

Production Technology Of Mash Bean

BLACK GRAM:

Common Names: Urd bean, mash bean

Botanical Name: *Vigna mungo*

Introduction:

Pulses are the most important source of vegetable protein in Pakistan. They are cultivated on 5% of the total cropped area. Their use ranges from baby food to delicacies of the rich and the poor. Major pulse crops grown in the country are chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), mung bean (*Vigna radiata*), black gram or mash (*Vigna mungo*) and khesari (*Lathyrus sativus*). There are other summer and winter pulses such as pigeonpea (*Cajanus cajan*), Cowpea (*Vigna unguiculata*), moth bean (*Vigna aconitifolia*), common beans (*Phaseolus vulgaris*) and faba bean (*Vicia faba*). These minor pulses are grown on small areas.

The total area under major pulse crops in Pakistan is about 1.5m hectares. Among these pulses, chickpea is the major winter food legume and mung is the major summer legume. Chickpea occupies 73% of the total pulses area with 76% contribution to the total production, whereas mung bean occupies 18% of total area devoted to pulses contributing 16% to the total pulses production. The black gram and lentil, each are cultivated on 5% of the total pulses area and each of them contributes 5% to the total pulses production.

Nomenclature:

Kingdom:	Plantae
Sub-kingdom:	Angiosperms
Order:	Fabales
Family:	Fabaceae
Subfamily:	Faboideae
Tribe:	Phaseoleae
Genus:	Vigna
Species:	<i>V. mungo</i>

Black gram is a short duration crop; it fits well in many intensive crop rotations. It is also used as green manure crop. It is mainly consumed as daal or split seeds (husked and unhusked) and husked daal is ground into a fine paste and allowed to ferment with rice flour to make traditional foods. The peculiarity of black gram is when ground with water develops mucilaginous character giving additional body to the mass. It contains 25% protein, 1.83% fat, 61.0% carbohydrate. Haulms are used as fodder. Husk and split beans are useful as livestock feed. It possesses deep root system, which binds soil particles and prevents erosion.

It is consumed in the form of split pulse as well as whole pulse, which is an essential supplement of cereal based diet. The combination of dal-chawal (pulse-rice) or dal-roti (pulse-wheat bread) is an important ingredient in the average Pakistani diet. The biological value improves greatly, when wheat or rice is combined with Black gram because of the complementary relationship of the essential amino acids such as arginine, leucine, lysine, isoleucine, valine and phenylalanine etc.

In addition, being an important source of human food and animal feed, it also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Being a drought resistant crop, it is suitable for dryland farming and predominantly used as an intercrop with other crops.

Composition of black gram:

Approximate analysis of nutrients in 100g of edible portion of blackgram:

Component	Amount
Protein (%)	20-25
Fat (%)	1.3
Ash (%)	3.40
Crude fiber (%)	4.2
Starch (%)	40 – 47
Vitamins	
Vitamin A (IU)	300
Vitamin B1 (mg / 100g)	0 .52- 0.66
Vitamin B2 (mg / 100g)	0.29 – 0.22
Niacin (mg / 100g)	2.0
Vitamin C (mg / 100 g)	5

Minerals	
Iron (mg / 100g)	7.8
Calcium (mg / 100g)	145

Origin and domestication:

It is cultivated in India, Pakistan, Bangladesh, Myanmar and Sri Lanka. India has been universally accepted as the original home of this crop. While green gram spread to many countries, especially in tropical and subtropical Asia, the black gram has remained more or less confined to South Asia. Currently, the green gram is being grown in USA. The progenitor of both black and green grams is believed to be *Vigna trilobata*, which grows wild in India.

Botanical description:

Black gram [*Vigna mungo* L] belongs to family Leguminosae. The plant attains a height of 30 to 100 centimeters, with stem lightly ridged, covered with brown hairs and much branches from the base. The leaves are large, trifoliolate and are also hairy, generally with a purplish tinge. The pods are long and cylindrical and about 4 to 6 centimeters in length. There are four to ten seeds in a pod. The seeds are generally black or very dark brown. This crop is itself a mini-fertilizer factory, as it has unique characteristics of maintaining and restoring soil fertility through fixing atmospheric nitrogen in symbiotic association with *Rhizobium* bacteria, present in the root nodules. Crop is suitable for inter cropping with different crops such as cotton, sorghum, pearl millet, green gram, maize, soybean, groundnut, for increasing production and maintaining soil fertility.

