PRODUCTION TECHNOLOGY FOR HORSE GRAM IN INDIA

(Indian Council of Agricultural Research)

Central Arid Zone Research Institute, Jodhpur -342 003

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Compiled and Edited by

D. KUMAR

PC

National Network Project on Arid Legumes

(Indian Council of Agricultural Research)

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Superb

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Place : Jodhpur

Dated: 25 March, 2007

(D. KUMAR)

PREFACE

Scientifically less known but loaded with great utility, horse gram is characterized with substantial adaptation towards worst of the worse soil and climatic conditions; least inputs and aftercares. Notably, it is cultivated on wide range (200-700 mm) of rainfalls on a variety of soils: gravelly soils, sandy soils, shallow red soils, hard uplands, acid lateric soils (pH 5.5), black cotton soils, paddy soils, stony soils and even on recently cleared forests. Even though, horse gram is grown in more than 17 million ha of lands in majority of Indian states but 90-95% area of this drought hardy legume is confined to 5 major states: Karnataka, Orissa, Andhra Pradesh, Maharashtra and Tamil Nadu. It is a rich source of grain protein; calcium, iron, phosphorus and vitamins, essentials for Indian vegetarians. Cheap dietary, aurvedic and medicinal uses related attributes have reckoned this arid pulse as the livelihood of poor peasants, relishing on poor soils for a poor cause of survival.

Importance of horse gram is furthered by its compatibility in a number of cropping systems along with crops, grasses, trees in early and late sown situations of rainfed lands. The crop due to some inherited defects like, long maturity, experiencing terminal drought photo and thermo - sensitivity, higher biomass production and poor conversion have been investigated and laudable technological developments have been achieved which can certainly help increase production of this less known minor pulse without additional inputs. The cultivators cultivating horse gram are reluctant to use new technologies, either they are not aware of the expected results of technological advancements or they have lost faith in multi-directional race for maintaining high living standard. They have forgotten old rituals, traditions or sustained life supporting ecological resources.

Horse gram cultivators are however, fighting for continuing the race for survival only. Therefore, it becomes all the more important to feed these peasants for survival technologies. Once the farmers are convinced not to be reluctant of new technologies; the same will pay them the advancement which could be practical, real sensed and generating appealing production without additional expenditures. In this bulletin, the packages and the results have been chosen, which are simple, convenient and economic, in nature.

It is hoped that the present bulletin on *Production Technology for Horse gram* will provide a real, rare and required help to the horse gram cultivators across the growing conditions and zones in raising their production *pre-se*, generating rural income and stepping up slowly towards livelihood sustenance.

(D. KUMAR)

INTRODUCTION

Horse gram known as poor men's and a crop of poor resource, is widely grown in India in almost 200-700 mm rainfall situations at a temperature range of 20-35°C. So, called drought hardy, horse gram is typically adapted to a wide range of soils, as deep red, loams, black cotton soils, clayey paddy soils, sandy and shallow soils, stony and gravelly uplands, cleaned rough forests etc. Thus, type of soil is not a bar to horse gram cultivation. It is grown as a sole crop and in a number of combinations. Due to wide adaptation in terms of soil and climatic situations, horse gram is grown in almost all states of India but its 90-95% area is confined to five major states of Orissa (16.0%). Tamil Nadu (18.0%), Karnataka, (34.0%), Maharashtra (18.0%) and Andhra Pradesh (16.0%). Under harsher environmental situations and resource constraints crop conditions, horse gram is known as the immediate and ultimate choice of poor arid farmers. Due to such adaptive features, it ranks 3rd among Indian Pulses in areas (1.7m ha), with a total production of 0.74 m ton. The productivity of the crop is rather poor being 494 kg ha^{-1} against 539 kg ha^{-1} for grain legumes as a whole. However, production contribution is about 28% for Karnataka, 18% for Tamil Nadu and about 10% for Maharashtra, Orissa and Andhra Pradesh, each.

ORIGIN AND DISTRIBUTION : Horse gram in India has been grown since pre-historic time and India is understood to be the centre of its origin. Out of 240 species related to horse gram, however only 23 are found in India and others are found in Africa, therefore, some reports do incidate Africa as the source of origin. According to recent classification horse gram belongs to the subfamily Fabodiae of family Fabaceae. Unless recently it was considered in genus *Dolichos*. But Verdecourt (1982), while studying it in detail grouped in genus *Macrotyloma* and named it *Macrotyloma uniflorum*. One more species, viz; *M. axillare* identified under this genus, is grown in wild condition, is a source of YMV and largely grown for fodder purpose.

