration of seed quality and pre-harvest sprouting of grains. The summer varieties should have good initial vigour and grow profusely in the first 25-35 days so that they are well established before the onset of flowering. The green gram varieties cultivated in Madhya Pradesh and Chhattisgarh state are given in Table.

| State | Name of varieties |
|-------------------------------|---|
| Madhya Pradesh & Chhattisgarh | Malviya Janchetna (HUM-12), Malviya Jankalyani (HUM-16), TJM-3, IPM-02-03 (Diksha), Azad-1, Swati, MH 421, PDM-139, HUM-1, BM-4, Type-9, Type-44, K-851 |

Sowing Time

Summer green gram should be sown as soon as the previous crop is harvested (wheat, mustard, cotton, potato, sugarcane, mustard, and cotton, etc.). The first fortnight of March is

most suitable for the sowing of the summer crop. Due to high temperature, the late sown green gram suffers more losses during the flowering stage and reducing yield.



Crop Geometry and Seed Rate

Seeds should be sown in 4 to 5 cm deep lines in a well-prepared seedbed with a good of moisture. If the surface layers are dry, the seed depth can be increased in those soils which do not form crust. The crop should be sown at a row spacing of 20 to 25 cm, with a seed rate of 20–30 kg/ha recommended for the summer season. A slightly higher seed rate is recommended for broad seeded varieties. Sowing can be done behind the local plough or with the help of a seed drill.

Seed Inoculation or Seed Dressing

For the prevention of soil and seed-borne diseases and better yield, seeds should be treated with antifungal bioagents, Rhizobium, and Phosphorus Solubilising Bacteria (PSB). Seed should be treated with 5–10 g Trichoderma or 2.5 g Thiram or 2 g Carbendazim/kg of seed for the prevention of soil-borne diseases. After seed dressing, the seed should be mixed with Rhizobium culture. One packet of Rhizobium culture (250g) is sufficient for a 10 kg seed. Rhizobium treatment increases nodule formation, leading to a 10-15% increase in yield, and also minimizes the use of nitrogenous fertilizers for the subsequent crop. Rhizobium culture is more significant for the summer crop as the number of natural microbes decreases during this season. For seed treatment, 50 g of molasses should be mixed with a half-liter of

water and 250 g of Rhizobium (local strain to be preferred). The mixture should be used to treat 10 kg of seed. The treated seed should be dried in the shade for 2-3 hours before sowing.

Fertilizer Requirement

In green gram, nitrogen fertilizer is typically not needed at higher doses because the crop fixes a significant amount of nitrogen on its own. Green gram grown after potatoes, peas and mustard, does not need nitrogen because the available residual nitrogen is adequate for this short-term crop. Green gram, like other legumes, has phosphorus, potassium, calcium, magnesium, and sulphur requirements that must be met with exogenous fertilizer if the soil is deficient in these nutrients. Phosphate fertilizer is usually required at a higher amount in irrigated crops or on severely P-deficient soils. It is always advisable to conduct soil tests and follow the recommended schedule, of fertilizer use while considering the anticipated yield. 10 kg nitrogen and 35 kg phosphorus should be added at the time of sowing for summer green gram grown after wheat.

Irrigation Management

Summer green gram is grown under assured irrigation only. This crop needs less water than many other crops due to its shorter life cycle. The flowering and early pod fill stage is the most crucial period for irrigation. It is essential to manage irrigation carefully to provide sufficient moisture at the time of pod filling, but it should not be high enough to delay the maturity. Depending on the climatic conditions and the soil's water holding capacity, 3–4 irrigations are usually adequate for the summer season green gram crop.

Weed Management

Crop-weed rivalry peaks between 20-25 days after sowing. Weeds reduce the grain yield of a green gram by 30-50 percent. However, the extent of the loss varies depending on the intensity and type of weed flora. *Cyperus rotundus*, *Amaranthus viridis*, *Trianthema monogyna*, *Digitaria sanguinalis*, and *Ageratum conyzoides* are the most common weeds in the summer green gram crop.