Like green gram, blackgram is an annual, semi-erect to spreading herb growing to a height of 25-90 cm. Stems are diffuse, branching sometimes procumbent, and covered with long dense brown or black hairs. It possesses strong tap root system with many laterals. Leaves are pinnately trifoliolate, hairy with large ovate to lanceolate and entire leaflets. Flowers are pale yellow, small with a yellow spirally coiled keel. The flowers are borne in clusters of 5-6 on a short hairy peduncle in axillary racemes. Pods are short, erect to sub erect, 4-7 cm long and 0.6 cm wide, brown to black in colour, hairy and with stout hooked beak, containing about 6-10 seeds. Seeds are small, oblong slightly truncated at ends measuring 4-5.2 mm. long and 3.5-4.1 mm wide; thousand seeds weight is around 40 gm with varying colour from black, dark brown to green. The testa is smooth and hilum white and concave. Pods do not shatter readily. Flowers are self-fertile and self pollinated. Flowering is indeterminate.

Production Technology:

Soil and climate:

Black gram is cultivated as rain-fed crop in cool hills and warm plains. It can also be grown up to a height of over 2,000 meters. It's claimed that the black gram's cooking quality is vastly improved when it's nurtured in the hills containing a moist climate of sorts. Heavy soils or at least those that are stiff loamy

and water retentive are the best type of soils for this plant. It also grows quite rapidly on brown alluvium and black cotton soils.

As tropical crop blackgram tolerates high temperature. It is cultivated both in kharif and summer seasons. It needs warm weather and due to the same reason the crop is grown during rainy season and summer season in North India. However in central parts it is grown during rainy as well as winter season. It is a short-day plant, but day neutral cultivars are available for cultivation in the long-days of summer. The optimum temperature for better growth ranges between 25 to 35 C but it can tolerate up to 42O C. It is a hardy and drought resistant plant, and can be grown in areas receiving moderate to low rainfall. It is sensitive to cloudy weather and cannot tolerate frost. It requires heavier and water retentive soil in places where rainfall is scanty, but in humid regions it is mainly grown in uplands. It is grown mostly as rainfed crop and relayed with maize in the drier areas in Sikkim. It is also grown on paddy field bunds. The crop is grown in the lower and mid-hill up to an elevation of 1400 meters.

Cultivation and Sowing:

The land requires a plough or two plus harrowing to attain a rough tilth (soil that has the proper nutrients and structure to grow healthy crops) for the pure crop during the kharif season. The black gram can be sown dry within furrows between the rows of the other crop, which is then followed by water irrigation. Depending on the climate, variety grown, and agricultural conditions of the region, sowing also entails doing it every early spring or February or June to July or the rainy season or October to November or autumn.

Ideal soils are well drained loam or sandy loam. Optimum pH range is 5.5–7.5. It is generally grown in areas which receive annual rainfall of 800 mm.

Field Preparation and Sowing:

Although balckgram does not require fine tilth better land preparation results in good germination and uniform stand of the crop. It also helps the crop to achieve higher seedlings vigour and early growth. Heavy soils need more cultivation with either plough or disking, followed by harrowing and land leveling, while the light soils will be ready with less cultivation. One or two deep cultivations, 2-3 harrowing and single planking would give better seedbed for blackgram. During Kharif, attention should be given to proper land leveling and drainage as any water stagnation affects the crop adversely when the sowing is done in the rice fallow, seeding can be done without cultivation, as it requires time to come to proper condition after tillage. In post-rainy season crop soil moisture conservation practices improve the crop yield. After the crop establishes, 1 or 2 intercultivations check the evaporation losses of moisture and reduce the weed population. Intercultivations also aid in better root proliferation.

Seed and Seed treatment with Rhizobium culture: Quality seed is the basic input needed to ensure good crop stand and ultimately higher yield. In spite of development of number of improved varieties of different pulse crops, their availability and popularity among farmers is low due to lack of systematic seed production and distribution facility.