BOTANICAL DESCRIPTION : Horse gram is an annual succulent herb, slender, downy, slightly twining branching, springing from the base of the plant, semi-erect, low growing habit with 30-35 cm height, leaves with 2.5 to 5.0 cm in length, are trifoliate. Stipules are 1 cm long, ovate lanceolate, minute stipules. Peduncles are short, bracteate, pedicellate, bisexuals, zygomorphic, complete. Calyx are downy teeth lanceolate, corolla are light yellow, petals are five, standard longer than wings, stamens diadelphos (9+1), filaments are alternately short and long anthers, introse, uniform diversified. Gynacium is with superior ovary. Style file from terminal, curved, stigma capitate and hairy. Pods are linear, recurned beaked with 5-7 seeds. Seeds are normal, flattened, 3-6 mm long, light red, brown, black or mottled, testa skinny, hilum small. Horse gram is a self fertilized crop matures in 3 to 4.5 months.

USES : It is consumed as whole seed, sproute or whole meals along with cereal flour by the rural polulation. Poor cooking quality has rendered restricted use of dry seeds. In Southern India, it is used in various tasty preparations such as *curry*, *papad*, etc. A mixture of five crops, (horsegram + Indfian bean, cow pea, niger and castor) *Panch dhani* is grown by Karnataka farmers to combat drought. This crop is said to have several medicinal properties for curing cough and bronchitis, kidney trouble and irregular periodicity of mensutral cycle. Utilimately horsegrm is understood to be the legumes of poor rural masses for them, for their livestock and for the soil health.

Horse gram is known as the cheapest source of vegetable protein. The seeds contain 18.5 to 31.0% protein with an average of 27.0%. On an average basis this legume contains 57.2% carbohydrate, 0.5 % fat and 3.2% minerals and is also a cheap source of vitamins, calcium and iron. However, sulphur containing amino acids (cystines and methionine) account for lower scores. In additions to presence of typsin inhibitors, horse gram is known to have some growth inhibiting factors, which can easily be inactivated on autoclaving.

ANTI-NUTRITIONAL FACTORS : Presence of oligosaccharides in seed of horse gram lead to flatulences production in human beings and animals. Anti-nutritional factors present in horse gram seeds are: typsin inhibitors, phytic acid and amylase inhibitors. However, on soaking and cooking effects of flatulences and anti-nutritional factors are reduced. Dehusking of seeds result in improvement of protein efficincy ratio, digestibility and cooking time is also considerably reduced from almost 2 hr to 30-45min.

VARIETIES : Number of improved varieties in horse gram are limited and they considerably vary from one state to next. Almost 99.0% varieties develop0ed in horse gram owe their origin from germplasm evaluations only, as given below:

Andhra Pradesh	:	PDM-1, VZM-1
Bihar	:	BR-5, BR-10, Madhu
Himachal Pradesh	:	HPK-2, KPK-4, HPK-5, HPK-6
Jharkhand	:	K-82, Birsa Kulthi
Karnataka	:	Hebbal Hurali-2, PHG-9, KBH-1
Rajasthan	:	Maru Kulthi, KS-2, AK-21, AK-42
Uttar Pradesh/Uttranchal	:	VLG-1

AGRONOMY : Horse gram is sown as a rainfed crop in poor soils in which most other crops may completely fail. In northern, India it is grown on onset of monsoonic rains. In Orissa it is grown in kharif in shallow red soils, gravelly soils and hard uplands, and also as post rainy season crop representing poor sandy soils in West Bengal on acid lateritic soils. In Karnataka it is grown in a number of system with a variety of crops in kharif.

Horse gram is widely grown as an intercrop with oilseeds (groundnuts, niger and sesame), millets (fingermillet and sorghum), maize, Amaranth, grasses (marvel grass, kidney bean) trees (*Albizia procerra*, neem, *A. nilotica*) in different states.

On black cotton soils and mixed red and black soils a system of broadbed and furrows graded at slopes of 0.4-0.6% has been successful for soil and moisture conservation. A seed rate of 30-50 kg ha^{-1} is used for different uses and purposes.

P deficiency is crucial for horse gram affecting plant growth and yield. Increase in P rates increases the uptake of N, P,K, Ca and Na by planbts. Generally 20-30 kg N and 50-60 kg P_2O_5 has been found optimum in horse gram.

