

Improved Production Technology for Kodo millet

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Foreword

Kodo millet is highly drought tolerant and therefore it can be grown in areas where rainfall is scanty and erratic. Kodo millet grain contains 8.3 per cent protein, 1.4 per cent fat, 65.6 per cent carbohydrates and 2.9 per cent ash with high fiber content and oxidant potential is much higher than any other millet and major cereals. The grain is recommended as a substitute for rice to patients suffering from diabetes disease. In India it is cultivated over an area of 1.96 lakh ha with total production of about 0.84 lakh tonnes and with productivity of 429 kg/ha during the year 2015-16. In India it is grown in Rajasthan, Uttar Pradesh, Tamil Nadu, West Bengal, Madhya Pradesh and Andhra Pradesh.

Low productivity in farmers' field in kodo millet can be increased by adopting good quality seed variety, agronomical, plant protection measures etc. This lucidly written farmer-friendly technical bulletin is a treasure trove of information on improved cultural practices in kodo millet cultivation.

This technical bulletin would help to know cultivation practices among farmers and extension personnel on the latest varieties, production and protection technologies, low cost technologies. I thank who are all responsible in bringing out this bulletin. I am sure this information given in this bulletin will assist the extension personnel, state department officials, students as well as other millet workers. I hope that this manual will prove valuable information to farmers for improved production technologies to increase yield.



(PRABHAKAR)

Project Co-ordinator
AICRP on Small Millets

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Introduction

Common name : Kodo
Vernacular Names : Kodo millet (English), Varagu, Haraka and Arikalu.
Family : Gramineae

Kodo millet is a highly drought resistance crop. It is the coarsest of all food grains. The kodo millet, also known as cow grass, rice grass, ditch millet. Native *Paspalum* or Indian Crown Grass originates in tropical Africa and it is estimated to have been domesticated in India 3000 years ago. The grain is covered with a horny seed coat which should be removed before cooking. The grain contains 8.3 per cent protein, 1.4 per cent fat, 65.6 per cent carbohydrates and 2.9 per cent ash. The fiber content of the whole grain is very high. The phosphorus content in kodomillet is lower than any other millet and its anti oxidant potential is much higher than any other millet and major cereals. The grain is recommended as a substitute for rice to patients suffering from diabetes disease.

In India, it is grown in Rajasthan, Uttar Pradesh, Tamil Nadu, West Bengal, Madhya Pradesh and Andhra Pradesh. In India it is cultivated over an area of 1.96 lakh ha with total production of about 0.84 lakh tonnes and with productivity of 429 kg/ha during the year 2015-16.

Climate

Kodo millet is grown mostly in warm and dry climate. It is highly drought tolerant and, therefore, can be grown in areas where rainfall is scanty and erratic. It is well thrive in areas receiving only 40 to 50 centimetre annual rainfall.



Soil

Kodo millet is grown from gravelly and stony upland poor soils to loam soils. Deep, loamy, fertile soils, rich in organic matter, are preferred for satisfactory growth. Well-drained soils with adequate moisture supply are required for uninterrupted growth of this crop.

Season

- Sowing with onset of monsoon is beneficial.
- Middle of June to end of July in different states
- Madhya Pradesh and Chhattisgarh: Last week of June to first week of July.



Varieties

A number of varieties with high yield potential have been released for different states.

Table 1 : Latest and popular varieties recommended for different states of India

Sl. No.	State	Varieties
1	Madhya Pradesh	JK 439, RBK 155, JK 13, JK 65 and JK 48, JK 137, RK 390-25, JK 106, GPUK 3, JK-98, DSP-9-1, TNAU-86
2	Tamil Nadu	KMV 20 (Bamban), CO 3, TNAU 86, GPUK 3, RK 390-25
3	Gujarat	GK 1, GK 2, GPUK 3, JK-13, JK-65, RK 390-25
4	Chhattisgarh	RBK 155 and JK 439, Indira Kodo-1, Indira Kodo-48, GPUK 3, JK-65, JK-98, Chhattisgarh-2, RK 390-25, TNAU-86
5	Karnataka	GPUK 3, RBK 155, RK 390-25, TNAU-86

Spacing

- Optimum spacing: Spacing of 22.5 cm between rows and 10 cm between plants.
- Line sowing is beneficial as it facilitates Intercultivation and weed management.



Seed rate

- 10 kg ha⁻¹ for line sowing
- 15 kg ha⁻¹ for broad casting.

Manures and fertilizers

- 5-7.5 t ha⁻¹ of farm yard manure
- Tamil Nadu, Madhya Pradesh and Chattisgarh: 40 kg N and 20 kg P₂O₅ ha⁻¹
- Other states: 20 kg each of NPK ha⁻¹
- High rainfall areas of Madhya Pradesh and Chattisgarh, nitrogen should be applied in 2 splits: half of the nitrogen at sowing and remaining half at 35-40 days after sowing.