Biofertilizers like Rhizobium leguminosarum atmospheric nitrogen to the tune of 10-25 kg/ha. The efficiency of these crop specific bacteria depends on the specific strains and efficiency also increases in presence of a good amount of organic matter, cobalt and molybdenum micro-nutrient, P, K, Ca, Mg and

low amount of nitrogen in soil. Some heterotrophic bacteria and fungi are known to have the ability to solubilize/mobilize inorganic phosphorus from insoluble sources. Important phosphate solubilizing microorganisms are Phosphobacterium, Pseudomonas, Bacillus, Aspergillus and Pencillium.

Seed treatment with slurry of Rhizobium and PSB (Phosphate Solubilizing Bacteria) is the right and effective method of application for getting maximum response

Note: The seeds should not be exposed to direct sunlight or it will hamper the activity of the microorganisms. 400-600 gm each Rhizobium and PSB are sufficient for treating 15 kg seeds for one hectare.

Planting time:

The blackgram is basically a hot season crop exhibiting tolerance to higher temperature and susceptibility to cold and frost. In northern parts of the county, where the temperatures during winter are quite low, it is cultivated only during the rainy season. i.e. from middle of June to middle of July. However, in the eastern states it is also grown during winter. In the central and southern states where there is not much variation in climate, it is cultivated both during summer and rainy season. Despite the slight variation in optimum date of sowing during different seasons depending on agro-climatic zone, variety and soil conditions sowing between mid-June to mid-July is found to be optimum time for kharif season. Early planting in first week of July result in higher yield and any delay in sowing beyond this date causes reduction in yield. The optimum time for sowing the summer crop is during March. In Sikkim the optimum time of sowing is during the months of July to August.

Seed Rate:

In blackgram a seed rate of 12-15 kg/ha for kharif sowing and about 20-25 kg/ha for summer sowing would be optimum. If pulses are raised in intercropping systems the seed rate depends on the proportion of area available for them.

Spacing: In blackgram, a row to row spacing of 25-30 cm and plant to plant spacing of 5-10 cm has been found to be optimum for summer crop. A wider spacing of 30-45 cm between rows and 5-10 cm within rows is optimum for kharif crop. optimum spacing is 30 x 10 cm.

Field preparation:

The land is prepared to get fine tilth using disc plough and country plough and beds and channels are formed. To tide over surface soil crusting, application of lime @ 2 t/ha along with 12.5 t/ha FYM or composted coir pith is done to get additional yield of 15–20%.

Season:

It is grown as kharif and summer crop in most of the areas but it is also being grown as rabi crop in a few areas.

Seed and sowing:

It is highly recommended to preserve of seed for sowing in the next season. As pointed out earlier, the seed for sowing was to be exposed to dew and sunlight for 3–5 days.

Water and Irrigation:

The residual moisture in maize fallows is usually adequate to get a good crop of black gram. In areas where the crop is raised under irrigated condition in summer, irrigation is necessary to save the crop from soil moisture stress and high temperatures. The time and number of irrigation depends on the soil moisture conditions and duration of the variety. In all 4-5 irrigations at an interval of 10-15 days may be required in most of the areas. The crop should be irrigated at flowering and pod filling stages but the water should not accumulate in the field. Pod-filling stage is the most important critical stage in terms of moisture stress. Three irrigations gave higher seed yield than one or two irrigation. If 2 irrigations are available, then it should be applied at branching and at flowering.

Weed Management:

The first 4-5 weeks after sowing is critical for crop weed competition i.e. 30 days after sowing. The extent of damage due to weeds can be as high as 50-60%. Good seedbed preparation, one or two manual weeding within days after sowing may effectively control the weeds.

Varieties of Mash Bean:

MASH 97

Type: Mash, Urd, Black gram, (*Vigna mungo*).

Parentage: Local cross: Selection from local land races.

Check: Mash 88

Breeders: Ali, A. et al.

Center: Pulses Research Institute, (AARI), Faisalabad.

Maintainer: Pulses Research Institute, (AARI), Faisalabad.

Status: Released 1997. Registered 1999

Growth habit: Plants semi-erect in habit, early maturing (70-80 days), and lodge tolerant.

Height and branching: Plants medium tall (40-50 cm), semi erect in attitude and medium branched, stem anthocyanin and hairiness absent.

Foliage: Foliage medium dense, light green in color, medium hairy, leaflet length 9.5, width 7.0 cm, leaf rachis anthocyanin medium.