PLANT PROTECTION : Horse gram even though a drought hardy crops yet is influenced by a number of diseases, like anthracnose, powdery mildew, dry root rot, leaf spot, arial blight and rusts, however, anthracnose, powdery mildew and yellow mosaic virus are most important diseases in various regions. Among insect pests, pod caterpillar, leaf minor, pod bug, pod fly, thrips, spotted borer, hairy caterpillar infest horse gram crop but pod borer and pod fly are most damaging.

CONSTRAINTS TO HIGH PRODUCTION :

1. The improved varieties being cultivated have basically been developed following pure line selection from the local germplasm. Thus, conventional breeding methodology needs to be taken up for over all improvement in yield, quality with shorter growth period for adaptation.

2. The cultivation of local land races with long maturity expose this legume towards considerable moisture stress particularly, during grain filling stage (terminal stress) resulting in low yield.

3. The pod shattering habit in local land races also causes considerable yield losses.

4. It is generally grown in poor soils with minimum agronomic inputs and without weeding by the tribals.

5. The crop is grown as second priority of the farmers on sub-marginal lands.

6. The role of this legume in various farming systems prevalent in its area of domain needs to be properly understood and worked out.

7. Horse gram is reported to be comparatively free from the attack of the pests and diseases. However, in certain agro-ecological ninches some disease-pests complex become important and cause considerable damage to the crop.

8. It is also attacked by storage pests (*Callosobruchus* sps.).

9. The technology developed for increasing the yield of this crop has not been disseminated to cultivators for achieving required yields.

10. Photo and thermo- sensitive nature of horsegram does not permit its horizontal expansion in non-traditional and remote regions.

IMPROVED VARIETIES

Horse gram a crop of high adaptive value, source of high protein content, having great medicinal and social uses is, grown in India under abrupt soil and climatic situations with less after care. It has not, however, been given due attention for its genetic upliftment, which is a cause of great concern. Besides, aforesaid merits, this drought hardy legume is attributed to various defects like, longer maturity, photo and thermo-sensitivity, poor harvest index and susceptibility to certain diseases, therefore, warrants its genetic improvement.

The crop is grown in marginal and sub-marginal lands with marginal inputs and after care, thus, varietal component becomes all the more important for accelerating productivity of this crop. Extension of varietal component is easy and farmers tend to rely considerably on varietal seed industry, it is therefore, desired to attach priority to this component of production. Almost 99% varieties so far developed have their origin from local germplasm. These developed varieties are specifically suited to specific zones or the states or even in northern or southern Indian situations only.

Earlier Co-1 variety was developed in 1970 by single plant selection in Ramanthapura district of Tamil Nadu. It gave 20-25% higher yield over local variety. In Karnataka two varieties Hebbal Hurali-1 and Hebbal Hurali-2 were developed in 1976 by selection. These varieties were early in maturity (90-100 days) as against 120 days for parents (PLKY-32 and EC-1460, respectively). Besides, improved in grain yield, their photo-insensitive nature allowed their cultivation through out the year.

Several varieties of horse gram different in seed color and maturity are cultivated throughout country. The seed may be brown, light red, grey, black or mottled. The important varieties of horse gram along with their important traits have been given in tabular form below (Table-1):

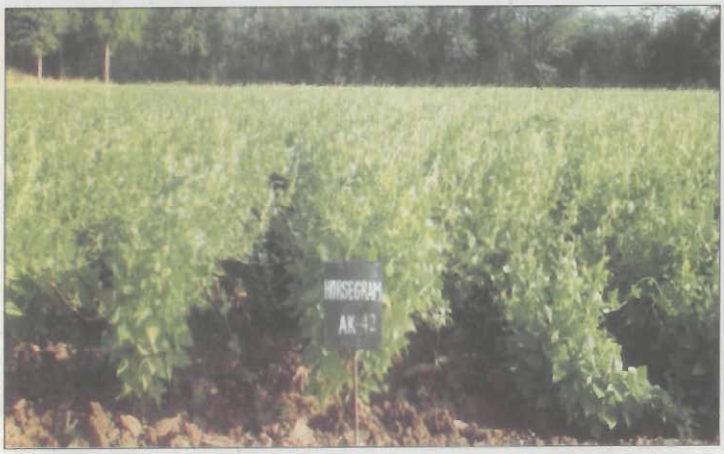
Table 1: Varietal status of horse gram in India.