*Amaranthus viridis**Ageratum conyzoides**Trianthema monogyna**Cyperus rotundus**Digitaria sanguinalis*

As a result, it's important to pay close attention to their management. Hand weeding is advantageous around 20-25 days after sowing. Hoeing by hand should be performed once or twice to encourage good cultivation practices. To remove weeds before flower initiation, rotary hoeing should be done as appropriate. Weeds that emerge late have a smaller impact on yield than weeds that emerge early. Pendimethalin 30 EC @ 3.75 ml/l can be used as a pre-emergence spray in green gram to effectively suppress weeds.

Plant Protection of Green Gram

Major Diseases and their Management

a) Yellow Mosaic Virus Disease

Yellow Mosaic Virus, a member of the Geminivirus family, causes this disease, which is spread by whiteflies (*Bemisia tabaci*). Yellow mosaic spots appear on the tender leaves, which grow larger over time and eventually turn completely yellow. Flowering and pod growth are hampered by yellowing. Early infection often leads to necrosis and the death of plants.



Control measures

- 1) Grow-resistant varieties reduce the infestation of yellow mosaic virus disease in green gram.
- 2) Diseased plants should be rouged out and buried or destroyed to prevent the further spread of the disease.
- 3) Whitefly (*Bemisia* spp.) infestation may be controlled by the spray of Triazophos 40 EC or Malathion 50 EC @ 2.0 ml/l or Oxydemeton methyl 25 EC @ 2.0 ml/l at 10-15 days intervals if required.

b) Macrophomina Blight (*Macrophomina phaseolina*)

Root rot, collar rot, seedling blight, stem rot, leaf blight, pod, and seed infection are all caused by *Macrophomina phaseolina* in green gram. The fungus causes seed rot and seedling mortality during the pre-emergence period. Seedling blight occurs in the post-emergence stage as a result of soil or seed-borne infection. The primary signs are secondary root decay and tap root cortex shredding. At ground level, the fungus attacks the stem, causing localized dark brown patches to coalesce and encircle it. On the outer tissue of the stem and root, black dots resembling sclerotia appear on the surface and beneath the epidermis. The disease develops rapidly and causes severe infestation under high temperature and water stress conditions.



Control measures

- 1) The diseased plants should be uprooted and destroyed so that the sclerotia do not form or survive.
- 2) Seeds treated with Trichoderma @ 5–10 g/kg of seed or Captan 75 WP @ 2.5 g/l and Thiram 80% WP @ 2 g/l before sowing provides significant protection.
- 3) The crop should be sprayed with Carbendazim 50 WP @ 1.0 g/l at an interval of 15 days with the appearance of the symptoms.

c) Rhizoctonia Blight (*Rhizoctonia solani*)

Rhizoctonia is a fungus that grows in soil. *Rhizoctonia solani* is the fungus that causes blight. It begins with the leaf lamina, petioles, or young branches. Eventually, the top of plants become blighted, and patches of such plants are conspicuously seen in the field. In humid conditions, a whitish web-like growth appears on the leaves. Infected tissues produce dark brown sclerotia. There are several collaterals and alternate hosts, including the prevailing weeds, which are the source of infection to the green gram.

Major Insects and their Management

a. Thrips (*Megaluro thrips distalis*)

Thrips (*Megaluro thrips distalis*), tiny dark brown insects that feed on the stigma within the flower, summer green gram, causing the flower to shed before opening and the terminal shoot to elongate. In case of serious infestation, the plants grow bushy, and the plant turns dark green, bearing few pods with shriveled grains. Sometimes there may be a complete failure of the crop.