Flower: Flowering early (42-45 days). Flower size medium, color yellow, peduncle anthocyanin absent.

Pod: Size medium, 5-6 seeded, constrictions weak, pubescence absent, beak short, pods/plant 35-45, length 4.2, width 0.5 cm.

Seed yield kg/ha: 700-800

Seed: Seed size medium, length 4.4, width 3.4, mm, Seed shape drum, color light black, shiny, surface smooth, dots absent.

Seed weight: (g/000 seeds) 42.0 g.

Variants: Growth and branching varies when sown early, or late.

Leading characters: Mash 97 a variety of Mash, Urd. Plants medium tall growing, semi- erect in attitude with light green medium hairy foliage. Flower color yellow. Pod medium long, beak short, and without pubescence, brownish black at maturity, and generally 5-6 seeded. Seed size medium bold, shape drum, surface smooth color black shiny.

MASH 2:

Type: Mash, (*Vigna mungo*).

Parentage: Local selection

Check: Local mash

Breeders: Ghafoor, A. et al.

Center: NARC, Islamabad.

Maintainer: NARC, Islamabad

Status: Released 1993. Registered 1996

Growth habit: Semi erect, semi spreading, medium early maturing (70-75 days).

Height and branching: Plants short (40-50 cm), medium branching, semi erect in attitude, hairiness profuse.

Foliage: Foliage medium dense, green in color, profusely hairy, terminal leaflet medium, ovate, length 6-8, width 4-5 cm, petiole 9-11 cm, anthocyanin weak, senescence medium.

Flower: Flowering medium (40 days). Flower size medium, standard color yellow, peduncle anthocyanin weak.

Pod: Size medium, blackish brown at maturity, round with weak curvature, shatter low, 6-7 seeded, constrictions weak, pubescence profuse, beak medium, hooked, pods/plant 35-40, length 4-4.5 cm, width 4-5 mm.

Seed yield kg/ha: 1500-1600

Seed: Seed size medium, length 4.4, width 3.1 mm. Seed shape drum, color dull black.

Seed weight: (g/000 seeds) 48.0 g.

Variants: Growth and branching varies when sown early, or late.

Leading characters: Mash 2 a short duration mash variety. Plants short, semi erect, foliage green, profusely hairy, flower light yellow. Pod shape round, beak medium, hooked, pubescence profuse, blackish brown at maturity, and generally 6-7 seeded. Seed size medium, shape drum, dull and black.

MASH 3:

Type: Mash, (*Vigna mungo*).

Parentage: Local selection

Breeders: Ghafoor, A. et al.

Center: NARC, Islamabad.

Maintainer: NARC, Islamabad

Status: Released 1993. Registered 1996

Growth habit: Erect growing, medium early maturing (65-70 days).

Height and branching: Plants short (40-50 cm), medium branching, spreading in attitude, hairiness medium.

Foliage: Foliage medium dense, green in color, medium hairy, terminal leaflet medium, ovate, length 7-8, width 4-5 cm, petiole 10-11 cm, anthocyanin weak, senescence medium.

Flower: Flowering medium (35 days). Flower size medium, standard color yellow, peduncle anthocyanin absent.

Pod: Size medium, blackish brown at maturity, round to semi flat, with weak curvature, shatter low, 6-7 seeded, constrictions weak, pubescence profuse, beak medium, hooked, pods/plant 30-40, length 4-4.5 cm, width 4-5 mm.

Seed yield kg/ha: 1000-1200

Seed: Seed size medium, length 4.3, width 3.0 mm. Seed shape drum, color dull black, dot medium, cotyledon color whitish.

Seed weight: (g/000 seeds) 46.0 g.

Variants: Growth and branching varies when sown early, or late.

Leading characters: Mash 3 a short duration erect growing mash variety. 5-10 days earlier to Mash 2, growth habit erect growing as compared to semi spreading in Mash 2, plant canopy narrow as compared to medium in Mash 2. Seed black, surface dull and dotted.

CHAKWAL MASH:

Type: Mash, (*Vigna mungo*).

Parentage: Exotic selection

Check: Mash 97

Breeders: Ahmad, G. et al.

Center: BARI, Chakwal

Maintainer: BARI, Chakwal

Status: Released 2002. Registered 2004

Growth habit: Semi erect, medium early maturing (70-80 days).