S.No.	Variety	Maturity (days)	Yield (kg/ha)	Special characterization	State of adaptation
1.	Co-1	110-115	600-700	Suited for rainfed areas. It is a selection from Munduka Lathu rarea. Plants are trailing with brown seeds. It was released in1970 for Tamil Nadu.	Tamil Nadu

2.	Maru Kulthi	90-95	700-800	Released in 1989 for all India, it was selected from local material, and is semi-spreading type with light brown seeds.	Rajasthan
3.	Paiyur-1	110-115	650-750	Suited for rainfed areas of southern India (T.N.)	Tamil Nadu
4.	Paiyur-2	105-110	700-900	High production, suited for sesame-groundnut-ginger-horse gram crop sequence in rainfed regions of T.N.	Tamil Nadu
5.	Hebbel Hurali-1	90-100	1800-2000	Selection from PLKU-32, it is somewhat photo- insensitive.	Karnatka
6.	Hebbel Hurali -2	90-100	1800-2000	Selection from EC-1, it is photo - insensitive to some extent.	Karnatka
7.	HPK-2	120-130	900-1200	Selection from local germplasm of Himachal Pradesh. It is semi spreading type with light yellow seed colour and seed weight is 30-50 g/1000 - seed.	Himachal Pradesh
8.	HPK- 4 (Baiju)	120-130	800-1000	It is same as HPK 2, but seeds are dark grey in colour and mottled in shape.	Himachal Pradesh

9.	Madhu	105-110	850-1000	Selection from local germplasm. It has bushy habit, seed colour is dark cream with red spots, grains are medium bold.	Bihar
10.	PDM -1	100-105	1400-1600	It is a local selection from Bhimali Patnam, suitable for kharif sowing. Plant type is spreading, flowers are yellow with light purple wash, seeds are buff coloured.	Andhra Pradesh
11.	VZM - I	100-105	1200-1500	It is a local selection from Vizia Nagaram. Plants are tall, semi erect, flowers are light yellow with purple wash. Seeds are black, suitable for kharif planting.	Andhra pradesh
12.	Birsa Kulthi-1	92-97	800-1000	A selection from local germplasm, released in 1985 for Bihar state, slightly trailing growth habit. Flowers are light yellow with pink spot in the centre of petal, seeds are creamy, moderately resistant to *Macrophomina* leaf blight.	Bihar
13.	HPK-2	120-125	800-1000	A selection from local material, adapted to Himachal Pradesh, semi-spreading growth habit, seed colour light green. 100-seed weight 4.5 g.	Himachal Pradesh

14.	V.L. Gahat-1 (VLG-1)	125-130 (Hillls)	800-1000	A selection from local material, collected from U.P. hills, released in 1983 for Uttar Pradesh hills. Plants are semi-erect with spreading branches, foliage light green and thin. Seeds are medium in size, shining brownish yellow, tolerant to blight.	Uttranchal
15.	KBH-1 (BGM-1)	100-110	900-1000	A selection from Bailhongal local, released in 1990 for the state of Karnataka. bushy, gives out tendrils, photosensitive, tolerant to YMV, seed colour light brown.	Karnatka
16.	PHG-9	100-105	1000-1200	A selection from Palampur local, released in 1997 by CVRC for South India and in 1998 by SVRC (Karnataka) for Southern Karnataka	Karnatka
17.	AK-21	85-90	800-1000	An early high yielding variety, suited for northern India, released in 1999 by CVRC.	Rajasthan
18.	AK-42	80-85	850-1100	Improved over PHG-9 and AK-21 early maturing variety released in 2004 by CVRC	Rajasthan



HORSEGRAM-AK-42 (field view)

AK-42 (single plant)

HORSEGRAM-AK-21 (field view)

AK-21 (single plant)

HORSEGRAM-AK-1 (field view)

AK-1 (single plant)

MARU-KULTHI - 1

PHG-9

CARIDA-1-18R

CROP PRODUCTION

Horse gram is ordinarily cultivated by the poor farmers on poor soil for poor cause. After care used by these farmers is again poor in resources. Reason is neither the farmers are resourceful nor soil and climate - environments permit the same. Improved varieties therefore, remain their only choice. Thus, question is how to extract maximum from the genetic potential of a variety. The same becomes more important to utilizing most economic, easily and conveniently available resources from the farmers. It is, therefore, desired to tag most essential but effective production components which could bring productive changes and could win the confidence of traditional farmers. In this chapter therefore, it has been tried to concise most important production components those could prove useful in yield enhancement of horse gram in different regional and seasonal situations.