Bio-fertilizers: Treating seeds with *Azospirillum brasilense* (nitrogen fixing bacterium) and *Aspergillus awamouri* (phosphate solubilizing fungus) @ 25 g kg⁻¹ is beneficial. The procedure for incorporating seeds with bio fertilizer as given for finger millet is followed.

Table 2 : Popular varieties and their special features

Variety	JK 13	JK 106	JK 65	DPS 9-1	Indira Kodo 1	Chhattisgarh kodo-2
Pedigree	Selection from mutant JK 76	Selection from Sidhi dist. germplasm	Selection from Sidhi dist. germplasm	Selection from local land race	Pure line selection	Mutant line of CO 3
Maturity (days)	95-100	100-105	105-110	105-110	100-105	95-100
Average yield (q/ha)	22-23	19-20	23-25	27-30	22-25	25-26
Special characters	Resistant to head smut and shootfly	Resistant to head smut and shootfly	Resistant to shootfly and moderately resistant to head smut	Tolerant to shootfly	Highly responsive to fertilizers, suitable for late sowing	Resistant to major insect pest, Early maturing
Area of adaptation	All Kodo millet growing areas of the country	M.P. State	All Kodo millet growing areas of the country	All Kodo millet growing areas of the country	Chhattisgarh	Chhattisgarh

Table 2 : Popular varieties and their special features (Continued)

Variety	TNAU-86	RK 390-25	Jawahar Kodo 137	JK -36	JK 155 (RBK 155)	GPUK 3
Pedigree	Pure line selection from IPS 85	Mutant of RK-390	Mutant of RK-390	Pure line selection	Selection from GPLMP 251	Pure line selection from GPLM 826
Maturity (days)	95-110	100-105	100-105	75-80	80-100	100-105
Average yield (q/ha)	27-30	25-28	26-29	10-12	20-22	18-20
Special characters	Early duration, non-lodging, milling recovery (52-53%)	Non-shattering and non-lodging	Suitable for sole as well as inter/mixed cropping, responsive to NPK, resistant to drought, lodging, and key pest Shoot fly and moderately resistant to head smut	Very early duration, Moderately resistant to shootfly	Resistant to head smut	Resistant to head smut and moderately tolerant to low moisture stress.
Area of adaptation	All Kodo millet growing areas of the country	All Kodo millet growing areas of the country	Rainfed areas of Madhya Pradesh	Madhya Pradesh	All Kodo millet growing areas of the country	Tamil Nadu, Gujarat, Madhya Pradesh, Karnataka, Uttar Pradesh and Maharashtra.



JK 155 (RBK 155)



GPK 3



TNAU-86



DPS 9-1



RK 390-25



RK 98

Cropping system

Inter cropping

- **Madhya Pradesh:** Kodo millet + Pigeon pea (2:1 ratio)
Kodo millet + Green gram/black gram (2:1 ratio).
Kodo millet + Soybean (2:1 ratio).

Crop rotation/Cropping sequence

- Kodo millet – soybean or Kodo millet or Kodo millet – niger - kodo millet crop was found to be sustainable system in Madhya Pradesh state.

Irrigation management

During dry periods, irrigations are required every 4-7 days depending on the severity of the drought and type of soil. First irrigation at 25-30 DAS and second irrigation at 40-45 DAS. Drain out the excessive rain water from the field during heavy and continuous rains.

Weed control

Important weeds: Among grassy weeds, *Echinochloa colonum*, *Enhinochloa crusgulli* (sawan), *Dactyloctenium aegypticum* (makra), *Elusine indica* (kodo), *Setaria glauca* (banra), *Cynodon dactylon* (doob), *Phragmites karka* (narkul), *Cyperus rotundus* (motha), *Sorghum halepanse* (banchari) are common. The broad-leaved weeds are *Celosia argentic* (chilimil), *Commelina benghalensis* (kankoua), *Phyllanthus niruri* (hulhul), *Solanum nigrum* (makoi) and *Amaranthus viridis* (chaulai).

Weed Control: It is essential to control weeds in the initial stages of plant growth. Generally two weeding at an interval of 15 days are sufficient. Weeding may be done with hand hoe or wheel hoe in line sown crop. Post-emergence application of 2, 4-D sodium salt (80%) @ 1.0 kg a.i./ha at 20-25 DAS. Isoproturon @ 1.0 kg a.i. /ha as pre-emergence spray is also effective in weeds control.