Control Measures

- (1) Timely irrigation at an interval of 15 days results in the low build-up of thrips.
- (2) Seed treatment with Thiomethoxam 70 WS 0.2% + foliar spray of Thiomethoxam 25 WG 0.02% is quite effective in controlling thrips.
- (3) Spray the crop at bud initiation stage with triazophos 40 EC @ 2.0 ml/l or dimethoate 30 EC or melathion 50 EC @ 2 ml/l.
- (4) Spray Neem Seed Kernel Extract (50 g/l) and neem oil 3000 ppm @ 20 ml/l.

b. Tobacco Caterpillar (*Spodoptera litura*)

The tobacco caterpillar is a polyphagous pest. Its moth lays eggs in masses on leaves. After hatching, first and second instar larvae feed gregariously on the leaf surface for about 2-3 days and leave behind the whitish membranous leaf only. In the solitary phase, the fully-grown larvae scatter throughout the entire field. The larvae make irregular holes on the leaf surface, and in severe infestation, they skeletonize the foliage and destroy the crop.



Control measures

- (1) Egg masses and young larvae feeding on leaves should be collected and destroyed to reduce infestation.
- (2) Foliar spray of Malathion 50 EC @ 2.0 ml/l or Novaluron 10 EC @ 0.75 ml/l is quite effective.
- (3) A spray of microbial pesticides like SNPV [500 LE/ha or 500 ml (1x10⁹ POB/ml)] or *Bacillus thuringiensis* formulations in synchrony with early larval instars is effective against the pest.

c. Pod Borer (*Helicoverpa armigera*)

Helicoverpa being a polyphagous pest of crops, also infests green gram. The immature larvae of the borer feed on leaves, flowers, pods, and seeds in pods, thus causing heavy losses in yield. Pod borer defoliation is characterized by rounded chew marks and angular holes. A high population in the drought-stressed crop can cause considerable damage if vegetative terminals and stems are eaten.

**Control measures**

- (1) Spray Spinosad 45 SC @ 150ml/ha at the appearance of larvae in the field.
- (2) Spray of Emamectin benzoate 5 SG @ 0.2 g/l effectively manages the larval population or Profenopohos 50 EC @ 2 ml/l or rynaxypyr 20 SC @ 0.15 ml/l.
- (3) Spray HaNPV @ 1ml/l or NSKE or crude neem 5% @ 50 g/l or neem oil 3000ppm @ 20ml/l.

d. Whitefly (*Bemisia tabaci*)

Whitefly nymphs and adults suck sap from leaves and make the plants very weak, showing downward cupping of the leaves, giving a sickly look, and the plant may die eventually due to severe attack of the pest. The insect secretes honeydew, which promotes the development of sooty mould, resulting in leaf blackening, a drastic reduction in photosynthetic rate, and leaf drying, ultimately leading to crop failure. The whitefly is a carrier of a variety of viruses, including the green gram yellow mosaic virus (YMV).



Control measures

- (1) Seed treatment with Imidacloprid 17.8 SL @ 3ml/kg of seed and 2 sprays of Imidacloprid 17.8 SL @ 0.2ml/l at 15 days of intervals is effective in reducing the incidence of whitefly and YMV disease and is a common practice.
- (2) Spray Acephate 75 SP @ 1.0 g/l and neem oil 3000 ppm @ 20 ml/l for reducing the whitefly population and YMV incidence in green gram.

Harvesting and Threshing

Summer green gram matures in 60 to 65 days. However, pod maturity is generally not uniform because the plants use to flower over an extended period. Therefore, it is sometimes difficult to decide a suitable time of harvest of the crop. Regardless, harvesting should start when two-thirds of the pods are mature. Harvesting immature pods too early can result in losses, while harvesting too late can result in pod shattering losses. Harvesting is done either manually or by machines. Green gram stalks with pods should be sun-dried for 3-4 days after harvesting. Spike tooth type power thresher for wheat with some modifications can be used for threshing green gram.

Harvesting Care

During harvesting, proper care should be taken to minimize quantitative and qualitative losses. *The Following caution should be taken during harvesting:*

- Harvesting should be done at proper maturity to ensure optimum grain quality and consumer acceptance.
- Harvesting before the crop's maturity usually results in lower yields, a higher proportion of immature seeds, poor grain quality, and more chances of infestation during storage.