CLIMATE AND SOIL REQUIREMENTS : This crop is grown in different types of soils with poor fertility where no other crop can be grown in rabi as well kharif seasons. To be precise the climatic and soil requirements of this crop are given below:

State /region	Season	Soil/ crop sequence	Specific regions/ situations
Northern India	Onset of monsoon	Poor marginal shallow red soils	-
Orissa	kharif	Gravelly soils hard uplands	Kalahandi, Sambalpur Cuttuck
West Bengal	rabi/post rainy season	Poor sandy soils acid latric soils (pH5.5)	Other regions
Karnataka	Assured rainfall	Inter crop	Eastern belts (immediately western ghats)
	Late kharif	Sole crop in poor red sandy soil. relay crop in finger millet.	When finger millet is poor.
	Kharif Delayed monsoon	Double crop. Main crop.	After groundnut season, when pearl millet, finger millet and sorghum are difficult to be sown due to late monsoon.

CROPPING SYSTEM

INTERCROPPING SYSTEM: Horse gram has been profitably cultivated with various companion crops, grasses and trees. Some important components are given below:

i) **OILSEEDS** : Horse gram is cultivated in Andhra Pradesh as intercrop between two rows of groundnut and hybrid sorghum when the former is in flowering stage. At Ambikapur (MP) the highest economic return was obtained by planting one row between two rows of niger at 40 cm row spacing. Niger and horse gram in 2:1 ratio was also good system giving 107-131 kg ha^{-1} grain yield compared to 188 kg ha^{-1} in pure stand.

ii) **MILLETS :** Horse gram tried with finger millet in Karnataka and with cow pea and sorghum, did not give promising results.

iii) **MAIZE :** On alfisols of Bangalore horse gram alone was more profitable than intercropped with maize.

iv) **AMARANTH** : Amaranth - horse gram (1:1) inter cropping produced highest amaranth equivalent yield (4.05 t ha^{-1}) in Rani-Chauri (Uttranchal).

v) **TREES** : In Karnataka, horse gram yield decreased in agroforestry system (*A. nilotica, A. indica, A. procera*). However, seed yield was highest in these trees spaced in 15 m row.

DOUBLE/ SEQUENCE/ROTATION SYSTEM : On uplands of Orissa, horse gram is the only crop, can be taken after upland paddy, maize, sorghum in rabi. There was no significant difference in horse gram yield when grown in winter season following kharif rice, maize, sorghum or finger millet. Net returns were higher when horse gram was followed by maize, sorghum or finger millet.

AGRONOMIC MANAGEMENT

SEED BED PREPARATION : On light soils one tillage with sweep cultivator (15 cm deep) is sufficient. On red loam, black cotton and acid latric soils one ploughing (20 cm deep) with disc harrowing is commenced in kharif season for avoiding soil hardening. On soils where horse gram is sown late in August after rice or in rabi, tillage with disc harrowing may be done. After each rains hoeing up to 2-3 cm may be done for conservation of soil moisture.

OPTIMUM SEED RATE : In Konkan region of Maharashtra, seed yield was not affected due to seed rate and inter-row spacing, but a 40 kg seed rate with 30 cm row

spacing gave higher seed yield. In Bihar plateau region, a combination of seed rate of 50 kg ha^{-1} with 20 cm row spacing gave 20.6 q ha^{-1} seed yield, but there may not be difference in 30-40 kg ha^{-1} of seed rate.

OPTIMUM PLANTING TIME : The same varies in different states, situations and with wide range of planting dates showing wide variations in grain yield. Following table gives a comparative picture.

State/region	Sowing time	Remarks
H.P.	15-20 June	Yield decreased after 25th June
Rajasthan (Marwad region)	10-15th July	Poor yielding after late sowing.
M.P.	28th August	Yield decreased thereafter.
Bihar (Plateau region)	24th August	12.3 q ha^{-1} grain yield.
Maharashtra* (Solapur)	15th June -10th July	Optimum yield.
Karnataka** (late sown conditions)	20th August	8.29 q ha^{-1} grain yield.
Karnataka (Bangalore)	15th August	Delayed sowing gave poor yield.
Tamil Nadu	20-25 Oct.	Optimum yield
Maharashtra	11-12 July	Dry sowing gave higher yield.

* D40-1, K-42 varieties, **, BGM-1 varieties were used.

INTER AND INTRA-ROW SPACINGS : In general photo-sensitive varieties require wide spacing for early planting and close spacing for late planting. Some optimum spacings are given below:

Dharwad	30-35.5 cm	22-25 cm row spacing gave lower yield
Bangalore	37.5 cm	BGM-1 variety (late duration)
	30cm	HH-2 (early duration)
Tamil Nadu	30, 25 cm	HPK-5
	35 cm	Co-1

FERTILITY MANAGEMENT

Horse gram is known to utilize residual soil moisture and nutrients when cultivated after harvest of non legume crop grown in wet season. Finger millet grown after green manuring horse gram, gave 11.0 q ha^{-1} yields over sole finger millet at Bangalore. Thus, it is good source of green manuring.