Height and branching: Plants short (30-40 cm), medium branching, semi erect in attitude, hairiness absent.

Foliage: Foliage medium dense, light green in color, nonhairy, terminal leaflet medium, ovate, length 7-8, width 4-5 cm, petiole 12-14 cm,

anthocyanin weak, senescence medium.

Flower: Flowering medium (45 days). Flower size medium, standard color yellow, peduncle anthocyanin absent.

Pod: Size medium, blackish brown at maturity, round to semi flat, with weak curvature, shatter low, 5-7 seeded, constrictions medium, pubescence weak, beak medium, pods/plant 35-40, length 4-4.5 cm, width 4-5 mm.

Seed yield kg/ha: 1000-1100

Seed: Seed size bold, length 4.0, width 3.0 mm. Seed shape drum, color grayish black dots absent, surface medium rough.

Seed weight: (g/000 seeds) 46.0 g.

Variants: Growth and branching varies when sown early, or late.

Leading characters: Chakwal Mash a short duration mash variety. Growth habit semi erect, plant canopy medium leaf color light green, narrow, non hairy, flower color yellow, pod brownish black at maturity, curvature weak and constrictions medium, seed drum shaped, bold, surface medium rough and dotless.

MASH 88:

Type: Mash, (*Vigna mungo*).

Parentage: Local selection from farmer's field.

Check: Mash 80

Breeders: Ahmed, M. et al.

Center: PRI, AARI, Faisalabad

Maintainer: PRI, AARI, Faisalabad

Status: Released 1990. Registered 1990

Growth habit: Semi erect, medium maturing (90-105 days).

Height and branching: Plants short (20-30 cm), medium branching, semi spreading in attitude, hairiness medium.

Foliage: Foliage medium dense, medium green in color, medium hairy, terminal leaflet medium, ovate, length 12-15, width 4-5 mm, anthocyanin medium, senescence medium.

Flower: Flowering medium early (40-50 days). Flower size medium, standard color yellow, peduncle anthocyanin medium.

Pod: Size medium, black at maturity, round to semi flat, with weak curvature, shatter low, 6-7 seeded, constrictions medium, pubescence weak, beak medium, pods/plant 40-50, length 4-5 cm, width 5-6 mm.

Seed yield kg/ha: 1200-1300

Seed: Seed size medium, length 3.5, width 2.8 mm. Seed shape drum, color black, dots absent surface dull.

Seed weight: (g/000 seeds) 41.0 g.

Variants: Growth and branching varies when sown early, or late.

Leading characters: Mash 88 a medium long duration mash variety. Growth habit semi spreading, plant canopy medium leaf color green, medium hairy, flower color yellow, pod black at maturity, curvature weak and constrictions medium, seed medium, drum shaped, dull black, and dotless.

Seed treatment: Seed rate is 20 kg/ha for pure crop, 10 kg/ha for mixed crop, 25 kg/ha for rice fallows and 50 g/100m length for bund sowing. Chemical seed treatment is done with carbendazim or thiram @ 2 g/kg of seed then after interval of 24 hours, the seeds are treated with 3 packets (600g) suitable strains of Rhizobium biofertiliser with rice gruel 15 minutes before sowing. Instead of chemical, the seeds are treated with Trichoderma viride @ 4 g/kg or Pseudomonas fluorescence @ 10 g/kg followed by biofertilizer. For Pre-monsoon sowing, the seeds are treated with paste made of ash (500 g/kg of seeds) + 3% gum and drying is recommended for 5 hours.

Fertilizer application:

Application of 12.5 kg N + 25 kg P₂O₅/ha for rainfed crop and 25.0 kg N+ 50 kg P₂O₅/ha for irrigated crop as basally before sowing is recommended.

Cropping systems:

Intercropping is common practice where one or two rows of black gram with maize, pearl millet, sorghum, pigeon pea, cotton and sugarcane. This crop is rotated with maize-wheat-urd, maize-potato-urd, rice-wheat-urd in north India.