- Delay in the harvesting of green gram results in shattering of pods and other losses caused by birds, rats, insects, etc.
- The best time to harvest the crop, when large i.e. 80 percent of the pods are fully matured.
- Avoid harvesting during adverse weather conditions i.e. rains and overcast weather.
- Use the right kind of harvest equipment for harvesting green gram (sickle).
- Avoid pest infestation before harvesting.
- The harvested bundles should be kept in one direction to ascertain efficient threshing.
- Keep the harvested bundles for drying in the field after cutting on the threshing floor, if weather permits.
- The harvested produce should be stacked in a dry, clean place in a cubical way to facilitate the circulation of the air around.
- Rogue out the admixtures before harvesting.
- Keep the harvested Green gram separately from one variety to another to get true to type variety (grains).

Post-Harvest Handling

There is a sizeable quantitative and qualitative loss of green gram during different post-harvest operations like threshing, winnowing, transportation, processing, and storage. Hence, it is appropriate to give due emphasis to reduce qualitative as well as quantitative losses of green gram during post-harvest operations. It has been reported that about 2.38 percent of losses occurred during post-harvest operations at the producers' level. The details are as under:

Estimated Post-Harvest Losses of a Green Gram at Producers Level

| Sl. No. | Stages | Production loss (%) |
|---------|---|---------------------|
| 1. | Losses in transport from field to threshing floor | 0.67 |
| 2. | Losses in threshing | 0.63 |
| 3. | Losses in winnowing | 0.61 |
| 4. | Losses in transport from threshing floor to storage | 0.19 |
| 5. | Losses in storage at producers level | 0.29 |
| | Total losses at producers level | 2.38 |

Source: Report on Marketable Surplus and post-harvest losses of a Green gram in India-2002, DMI

The post-harvest losses of a green gram can be minimized in the process of threshing, winnowing, storage, processing, handling, and transportation.

(a) Threshing and Winnowing

It has been reported that 0.63 percent losses occur during threshing and 0.61 percent losses occur during winnowing. To minimize losses, threshing and winnowing operations on the pucca platform must be completed in a short time using improved equipment.

(b) Transport Losses

It has been observed that 0.67 percent of the produce is lost during transportation from the field to the threshing floor. Transporting of produce from the threshing floor to storage results in 0.19 percent of the loss. To minimize losses, efficient and fast transportation is needed, as well as good packaging material.

(c) Processing

The loss at this point has been estimated to be up to 1% due to the use of old and obsolete processing methods. Improved dal milling method should be used to minimize milling losses and increase performance.

(d) Storage

Bean weevils can be controlled by storing seeds with about 12 percent moisture in standard grain bins that have been fumigated. If seeds have moisture content greater than 12%, they can be dried by blowing unheated air through thin layers until the moisture content is close to or equal to 12 percent. Bruchids can cause up to 100% losses if the crop does not care properly. These are reported to infest the crop at the drying stage and in barnyards; however, they generally attack under storage conditions. The adults are small brownish beetles, with characteristic emarginated eyes. Eggs are laid, stuck on the outer sides of the pods by the female beetle which may lay up to 90 eggs. Eggs are laid directly into the seed if the pods have dehisced. The newly emerged larvae bore into the seeds and feed on them. For control of this pest, stores should be cleaned and the residual bruchid population should be destroyed. Seeds can only be stored in boiled and dried gunny bags. During storage, a loss of

around 7.5 percent is estimated due to inefficient and ineffective storage methods. Quantitative losses are mostly caused by spoilage, driage, or loss of a portion of the produce, as well as insect, rodent, or bird infestation. Improved scientific storage facilities should be adopted to reduce the losses considerably.

Conclusion

Green gram is a most important pulse crop with around 25% protein content which is almost three times that of cereals. It meets the protein needs of the country's vegetarian population. In addition to being an essential source of human and animal nutrition, green gram helps to maintain soil fertility by enhancing soil physical properties and fixing atmospheric nitrogen. In green gram, there is a sizeable quantitative and qualitative loss of green gram during different post-harvest operations like threshing, winnowing, transportation, processing, and storage. It has been reported that about 2.38 percent of losses occurred during post-harvest operations at the producers' level. Proper post-harvest operations practices should be adopted to reduce qualitative as well as quantitative losses of green gram in the summer season.

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