P deficiency is very critical for horse gram, it decreased growth and biomass production; adverse effects were observed on leaf growth, it completely inhibited tertiary roots and decreased the weight of primary and secondary roots. Increased supply of P increased uptake of N,P,K,Ca and Na and growth of plants.

In HP hills, yield increased following 40-60 kg P_2O_5 ha^{-1}. In Koraput (Orissa) 15 kg N ha^{-1} gave the same yield as 30 kg N ha^{-1}. In Mayurbaing there was response of P for 37 to 60 kg P_2O_5 ha^{-1}. Thus, in general N @ 15 kg and P_2O_5 @ 40-60 kg ha^{-1} were observed optimum.

MICRO NUTRIENTS : Applications of 100 g Mo/ha proved superior over seed treatment and foliar application in latertic soils of West Bengal. Fe @ 60 ppm as foliar spray in the form of $FeSO_4$ increased yield by 20% by removing deficiency of Fe and Zn. Applications of 30kg S/ha increased straw and seed yield both. B:C ratio also improved with 30 kg S/ha. Application of 22.4 kg P_2O_5 ha^{-1} + *Rhizobium* inoculations in horse gram at Sambalpur (Orissa) increased nodules number, N and dry matter content of shoot and roots than either treatments leading to 44% yield increment.

ALLELOPATHIC EFFECTS : Growing horse gram and black gram near *Chir pine* forest is recommencded for better production. However, foliar and bark extracts of *Adina cordifolia* and *Grewia oppositifolia* inhibited germination of horse gram. Similarly combination of horse gram and *Digera muricala* were not compatible.

Horse gram incorporation at flowering and treatment of N_{30} + P_{30} kg ha^{-1} both improved soil quality parameters (soil organic carbon, status of P,K and S) and resulted in higher yield of sorghum and sunflower by about 28 and 18%, respectively on Alfisols of A.P.

PLANT PROTECTION

Horse gram an important arid legume is generally grown without agronomic and plant protection inputs. However, due to somewhat congenial situations with high humidity and appropriate temperature prevailing in northern hilly tracts and southern high rainfall zone, diseases may appear. The same may necessitate plant protection measures for sustaining production of this crop. It is, therefore, desired to formulate some plant protection strategies. Such strategies must be simple that farmers can afford including diseases resistant varieties and some organic means. Hence, some important diseases and insect pests which damage horse gram have been discussed below particularly for their symptoms and management measures.

DISEASES

i. Anthracnose (Colletotrichum lindemuthianum (Sacc. & Mogn.) Bri & Cav.

It is a major disease of horse gram, cow pea, black gram and beans

The most prominent symptom is a characteristic spotting on the pods. Firstly, water soaked lesions appear on the pods, later becoming brown and enlarging to form circular spots of varying size. The spots are usually depressed with dark centers, and bright red, yellow or orange margins. They may occur more often on the under surface of the leaf than on the upper surface and also occur on the petioles and stems. When the infections are severe on the leaf petiole and stem the affected parts may wither off. Often the seedlings are blighted due to infection soon after the seeds germinate.

Management : Crop rotation and field sanitation are convenient approaches to eliminate the disease. Seed treatment with carbendazim @ 2g/kg of seed will reduce the primary inoculum. The disease incidence in the field can be managed with carbendazim 0.1% spray.

ii. Powdery mildew : *Leveillula taurica* (Lev.) Arnaudi.

The powdery mildew disease is also one of the important diseases of horse gram. It can also be seen in other pulse crops, like cow pea, black gram, green gram etc.

Symptoms : A white powdery growth occurs on the leaves, spreading to cover the stem and other plant parts. The infection may take place at any stage of plant growth, but more severely when the plants are flowering and it persists until harvest. In severe cases, the entire plant becomes affected and wilted.

Management : Two sprays of calixin (0.05%) were found effective in controlling powdery mildew of horse gram with higher cost: benefit ratio. Since, this is not economical; attempts should be made to plant resistant varieties to combat the disease.

iii. Dry root rot : (*Macrophomina phaseolina* (Tassi) Goud.

Dry root rot can infect the horse gram at the time of flowering and pod formation stages. This disease can be seen in other crops like cow pea, black gram and green gram etc.