Diseases of Black Gram:

Blackgram is infested by a number of diseases but YMV, Leaf Crinkle, Leaf Blight, Powdery Mildew and rust are widespread in Sikkim. These are as follows:

Yellow mosaic virus of blackgram:

Causal Organism: Mungbean yellow mosaic virus (geminivirus) This virus disease is the most destructive disease of blackgram in India. It was first reported from Delhi in 1960 but is known to occur in other parts of the country also. It can attack pigeonpea also. The loss in yield depends upon the stage at which the crop is infected. If the infection is early in the season there may be total loss of yield from the crop.

Symptoms: The diseased plants start appearing in the field when the crop is about a month old. Two types of symptoms, depending on host response, are seen. The yellow mosaic in the form of yellow mottle is a more common and aggressive symptom on susceptible varieties of urdbean. Necrotic mottle symptoms of the disease depict a resistant reaction of the host and are observed on tolerant urdbean varieties.

The general pattern of development of both symptoms is the same. The first visible sign of the disease is the appearance of yellow spots scattered on the lamina surface. They are mostly round in shape. In yellow mottle, the spots are diffuse and expand rapidly. The leaves show yellow patches alternating with green areas which also turn yellow. Such completely yellow leaves gradually change to whitish shade and ultimately become necrotic. These colour changes of affected plants are so conspicuous that the disease can be detected in the field from a distance. In case of necrotic mottle, the centre of yellow spots develops necrosis which is demarcated by finer veins.

The virus becomes systemic in the plant and all newly formed leaves show signs of mottle from the very beginning. In case of attack of yellow mottle alone or with necrotic mottle there may be reduction in size of leaves. Number and size of pods per plant and seeds per pod are greatly reduced (Singh and Srivastav, 1985). The pods are deformed and contain shriveled, undersized seeds. The percent yield loss is higher in plants inoculated early in the season than in those inoculated in mid-or late season. Plants showing only necrotic mottle do not show reduction in size of leaves and pods.

Host Range: In India it has a large host range which includes, besides mungbean and urdbean, *Eclipta alba*, *Xanthium strumarium* and *Cosmos bipinatus*.

Mode of Transmission: In India, the Mungbean yellow mosaic virus is neither sap nor seed or soil transmitted. *Bemisia tabaci* (whitefly) is the only known vector. Female adults are more efficient vectors than males. Minimum acquisition feed time is 15 minutes and the same time is required for inoculation. Increasing feeding period up to 4 hours increases transmission ability. Latency (incubation period) in the vector is at least 3 hours, optimum being 5-6 hours. Pre-acquisition starvation of the vector increases efficiency to acquire the virus. A single viruliferous whitefly can transmit the virus but maximum infection is obtained with 10-20 whiteflies per plant. Neither female nor male adults can retain the virus throughout their life span. Normally, the adults retain infectivity for 10 days.

Control of plant viruses through control of vectors is often not very effective due to the fact that common insecticides do not cause instant death of all individuals in the vector population and even a very low surviving population is capable of spreading the disease rapidly. For this reason oil sprays have

been more effective since they immobilize the whitefly within 15 minutes. However, use of oil has not yet been popularized due to non-availability of suitable preparations and chances of phytotoxicity.

Leaf crinkle (blackgram leaf crinkle virus): Affected plants show crinkling leaves, on upper surface the stipules become thick and broader, buds and flowers give bushy appearance.

Sterility mosaic (blackgram sterility mosaic virus): No flower formation is the symptoms of this disease and the plants never come to bearing.

Control Measures:

Use of resistant varieties, removal of affected plants, and control of vectors like sucking insects by keeping light trap in the field.

Cercospora Leaf Spot (Caused by *Cercospora canescens* and *C. cruenta*)

Symptoms: The spots appear on leaves, gray to brown in colour and circular to irregular in shape. These spots increase in number and size, which turn into lesions of a reddish brown margin. The size of pods and seed is reduced, hence yield decreased considerably.

Perpetuation: The disease causing fungus is seed borne.

Root and Stem Rot (Sometimes known as charcoal rot, caused by *Macrophomina phaseolina*, *Rhizoctonia bataticola* and *R. solani*)

Symptoms: The disease is difficult to identify in initial stages. However, dark lesions are formed on the main stalk near soil level, forming localized dark green patches. The tissues of the affected portions become weak and shredded easily. If the plants will pull out, the basal stem and root may show dry rot symptoms.

Perpetuation: The disease causing fungi are soil borne and remain viable for long period.