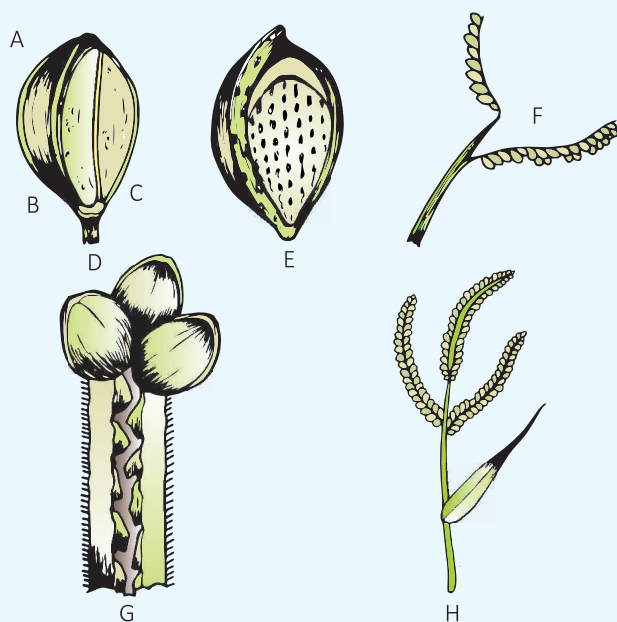
- Hand weeding twice around 20 and 35 days after sowing and 2-3 inter cultivations are necessary.
- In assured rain fall areas of Madhya Pradesh pre-emergence application of Isoproturon @ 0.5 kg a.i./ha is also effective in control of weeds.

Harvesting

In Kharif season, the crop becomes ready for harvest in the month of September or October in northern India and in Rabi season, it is harvested from January to February.

Yield

With improved package and practices; one can obtain 15-18 quintal grain and 30-40 quintal straw per hectare.



Kodo millet inflorescence and its parts

- (A) Upper floret; (B) Second glume; (C) Lemma of lower floret
 (D) Spikelet; (E) Floret; (F) Rachis; (G) Arrangement of rachis in spikelet;
 (H) Inflorescence

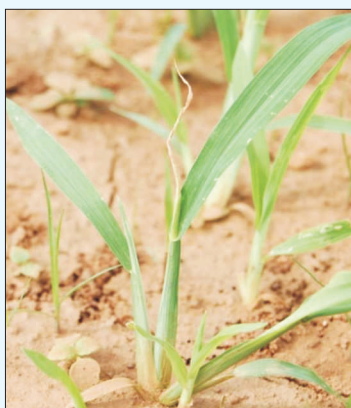
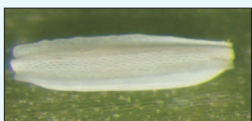
Table 3 : Insect Pests of Kodo millet

Common name & Scientific name	Nature of Damage	Management
Shoot fly (<i>Atherigona</i> spp.)	The damage of this pest is observed from sowing to six weeks of old crop. As result of it's feeding the central shoot starts drying and shows the typical symptoms of dead heart in the early stage and profuse tillering in the later stage, which are also affected. Damaged tillers may produce ear heads, but with no grains (white ears). Maximum incidence occurs during late July or early August.	• Early sowing of crop i.e. second fortnight of July or with the onset of monsoon. • Adopt higher seed rate (1.5 times the recommended seed rate) to make up for seedling mortality • Monitored by fishmeal trap • Soil application of phorate 8-10 kg/acre in furrow is effective in checking shoot fly infestation in kodo and little millet and gave higher yields. • Carbofuron 3G (1.5 kg ai/ha) as soil application was most effective in reducing shoot fly incidence in proso millet. • Spraying of quinolphos (2ml/lit) effectively reduced shoot fly infestation in little millet

Table 4 : Diseases of Kodo millet

Common name & Scientific name	Symptoms	Management
Brown Spot (Seedling Blight or Leaf Blight), <i>Alternaria tenuissima</i>	Appearance of brown to dark brown spots on the leaf lamina, especially in older plants where in the woolly growth of the fungus can be seen in the centre of the lesion, especially under high humidity conditions.	
<i>Sorosporium paspali-thunbergii</i> The disease is seed and soil borne	Head Smut infected kodo plants are stunted and almost all the panicles in the infected plants are converted into a long sorus ranging from 2.1 to 14.6 cm long and 0.1 to 0.6 cm broad. In early stage, the entire sorus remains surrounded by a creamy membrane. Sometimes, the sorus remains enclosed in the boot leaf and does not emerge fully. At maturity, the membrane of the sorus bursts and exposes the black mass of spores.	Seed treatment with chemicals such as Carboxin, Carbendazim, Mancozeb, Chlorothalonil and Thiram is useful.

Insect Pests and Diseases of Kodo millet



Egg, Maggot and adult of shoot fly

Central shoot drying
(dead heart)



Fish meal trap



Head smut



Leaf, stem and
Sheath blight