Symptoms : The first outward symptom of the disease is yellowing of the leaves. Within three or four days they drop off. The affected plants wilt and die within a week. The bark of the root and basal stem are fibrous and are found associated with black powdery mass of sclerotia of the fungus. The plants bear pods with partially filled seeds. The disease appears in patches and becomes severe during dry periods.

Management : Application of organic amendments like farmyard manure, neem cake and seed treatment with *Trichoderma viride* @ 4g/kg of seed and *Pseudomonas fluorescens* @ 10 g/kg of seed can reduce the disease incidence. Enhanced soil moisture can reduce the *M. phaseolina* population.

iv. Rust : *Uromyces phaseoli typica* Arth. (Syn.U. appendiculatus (Pers) Fries.

The rust disease can be seen in other pulse crops also.

Symptoms : The fungus produces characteristic rust pustules on the plant. The pustules are mostly found on the leaf blade. They are more conspicuous on the under surface of the leaves. Often a number of such pustules may occur on the same leaf. The infection may spread to young stem also. Plants with heavy rust infection will give a brown tinge when looked from a distance. In advanced stage of infection the leaf may wither resulting in considerable damage to the crop.

Management : Development of rust resistant varieties and adjusting the sowing dates of the crop to avoid severe infections of the plant in the field may help considerably in reaping better harvest.

v. Aerial blight : *Rhizoctonia solani* Kuhn

The disease can cause 10-60% loss depending upon the severity of the disease.

Symptoms : Aerial blight is seen on the foliage as irregular water soaked area. Under high atmospheric humidity the spots coalesce rapidly and cover a large part of the leaf lamina. There will be white mycelial growth also on the affected area. Severely affected leaves shed in large number.

Management : The management of the diseases caused by *R. solani* is difficult due to its sporophytic surviving ability in the soil. Use of soil fungicides may not be economical. Soil application of *Trichoderma viride*, *T. harzianum* and *Gliocladium virens* significantly reduce the mycelial and sclerotial production of *R. solani* .Use of resistant varieties will be the only economical control measure.

vi. Yellow mosaic :

Mung bean yellow mosaic gemini virus

Symptoms : Initially small yellow patches or spots appear on the green lamina. Young leaves first show the symptoms. In due course, the area of yellow discoloration increases in new growth and may completely turn yellow. The infected plants mature later and bear very few flowers and pods. The pods are small and distorted. The seeds are also reduced in size and are shriveled.

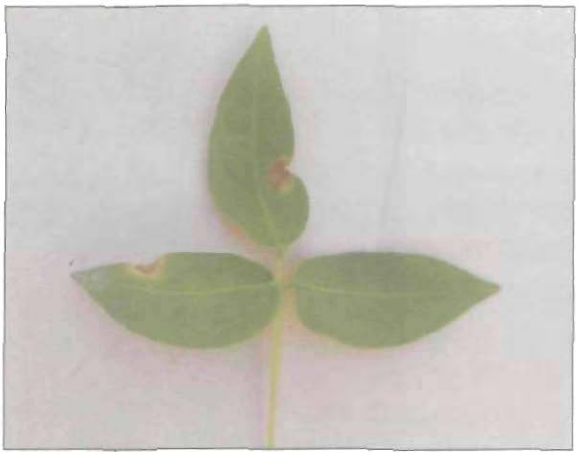
Management : Use of resistant cultivars for cultivation is one of the best strategies of disease management, removal of the infected plants and periodical spray with systemic insecticide Monocrotophos (0.1%) or neem oil soap emulsion (3% spray) and early sowing during first fortnights of August and September can minimize the disease incidence.

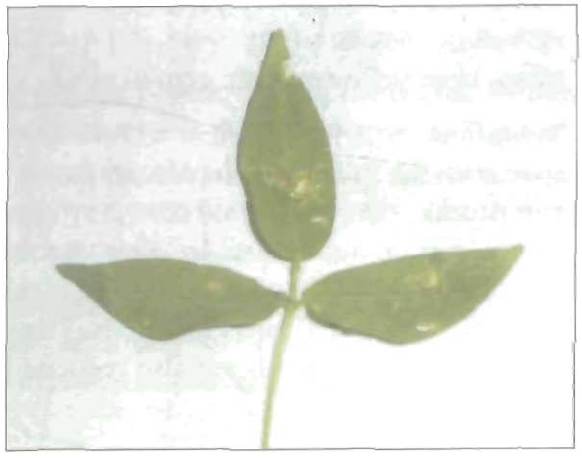
vii. Leaf spot : *Cercospora dolichi* Ell. &EVr.