Anthracnose (Caused by *Colletotrichum lindemuthianum* or *Gloeosporium phaseoli*)

Symptoms: All the aerial parts of the plants are infected by the disease causing fungus. Initially, small spots appear in scattered manner but later on they coalesce, giving rise to broad lesions, which become dead. The spots are usually depressed with dark centre and bright red or orange margins. Sometimes, such lesions are seen lenticular to circular sunken and tan to brown.

Perpetuation: The disease is seed borne, but secondary spread takes place by air borne.

Control:

Cultivation of disease resistant variety is only the most easy, economical and safe method. However, following measures could be beneficial if applied.

- Avoid the cultivation of gram in the diseased area for three years.
- Improvements of soil condition with good drainage minimize the disease incidence.
- Use of disease free seed or seed treatment with suitable seed dressing fungicides before sowing.
- Late and deep sowings reduce the incidence of the disease.
- Mixed croppings of gram with wheat, barley, rape, mustard, safflower, sorghum and millet help to check the disease.
- Diseased plants should be uprooted from the field and burnt. Avoid the making of bhusa stacks in the field.
- Sweeping the threshing floor and burning or burying all plant debris.

Insect pests: Blackgram suffers from a number of insect pests of which Gram pod borer, hairy caterpillar are important.

Gram pod borer (*Helicoverpa armigera*): It is found all over India and is widely distributed in the tropics and sub-tropics.

Damage and Symptoms: The caterpillars feed on the green plant parts and cause defoliation of young plants. Maximum damage is caused to the pods in which round wholes are found. Young larvae feed by scraping surface and older ones chew into flowers and pods destroying 30-40% of them before pupation.

Control Measures: The caterpillars could be handpicked in early stages and destroyed.

Hairy caterpillar (*Diacrisia obliqua*): It is a polyphagous pest of blackgram. The moth is medium-sized, pale yellow coloured with wings having black spots and 5 cm expanse.

Damage and Symptoms: The caterpillars damage the plants by eating leaves and soft portions of stem and branches. In severe case, plants may be completely denuded.

Control Measures: Since the first two instars are gregarious, they may be hand picked and destroyed in kerosene water.

Harvesting:

The plants are harvested when 80% of the pods are matured and the plants are stacked for few days before threshing. Time and method of harvesting depends on the nature of maturity. In varieties

exhibiting synchronous maturity, harvesting should be done by cutting entire plant at ground level when the plants show about 90% maturity. If the variety does not have synchronous maturity pods have to be harvested manually as and when they mature. This is a long and labour-intensive process accounting for 25-30% of the total production cost and 40-50% of the labour cost. Number of pickings and duration of harvest time depends on the variety. Pod picking should be done preferably during morning or evening hours to prevent shattering losses while handling the pods.

Harvesting care:

Following care should be taken during harvesting:

- Harvesting should be done timely. Timely harvesting ensures optimum grain quality and consumer acceptance.
- Harvesting before the crops mature, usually result lower yields, higher proportion of immature seeds, poor grain quality and more chances of disease attack during storage.
- Delay in harvesting, results in shattering of pods and other losses caused by birds, rats, insects etc.
- Harvest the crop, when a large percentage of the pods are fully matured.
- Separate out the admixtures of other crop prior to harvesting,
- Avoid harvesting during adverse weather condition i.e. rains and overcast weather.
- Avoid pest infestation prior to harvesting.
- Use proper harvest equipment i.e., sickle etc.
- All the harvested stems should be kept in one direction in order to ascertain efficient threshing.
- The harvested bundles should be stacked in a dry place. The stacking should be cubical to facilitate circulation of the air around.
- Keep the harvested stems for drying in the sun.
- Keep the harvested crop separately from one variety to another to get true type of variety

Postharvest:

The harvested produce is sun-dried in threshing yard and after the moisture level has come down, it is threshed by trampling wither by animals or tractor, or by beating with wooden sticks. The grains are separated from plant parts and other admixture by winnowing. Seeds are graded according to size by passing through appropriate sieve and separated from broken grains. The moisture content at the seed should not exceed 12% before being stored in godowns. The storage place should be dry and properly ventilated and free from insect, pest, pathogens and rodents.

Yield: The average yield is 600-700 kg/ha for rain fed condition, 1000–1300 kg/ha for irrigated and 500 kg/ha for rice fallow condition.

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