The leaf spot caused by *Cercospora* can be noticed in other pulse crops also.

Symptoms : Usually water soaked lesions appear on the leaf blade and soon the affected tissues turn brown to reddish brown, well defined spots often bound by veins and purplish border develop. The centre of which may turn gray. Powdery growth, due to the sporulation of the fungus, may also be seen at the centre of the spots. Though the spotting is mostly confined to leaf blades, but occasionally may occur on the fruit and floral parts. In some cases, the affected tissue is killed and the dead portion drops out, leaving short-hole symptoms on the leaves.

Management : Seed treatment with Captan 3 g/ kg of seed can be used. Spraying the infected plant with Mancozeb (0.2%) can reduce the incidence of the disease.





INSECT PESTS

i. Pod fly : *Melanagromyza obtusa* M. (Family: Agromyzidae; Order: Diptera)

The adult is a small black fly with slight bright greenish tinge and glossy black abdomen. It lays eggs singly within pods by piercing the pericarp with its ovipositor. The eggs are needle shaped and can be seen projecting inwards from the walls of the pods. One pod may contain up to 5 eggs.

Management : Attract and kill the flies using fish meal trap or spray Carbaryl 50 wp @ 0.2% or Dimethoate 30 E @ 0.05% in the early stages of attack.

ii. Pod caterpillar :

Helicoverpa armigera (Hb) (Family: Noctuidae; Order: Lepidoptera)

This polyphagous species is an important pest of other pulses also. The adult moth has a V shaped specks on the light brownish forewings and a dark border on the distal end of hind wings. The adult lays sculptured spherical yellowish eggs with flattened bottom singly on tender leaves and shoot.

Damage : The young larvae feed on the tender leaves, buds and flowers for a short time and subsequently it bores into the pods and feeds on the seeds with its head and part of the body thrust inside, the rest of dorsally on the body.

Management : Attract and kill the nocturnal adults using light trap or pheromone lure. Spray the crop with *Helicoverpa* NPV @ $1.5X10^{12}$ POB/ha.

iii. American serpentine leaf miner :

Liriomyza trifolii Burgess (Family: Agromyzidae; Order: Diptera)

Adult is a very small (1-1.5mm) pale yellow fly. The eggs are trusted on the leaf surface.

Damage : The emerging maggots mine the leaves and feed on the mesophyll making serpentine on the leaves. Due to severe mining by the larvae and feeding punctures by the adult flies leads to defoliation of crop. Several maggots mine on a single leaf and infestation is usually seen on mature leaves.

Management : The pest infestation can be reduced by collection and destruction of first affected leaves and by spraying 5% neem oil emulsion on the leaves.

iv. Green leaf hopper : *Empoasca kerri* Pruthi (Family: Cicadellidae; Order: Hemiptera)

The adults are yellowish-green in color. Eggs are laid under side of the leaf, embedding them into the leaf veins. The winged adults are displaced at the slightest disturbances and are phototropic in nature.

Damage : Nymphs and adults, are generally confined to the underside of leaves, suck sap from veins and vein lets. As a result, tips of affected leaves become pale initially and later brown, turn upwards and get dried.

Management : Spray Dimethate 30EC (0.05%) to check the population build up of the pest. The pest can also be managed by spraying the crop with Imidacloprid @ 20 g ai/ha.

v. Pod bug : *Clavigralla gibbosa* S. & *C. horrens* D.(Family: Coreidae; Order: Hemiptera).

Damage : These greenish brown bugs and nymphs suck juice of unripe seeds from the green pods. The attacked pods show light yellow patches on their surface and they shrivel and die subsequently.

vi. Leaf roller : *Nacoleia vulgaris* Guen. (Family: Pyralidae; Order: Lepidoptera)

The moth is slender with yellowish brown. The moth lays flat scale-like eggs in rows on tender leaves.

Damage : The larva feeds on green matter of the leaves in its early stages. Later it webs together the leaves and feeds from within skeletonizing them completely. The damage caused in this way to the host plants is very serious. The pest attacks other pulse crops like cowpea, black and green gram during August to February. The caterpillar is parasitized by *Cardiochila fulvus* Cam. and *Xanthopimpla punctuator* L. and by a tachnid (Mammen and Jopesh,1975).

Management : Remove and destroy the rolled leaves which contain different stages of the pest.

Spotted pod borer damage

Poly damage in pods

Hairy Catterpillar damage

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